

Firearms/Toolmarks Discipline Standard Operating Procedure for Physical and Visual Examinations

1 Scope

This procedure is designed for the evaluation and examination of physical and/or electronic evidence to determine whether items may be physically consistent with an item, reference sample, or test item based on the class and/or physical characteristics. This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following categories of testing:

- Firearms
- Toolmarks

Additionally, the following terms will be used throughout the procedure:

- ***Physical Characteristics***: Observable features of a specimen which indicate a restricted group source and are determined prior to manufacture (e.g., shape, color, design).
- ***Class Characteristics***: Measurable or discernible features of a specimen which indicate a restricted group source. They result from design features and are determined prior to manufacture.

2 Equipment/Materials/Reagents

- 3D topographical instruments
- Casting media
- Certified Reference Material
- Computer
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal Protective Equipment (PPE)
- Test media (e.g., lead, brass, copper)

3 Standards and Controls

Exemplars derived from evidentiary items during examination and reference materials serve as controls. When available, the following reference materials may be used:

- Reference Firearms Collection
- Reference Ammunition File
- General Rifling Characteristics database
- Other Government Agency databases
- Manufacturer's catalogues/literature
- Purchased databases
- Published literature
- Open source information

4 Performance Checks

Performance checks on measuring devices are required when those measurements may be utilized to make judgements regarding the further examination, classification, or comparison of an item, or to form conclusions regarding the item. See *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*. When measurements are taken simply to document the physical size or shape of an item, performance checks are not required.

5 Sampling

Not Applicable.

6 Procedures

6.1 Examination of Physical Evidence

6.1.1 Physical evidence is defined for these procedures as an item submitted for comparison based upon its class characteristics. Physical evidence can include various evidentiary items (e.g., photographs, tools, toolmarks, metal components, cartridges, bullet components, electronic files saved to disc).

6.1.2 If the physical evidence appears to have potentially probative trace evidence of value, consult with a trace evidence Examiner. If the trace evidence is determined to be of potential value, it will be preserved and recorded. Coordinate the removal and preservation of the trace evidence with a trace Examiner from the appropriate unit.

6.1.3 Ensure that evidence is marked in accordance with the provisions of the *FBI LOM Assigning Cases and Examination of Evidence*.

6.1.4 Determine any class and/or physical characteristics features of the physical evidence:

- | | |
|----------|--|
| • Weight | • Manufacturer information |
| • Height | • Type of action |
| • Length | • Design features |
| • Width | • Color, texture, mold marks, obvious alterations, etc |

6.2 Examination of Electronic Evidence

6.2.1 Electronic evidence is defined for these procedures as an item and/or request submitted for comparison based on its class characteristics. Electronic evidence can either be a known or questioned item (e.g., photographs and electronic files saved to disc).

6.2.2 Ensure the electronic evidence, when printed or copied, is labeled with the appropriate item identifiers.

6.2.3 Determine any class characteristics or observed features of the electronic evidence.

6.3 Conclusions of Class Characteristics Comparisons

6.3.1 Compare the class and/or physical characteristics of the evidentiary item to the class and/or physical characteristics of an item, reference sample or test item. Conclusions will reflect one of these possibilities:

- a. Elimination - the physical dimensions and/or design features of the evidentiary item is significantly different with an item, reference sample, or test item.
- b. Inconclusive – the physical dimensions and/or design features present for comparison are insufficient to form an opinion as to whether the evidentiary item is physically consistent with an item, reference sample, or test item.
- c. Association – the physical dimensions and/or design features of the evidentiary item is physically consistent with an item, reference sample, or test item.

6.4 Secondary Evidence

Any secondary evidence derived from a physical and visual examination(s) will be marked, recorded, and returned in accordance with the provisions of the *FBI Laboratory Quality Assurance/Operations Manuals* and the *FTD QAM Marking and Examination of Evidence*.

7 Calculations

When physical evidence is presented with a different dimensional scale than the reference item (object vs. photo), the comparison ratio calculation is suitable for comparison purposes.

$$\text{Comparison ratio: } \frac{A \text{ (short measurement)}}{B \text{ (long measurement)}}$$

8 Measurement Uncertainty

Not Applicable.

9 Limitations

A physical and visual examination is not for the purpose of source identification. An association conclusion of “physically consistent with” indicates a restricted group from which the evidence may have originated. Examinations of electronic evidence may be impacted by data quality and size of the item(s) in question.

10 Safety

Based upon the type of item(s) being submitted, appropriate safety measures should be employed during the examination. When handling physical evidence, the Examiner(s) or appropriately trained personnel should be mindful of the potential for biological hazards and take the necessary precautions.

Consult the *FTU Safety Protocols for Handling of Firearms and Ammunition* located in Appendix A of the *FTD SOP Firearm Examinations*.

11 References

FBI Laboratory Quality Assurance Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Operations Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Safety Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web, Accessed 5 February 2020.

Rev. #	Issue Date	History
5	10/02/17	Original issue for Firearms/Toolmarks Discipline, which includes Firearms/Toolmarks Unit and Scientific Analysis Unit/Toolmark Group. Existing document modified to include the Huntsville, AL satellite location.
6	03/02/20	Renamed and updated to reflect new name of document. Titles of reference FTD documents updated as needed. Minor edits for grammar and clarity throughout. Association Examinations renamed throughout the document to reflect new exam name "Physical and Visual Examination". Updated Scope to be consistent with Class Characteristic Conclusions in Section 6.3. Section 2 updated. Section 4 Performance Checks added. Expanded Section 6.1.4 to include additional class characteristics. Section 6.3 updated for consistency and 6.3.1(c) added to define an association conclusion. Section 8 Limitations also updated. SWGGUN ARK reference updated. Titles of reference FTD documents updated where needed.

Approval

Firearms/Toolmarks
Unit Chief

Redacted - Signatures on File

Date: 02/28/2020

Scientific & Biometric
Analysis Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/Toolmarks Discipline Standard Operating Procedure for Bullet Examinations

1 Scope

This procedure is designed for the evaluation and examination and comparison of bullet(s) bearing toolmarks. Bullet examinations include the evaluation of submitted items (e.g. bullets, bullet jackets, bullet cores, bullet fragments; referred to as bullets and/or item in the remaining document) to determine the value of any toolmarks that may be present, and the physical and microscopic examination of a bullet to determine a source conclusion.

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Firearms

Additionally, the following terms will be used throughout this procedure:

- **Toolmark:** Impressed and/or striated feature(s) created when a tool (harder object) makes forceful contact with an item (softer object) transferring physical and/or microscopic features.
- **Physical Characteristics:** Observable features of a specimen which indicate a restricted group source and are determined prior to manufacture (e.g., shape, color, design).
- **Class Characteristics:** Measurable or discernible features of a specimen which indicate a restricted group source. They result from design features and are determined prior to manufacture.
- **Subclass Characteristics:** Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.
- **Individual Characteristics:** Marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are produced incidental to manufacture and/or caused by use, corrosion, or damage.
- **Unsuitable:** An item bearing no class or individual characteristics for comparison.
- **Suitable:** An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV):** An item that may or may not bear class characteristics and contains individual characteristics having quality and/or quantity for a source conclusion comparison.
- **Limited Microscopic Marks of Value (LMOV):** Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **No Microscopic Marks of Value (NMOV):** Absent of individual characteristics for a source conclusion comparison.

- **Comparison:** The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.
- **Light Comparison Microscopy (LCM):** The use of connected optical microscopes to compare and evaluate microscopic features between two toolmarks.
- **Virtual Comparison Microscopy (VCM):** The use of software to compare and evaluate the digital reproduction of microscopic features between two toolmarks.
- **3D Toolmark Topographical Instrument (3D instrument):** A device that can measure and record the x, y and z positions of microscopic features contained within a toolmark and produce a digital reproduction of the toolmark.
- **Source Conclusion:** An Examiner's conclusion regarding the origin of a toolmark or fracture.

2 Equipment/Materials/Reagents

- Known exemplars
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal protective equipment (PPE)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars may include bullets (test fires) produced by a known firearm. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the measurement equipment will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

5.1 Statistical sampling is not applicable in the FTD.

5.2 Non-Statistical sampling is employed in the FTD. It is based on the training, experience and competence of the examiner. No assumptions are made regarding items/portions that were not selected for examination and Results of Examination in *Laboratory Reports* are specific to the items/portions that were examined.

6 Procedures

6.1 Evaluation of a Bullet Bearing Toolmarks

6.1.1 Review all previous observations of the item that were recorded in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.1.2 Ensure that the item and/or container has been properly labeled with the appropriate identifier.

6.1.3 Ensure that the item has been reviewed for any trace evidence that could be of probative value. It is at the discretion of the examiner to ensure coordination of the removal and preservation of trace evidence with the appropriate discipline examiner.

6.1.4 If no trace evidence is observed or has no probative value, the item can be cleaned in preparation for examination in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.2 Level 1 Analysis – Evaluation and Classification of a Bullet Bearing Toolmarks

6.2.1 Physical Characteristics

6.2.1.1 If possible, attempt to determine the physical characteristics of the bullet:

- Base type
- Composition
- Cannelure
- Type of bullet
- Weight

6.2.2 Class Characteristics

6.2.2.1 If possible, attempt to determine the class characteristics of the bullet:

- Caliber
- Diameter
- Groove Impression width
- Land impression width
- Rifling Number
- Rifling Direction

6.2.2.2 Refer to the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment* for guidance on recording general rifling characteristics (GRCs).

6.2.2.3 Class differences may result from intentional design decisions made by the manufacturer or from minor variations in tool dimensions or finishing methods that are within acceptable manufacturing tolerances for a particular tool.

6.2.3 Subclass Characteristics

6.2.3.1 Evaluate for any subclass characteristics in the toolmarks.

6.2.3.2 If possible, attempt to determine the impact on the comparison examination.

6.3 Level 2 Analysis (Microscopic) – Evaluation, Classification and Comparison of a Bullet Bearing Toolmarks

6.3.1 During the microscopic evaluation, observations may provide further information regarding the class and/or sub characteristics of the toolmarks.

6.3.2 Individual Characteristics

6.3.2.1 Evaluate the individual characteristics of any observed toolmarks to determine if the microscopic marks are of value for comparison purposes. Value refers to the significant quality and quantity of the individual characteristics present on an item. This evaluation can result in any of the following classifications:

NMOV	Microscopic marks are of <i>no value</i>	No microscopic comparison
LMOV	Microscopic marks are of <i>limited value</i>	Suitable for microscopic comparison
MOV	Microscopic marks are of <i>value</i>	Suitable for microscopic comparison

6.3.3 For test fired bullets, evaluate the working surfaces of the known barrel to determine if any manufacturing characteristics may assist in restricting and/or eliminating the influence of subclass characteristics.

6.3.4 All observations of a bullet bearing toolmarks, to include evaluations of physical, class, subclass and individual characteristics, will be recorded on the appropriate *FTD Worksheet* located in Appendix B of *FTD QAM Case Assignment, Records, Results and Verifications*.

6.3.6.1 For items with no observed class characteristics and NMOV, no further examinations will be performed.

6.3.8.1 For bullets with observed class characteristics and NMOV, additional information may be reported using other Standard Operating Procedures within the FTD (e.g., class characteristic database search, reference materials).

6.4 Level 2 Analysis (Microscopic)– Comparison and Pattern Matching

6.4.1 A comparison of bullets bearing toolmarks will be performed in accordance with the *FTD SOP Comparison and Pattern Matching*.

6.4.2 When an inconclusive or elimination conclusion is reached between bullets, a search of the FBI Laboratory's GRCs database may be performed in accordance with the *FTD SOP Class Characteristic Database Entries and Searches* to produce a list of firearms that could have fired the bullet(s).

7 Calculations

Using the following equation, the diameter of a mutilated bullet can be determined using the land and groove measurements (sum of land and groove measurements equals the circumference):

$$\text{Circumference} = \pi \times \text{diameter}$$

8 Measurement Uncertainty

Not Applicable.

9 Limitations

Identifiable microscopic marks may not be reproducible from shot to shot due to changing of the barrel, corrosion, leading, etc. Under such circumstances it may be impossible to identify the known test bullets with each other. Further, mutilated, corroded, and deformed bullets may be of no value for comparison purposes.

10 Safety

Take standard precautions for handling of all evidentiary items and measurement equipment. PPE should also be utilized.

11 References

Mathews, J.H., Firearms Identification, Vols. I-III, Charles C. Thomas, Springfield, IL (1977).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

"FTU Safety Protocols for Handling of Firearms and Ammunition", Appendix A, *FTD SOP Firearm Examinations*

Glossary of the Association of Firearm and Tool Mark Examiners, AFTE Training and Standardization Committee, 6th Edition, Version 6.030317.1.

Gunther, J.D., and Gunther, C.O., The Identification of Firearms, John Wiley, New York (1935).

Hatcher, J.S., Jury, F.J., and Weller, J., Firearms Investigation, Identification and Evidence, The Stackpole Co., Harrisburg, PA (1957).

Harris, Daniel C., Quantitative Chemical Analysis, 3rd ed., W. H. Freeman and Company, New York (1991).

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. Accessed 5 February 2020.

Rev. #	Issue Date	History
4	03/07/12	Updated section 8 for consistency with Revision 5, QAM. In sections 6.2.4 and 6.3.3, added reference to GRC SOP.
5	03/02/20	Updated Title of SOP, Reformatted Scope and added terminology to Section 1. Equipment listing updated in Section 3. Titles for referenced SOPs were updated in Section 3. Referenced new SOP in Section 4. Clarified sampling options in Section 5. Procedures were updated throughout Section 6. Referenced new SOPs in Section 6.41 and 6.4.2. Updated Section 8 title. Updated references in Section 11.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
 Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
 Technical Leader

Date: 02/28/2020

FBI Laboratory Firearms/Toolmarks Unit Shooting Incident Reconstruction

1 Scope

This procedure outlines the roles and responsibilities for Firearms/Toolmarks Unit (FTU) members deployed on a Laboratory Shooting Reconstruction Team (LSRT) and the methods for the examination of bullet trajectories and documentation of a Shooting Incident Reconstruction (SIR).

2 Equipment/Materials/Reagents

The Shooting Incident Reconstruction Kit (SIRK) is a hard shell case that contains and protects the equipment necessary to perform a SIR. The SIRK case includes the following equipment: Bullet Test Kit (BTK); trajectory and/or dowel rods of various calibers; string; angle finder; smart level; lasers; protractors; tape measures; basic tool kit; plumb bob; appropriate boots/protective clothing; calipers; compass.

3 Standards and Controls

Lead and copper bullets are used as a positive control when performing field processing of gunshot residue for distance determination and presumptive testing for lead and copper residues using the BTK. Chemical reagents for field examinations will be prepared as outlined in the Firearms/Toolmarks Unit, *Comprehensive Gunshot Residue Examinations in Muzzle-to-Target Distance Determination* procedure. Samples generated from these examinations that are used to reach a conclusion are considered secondary evidence and will be turned over to the requesting agency for chain-of-custody purposes.

4 Responsibilities

4.1 The Unit Chief (UC) will:

- Liaison with Evidence Response Team Unit (ERTU) or requesting agency
- Select examiner for Shooting Incident Reconstruction (SIR)
- Track FTU deployments
- Determine if additional firearms analysis will be necessary
- Ensure FTU LSRT members have received training for handling hazardous material

4.2 An LSRT FTU Examiner will:

- Communicate with ERTU or requesting agency
- Inspect SIRM before deployment
- Communicate with Operational Projects Unit (OPU)
- Ensure the proper documentation is collected which will provide an accurate representation for the SIR results of examination
- Write and issue a report containing the SIR results of examination

5 Calibration

Not applicable.

6 Sampling

Not applicable.

7 Procedures (Operations)

7.1 UC (or designee) LSRT Deployment Actions

7.1.1 When a request to support a SIR is received in the FTU, the UC will determine if the FTU has the necessary resources for supporting the operation.

7.1.2 The UC will select an examiner/team from the FTU to perform the SIR. The selection of an examiner/team will be on a rotating basis to ensure an even distribution of assignments. To track deployments, the rotation selection of examiners will be recorded on the FTU Share drive, LSRT folder. The UC will be responsible for maintaining this record.

7.1.2.1 Newly qualified examiners in the FTU will assist in supporting the LSRT on at least three responses before serving as the LSRT FTU examiner lead. Additionally, newly qualified examiners and/or technicians should complete the ERTU Basic Training course before being deployed on a LSRT.

7.1.3 Prior to deployment, communications will be established between the UC, ERTU, OPU, and/or the requesting agency. Pre-deployment communications will attempt to assess the conditions and safety of the scene, possible number of shooters and shots fired, and firearms that may have been involved or present. This information is necessary to evaluate the available resources that will be committed to supporting the operation.

7.1.4 During pre-deployment communications, the UC will determine if the FTU will be deployed in support of a SIR.

7.1.5 If possible, during pre-deployment communications with the requesting agency it should be determined if forensic firearms comparison examinations will be necessary and which agency will perform them.

7.1.6 Prior to deployment the UC will ensure that FTU members supporting the LSRT have successfully completed the Laboratory's safety program for handling hazardous materials.

7.2 FTU Deployment in Support of LSRT

7.2.1 On ERTU supported deployments, the ERTU designee will be the lead for the LSRT deployment.

7.2.2 The ERTU lead is responsible for operational orders and logistical movement of the LSRT during deployment.

7.2.3 While on scene, the ERTU lead manages the expectations of the investigative product being produced by the LSRT and will handle communications between the LSRT, Field responders, and Laboratory management.

7.3 LSRT FTU Examiner Lead

7.3.1 The LSRT FTU examiner lead is responsible for conducting a thorough examination, documenting the shooting scene, and conveying the expectations of the reconstruction capabilities to the ERTU lead and/or requesting agency.

7.3.2 The LSRT FTU examiner lead will be involved with pre-deployment communications and meetings to obtain information about the shooting scene to determine the equipment and FTU members necessary to successfully complete the SIR.

7.3.3 Prior to deployment, the LSRT FTU examiner lead will inspect the SIKK to ensure the necessary equipment is present for processing the scene.

8 LSRT FTU Examiner Lead Scene Responsibilities

8.1 The LSRT FTU examiner lead will provide guidance and information about the SIR to the ERTU lead while he/she consults with the agency in charge of the scene regarding the scope of work and details of the operation.

8.2 The LSRT FTU examiner lead will ensure the appropriate warrants are in place before proceeding with the SIR.

8.3 Prior to entering the scene, the LSRT FTU examiner lead will determine if a crime scene log is in place and sign before entering and leaving the crime scene.

8.4 Before conducting a SIR, the LSRT FTU examiner lead will perform an initial walk through of the crime scene with ERTU lead and/or person in charge to assess the scene and determine the order of operation.

8.5 The LSRT FTU examiner lead is responsible for conducting a thorough examination of the shooting crime scene and should discuss the expected order of operation with members of the LSRT.

9 Conducting/Processing SIR

9.1 Depending on the requirements of the scene, the following actions may be taken:

- Initial scene photographs
- Establish the position of the object being examined by assessing the scene/surroundings to determine the object's position in the local environment
- Search scene for evidence
- Photographs of evidence as found and marked
- Measurements of object(s), car(s), evidence, and room(s), if available, a total station (or similar equipment provided by OPU) may be used to record the position of objects
- The recovery of evidence is conducted by local agents and/or law enforcement – this should only be done after the evidence has been located in the local environment
- Identification and labeling of possible bullet holes and bullet impacts
- Photographs of object/car with holes/impacts labeled
- Measurement of holes/impact positions, if available, a total station (or similar equipment provided by OPU) may be used to record their positions
- Examination of the physical effects around holes/impacts, and possible hole diameters
- If necessary, conduct lead and copper residue tests around holes and impacts, positive and background controls must be performed
- Examination of cracking pattern/craters in automobile glass
- Evaluation of holes/impacts to determine their relationship to trajectories
- Establish trajectory using a trajectory rod, laser and/or string
- Measurement of trajectory angles (horizontal and vertical), either by directly measuring the angles from the rod or by measuring multiple three-dimensional (x, y, z) points on the trajectory rod. If available, a total station (or similar equipment provided by OPU) may be used to record multiple points on a trajectory rod.
- Photograph trajectories
- Close out walk through of the scene
- Scene release photographs

10 Calculations

The following equation can be used to determine a very approximate angle of impact for a bullet hole:

$$\text{Angle} = \sin^{-1} (\text{width/length})$$

where width equals the short dimension of the elliptical hole and length equals the long dimension of the elliptical hole.

11 Uncertainty of Measurement

Not applicable.

12 Limitations

Caution should be exercised in reaching conclusions about common trajectories and in establishing trajectory angles, taking into account appropriate uncertainties, zones or approximate positions. Additionally, due to vehicle glass breakage, bullet fragmentation, bullet deflection and many other factors, not all trajectories can be successfully reconstructed. Consequently, the number of trajectories reconstructed may not indicate the number of shots that were fired.

Presumptive chemical tests are not conclusive and are meant to provide additional information regarding the possibility of a bullet impact or passage. Although, presumptive tests are specific for lead and copper residues, they do not distinguish whether lead and copper are the result of a bullet or by another source.

13 Safety

Protective gloves, eyewear, boots and clothing should be available for protection from blood, broken glass and other environmental hazards. Additionally, due to the conditions present at the scene, it may be necessary to coordinate with ERTU to have a Safety officer present when performing a SIR.

14 References

SWGGUN.org, Guidelines for Projectile Path Reconstruction – Essential Elements

Haag, Lucien C., Shooting Incident Reconstruction, Academic Press, Burlington, MA (2006).

Pejsa, Arthur J., Modern Practical Ballistics, Kenwood Publishing, Minneapolis, MN (1989).

Stein, M., Leist, Y., and Tassa, M., "A New Field Kit for Bullet Hole Identification." Journal of Forensic Sciences, JFSCA, Vol. 29, No. 1, Jan. 1984, pp. 169-176.

FBI Laboratory, Quality Assurance Manual

FBI Laboratory, Operations Manual

FBI Laboratory, Safety Manual

FBI Laboratory, FTU Quality Assurance Manual

<u>Rev. #</u>	<u>Issue Date</u>	<u>History</u>
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation
1	11/05/07	Changed Title and Header from Bullet Trajectory Reconstruction. Sections 2 and 6.1.2 replaced BTR kit with Shooting Incident Response Kit (SIRK). Removed smartlevel and angle finder calibration information from section 4. Updated language used in sections 6.2.2 and 6.2.3.
2	04/01/13	Title redacted "Response" for "Reconstruction." Section 1 revised to include LSRT. Section 2 changed the name for SIRK, added BTK and compass. Section 3 was expanded for lead and copper tests controls for BTK and cited FTU practice for GSR. Section 4 changed to "Responsibilities" outlining the roles of members of LRST. Section 5 and 6 were formerly 4 and 5. Section 7 changed to "Operations" (formerly Calculations) outlines the actions steps during pre-deployment of LSRT. Section 8 "On Scene Operations." Section 9 "Conducting/Processing SIR" expanded elements for conducting SIR. Sections 10 through 13 were formerly 7 through 11. Section 13 added safety officer requirement.

Approval

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Firearms/Toolmarks Discipline Standard Operating Procedure for Comprehensive Gunshot Residue – Distance Determination Examinations

1 Scope

This procedure is to provide the Examiner with a protocol and processing sequence in conducting gunshot residue – distance determination examinations and the physical effects due to gunshots. This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Firearms

2 Equipment/Materials/Reagents

- Microscope (stereozoom)
- Camera (infrared capability if possible)
- Lens paper
- Lead and copper bullets
- Nitrite cotton swabs
- Personal protective equipment
- Cotton twill test cloth or equivalent
- Inertia bullet puller
- Fiber tape or equivalent
- Steel tape measure
- Felt marker or equivalent

3 Standards and Controls

Standards are not applicable.

Controls are handled as follows:

- A lead bullet is used as a positive control for the Sodium Rhodizonate Test (SoRho).
- Nitrite cotton swabs are used as the positive control for Modified Griess Test.
- A copper jacketed bullet is used as the positive control for the Modified Dithiooxamide Test (DTO).

4 Sampling or Sample Selection

Not applicable.

5 Procedure

5.1 Examination Sequence and Flow Chart

The *Gunshot Residues Examination Sequence Chart* (Appendix A) illustrates the procedural sequence of the visual and microscopic examinations and subsequent chemical processing. For the Modified Griess Test, DTO Test, SoRho Test, and the Modified SoRho Test there are decision points which are reached. Note that the Modified Griess Test always precedes the DTO Test and SoRho Test because the SoRho Test has the potential to chemically interfere with the results of the Modified Griess Test.

5.1.1 If a chemical reagent must be prepared before an examination, the following information must be recorded on the appropriate *FTU Chemical Reagent Log* (Appendix B): FTU Lot number (date the reagent was prepared), initials of preparer, performance check, parent chemical, FBI Laboratory Lot number and barcode (if available).

5.1.1.1 The FTU Lot number for reagents used during examinations will be recorded on the appropriate *FTD Worksheets* (Appendix D – *FTD Case Assignment, Records, Report Writing and Review*).

5.2 Visual and Microscopic Examination of Evidence

5.2.1 It should be noted that the initial examination is in regard to the observable physical characteristics and microscopic examination for residues which may be present.

5.2.2 Initially, a visual examination is performed to determine the presence of gunshot residues. A sketch(s) or photograph(s) is taken to record the item being examined and the relative position of hole(s) or gunshot residues is recorded. When visually examining clothing having a dark color or pattern, the use of infrared photographs can assist in the detection of gunshot residues.

5.2.3 Microscopic examinations are performed using a stereozoom binocular microscope with appropriate lighting. The examiner will be looking for various types of relevant physical effects and residues.

5.2.3.1 Indicative of/consistent with the discharge of a firearm:

- a. Vaporous lead (smoke).
- b. Particulate lead shavings or solidified droplets.
- c. Unburned gunpowder.
- d. Melted, adhering gunpowder.
- e. Soot

5.2.3.2 Indicative of/consistent with the passage of a bullet:

- a. A hole in an item.
- b. A visible ring around the perimeter of the hole (bullet wipe).

5.2.3.3 Indicative of/consistent with a contact shot:

- a. Ripping, tearing.
- b. Burning, singeing.
- c. Melted synthetic fibers.
- d. Heavy vaporous lead residues (smoke).

5.2.4 Data regarding these physical effects and visible residues will be recorded on the appropriate *FTD Worksheets*.

5.3 Chemical Residues and Their Processing

5.3.1 After completion of the microscopic examinations, certain chemically specific, chromophoric tests are conducted for the various types of gunshot residues. The initial test, *FTU SOP The Modified Griess Test for Nitrite Residues*, is directed toward the detection of deposits of nitrite compounds from burned or partially burned gunpowder around a suspected bullet hole or patterns of suspected shot pellet holes.

5.3.2 *FTU SOP The Dithiooxamide Test for Copper Residues* (DTO) is directed toward the detection of copper residues which might be present from the firing of a copper jacketed bullet. These residues include particulate and vaporous copper and “bullet wipe,” a ring-shaped deposition often found around the perimeter of a bullet hole.

5.3.3 *FTU SOP The Sodium Rhodizonate Test for Lead Residues* (SoRho) is directed toward the detection of any type of lead residue which might be present. This would include vaporous lead (smoke) usually associated with closer ranges, particulate lead and “bullet wipe,” a ring-shaped deposition often found around the perimeter of a bullet hole.

5.3.4 The results of these tests will be recorded on the appropriate *FTD Worksheets*.

5.4 Interpretation of Results

5.4.1 Gunshot residue – distance determinations are a result of residues detected on an item of evidence. The absence of residues is not a basis for expressing a distance determination. The results of the SoRho Test should be consistent with the results of the Modified Griess Test at a particular muzzle-to-target distance and with any physical effects present.

5.4.2 The Contact Shot: A contact shot is based on the presence of very characteristic ripping and tearing of an item, the burning and singeing of cloth, the melting of synthetic fibers, and the heavy vaporous lead (smoke) deposits around the suspected bullet hole.

5.4.3 Nitrite Residues: With increases in muzzle-to-target distances, patterns of detectable nitrite residues around a suspect bullet hole vary in size and density. When a pattern of nitrite deposits is found, it is possible to reproduce this pattern using the submitted firearm and ammunition in combination. When only scattered nitrite residues are found, it is possible to find the maximum distance to which such residues are deposited, using the submitted firearm and ammunition in combination.

5.4.4 Copper Residues: Particulate and vaporous copper is characteristically deposited at close ranges and is chemically detectable utilizing the DTO Test. Copper bullet wipe is consistent with the passage of a bullet and cannot determine distance.

5.4.5 Vaporous Lead/Lead Residues: Vaporous lead deposits are characteristically deposited at close ranges and are chemically detectable utilizing the SoRho Test and Modified SoRho Test. Such residues are produced to a particular maximum distance, which is determined utilizing the suspect firearm and ammunition in known-distance tests. Lead bullet wipe is consistent with the passage of a bullet and cannot determine distance.

5.5 Known-Distance Tests

5.5.1 When reproducing residue patterns detected on evidentiary items, it is essential that the suspect firearm and ammunition like the suspect ammunition be used in the known-distance tests. Patterns of residues will vary with changes in or to ammunition, barrel length, caliber, and powder charge.

5.5.2 For the majority of situations, white cotton twill cloth is suitable as a test target media. However, there may be instances where the characteristics of the evidence item are unusual enough to preclude meaningful test patterns with the cotton twill cloth. In such cases, it may be necessary to duplicate the evidence material, or to utilize a portion of the evidence item for firing known-distance tests.

5.5.3 When reproducing test patterns of residues, it is appropriate to fire known-distance targets that will produce test patterns both smaller and larger than the residues found on the evidence item. Using the most similar test patterns, a “bracket” is established to include the evidence pattern. Such a “bracket” should be wide enough, typically a foot¹ in width when outside near contact/contact, to account for differences expected in commercially manufactured ammunition and variations normally expected from shot-to-shot. A reported “bracket” must be verified by a second examiner and supported by known-distance tests performed at the same distances reported.

5.5.4 When certain types of residues are found, it is necessary to find the maximum distance to which these residues are projected from a firearm. The procedure in these instances is to gather data that can be used to establish the distance at which the particular residue is always

¹ Dillon, J.H., “A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations,” AFTE Journal, Vol. 22, No. 3, 1990, pp. 266.

found, and the distance at which it is never found in known-distance tests. This forms a bracket for the maximum distance situation for a particular type of residue.

6 Calculations

Not applicable.

7 Measurement Uncertainty

Not applicable.

8 Limitations

The Modified Griess Test, DTO Test, SoRho Test and Modified SoRho Test yield reactions to nitrite, copper and lead residues, respectively, regardless of whether or not these residues are in fact the result of the discharge of a firearm. Distance determinations reached as a result of gunshot residue examinations must be based on residues found to be present, not on the absence of residues.

Distance determinations involving a wound and/or injury are outside the scope of this procedure.

9 Safety

The safety procedures set forth in the Modified Griess Test, DTO Test and SoRho Test procedures should be followed. When firing known-distance tests, the safety protocols and range rules will be followed.

Reagent solutions should be prepared in a manner consistent with current Safety Data Sheet provisions regarding acids and bases. For disposal of the chemicals used for this procedure, refer to the *Hazardous Waste Disposal (Section 5 - FBI Laboratory Safety Manual)*, which is maintained on the Laboratory Division SharePoint site.

10 References

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. 28 November 2018.

Dillon, J.H., “A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations,” AFTE Journal, Vol. 22, No. 3, 1990, pp. 257-274.

Lekstrom, J.A., Koons, R.D., “Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test,” Journal of Forensic Sciences, Vol. 31, No. 4, 1986, pp. 1283-1291.

Schous, C.E., “A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues,” AFTE Journal, Vol. 31, No.1, 1999, pp. 3-8.

FBI Laboratory Quality Assurance Manual, latest revision.

FBI Laboratory Operations Manual, latest revision.

FBI Laboratory Safety Manual, latest revision.

FTD Quality Assurance Manual, latest revision.

“FTU Safety Protocols for Handling of Firearms and Ammunition”, Appendix E, *FTD QAM – Mission Statement, Administrative, and Operational Guidelines*, latest revision.

Rev. #	Issue Date	History
7	04/01/13	Throughout document changed Sodium Rhodizonate to SoRho where appropriate. Section 3 added “FTU Chemical Reagent Log” and clarified documentation for reagent log. Section 6.4.5 redacted “only if”. Section 9 added “Test” for. Section 9 added second paragraph on limitations for wounds. Section 10 added GSR room. Updated references in Section 11 by adding SWGGUN.org. Corrected spelling error in Appendix B FTU Chemical Reagent Logs.
8	03/02/18	Title was updated and muzzle-to-target reference was removed. Scope was updated for clarity and application to FTD personnel. Formatting changes were made to Sections 2 and 3 that included additions of tables. Removed Section 4 titled Calibration, renumbering was completed in remaining sections. Formatting change to Appendix A title reference in Section 5.1 and 5.2.1. Moved chemical reagent preparation instruction under Section 5.1. Added soot to 5.2.3.1 listing. Made reference to FTD Worksheets in Section 5.2.4. Details about the bracket generated and the verification process for a reported bracket were added to Section 5.5.3. Updated procedural reference for chemical disposal in Section 9. Reference section was updated including FTD reference. Updated formatting of Appendix A.
9	04/17/19	Updated Appendix B, specifically the <i>FTU Chemical Reagent Log – Modified Griess Test Media Preparation</i> .

Approval

Redacted - Signatures on File

Firearms/Toolmarks
 Technical Leader

Date: 04/16/2019

Firearms/Toolmarks
 Unit Chief

Date: 04/16/2019

QA Approval

Quality Manager

Date: 04/16/2019

Appendix A: *FTU Gunshot Residues Examination Sequence Chart*

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Appendix B: *FTU Chemical Reagent Log – 1.0 pH Potassium Chloride Buffer Solution*

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Appendix B: *FTU Chemical Reagent Log – 2.8 pH Bitartrate/Tartaric Acid Buffer Log*
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Appendix B: *FTU Chemical Reagent Log – 5% Hydrochloric Acid Solution*

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Appendix B: *FTU Chemical Reagent Log – 15% Acetic Acid Solution*

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Appendix B: *FTU Chemical Reagent Log – Nitrite Positive Control Swabs*

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**FBI Laboratory
Firearms/Toolmarks Unit
The Dithiooxamide Test for Copper Residues**

1 Scope

The Dithiooxamide Test (DTO) is designed for detecting depositions of vaporous and particulate copper around a suspected bullet hole. Such depositions may be on evidence items such as clothing, furniture, bedding, and wallboard.

2 Equipment/Materials/Reagents

Electronic balance (minimum weighing range must exceed 0g - 50 grams, but not exceed 0 - 3000 grams; the linearity specification must not exceed 0.1 gram); Microspatula; Filter paper; Aerosol spray equipment; Blotters/brown wrapping paper; Glass stirring rod; Disposable PVC gloves; Hot plate/magnetic stirrer; Polyethylene bottles; Laboratory coat; Glass beaker (500 mL); Exhaust hood; Ammonium Hydroxide (reagent grade or better); Concentrated ammonium chloride (reagent grade or better); Dithiooxamide (reagent grade or better), Potassium Chloride (reagent grade or better), Hydrochloric acid (reagent grade or better).

3 Standards and Controls

Standards are not applicable. A copper jacketed bullet is used as a positive control for the DTO Test. If a chemical reagent must be prepared before an examination, the following information must be recorded on the FTU Chemistry Log (Appendix C): chemical produced, preparer, date (lot number), parent chemical, FBI Laboratory serial number and the performance check. The chemical lot number for reagents used during examinations will be recorded in the examination notes.

4 Calibration

Not applicable.

5 Sampling

Not applicable.

6 Procedures

6.1 Preparation of Reagents and Test Media

6.1.1 Storage of prepared chemicals and test media should be such that contamination is not possible. Storage containers should be kept sealed until the contents are needed. Fractions or multiples of the weights and volumes indicated may be used as appropriate to the amount of work to be done. For disposal of the chemicals used for this procedure, refer to the Guideline for Hazardous Waste Management in the Firearms-Toolmarks Unit (FTU), copies of which are maintained in the FTU Chemistry Room.

6.1.2 Reagents for the Dithiooxamide Test (DTO)

6.1.2.1 Add 500mL of ammonium hydroxide to 500mL of distilled water (dH₂O) – 50% Ammonium Hydroxide solution. Properly label storage and applicator containers.

6.1.2.2 Add 0.2 grams of dithiooxamide (DTO) to 100mL of ethanol (C₂OH) – DTO solution. Properly label storage and applicator containers.

6.1.3 Reagents for the Modified Sodium Rhodizonate Test for Use with DTO

6.1.3.1 Dissolve a small amount of sodium rhodizonate in distilled water to prepare a saturated solution. Make enough for immediate use, 150mL should be sufficient. Do not store solution.

6.1.3.2 Add 0.75g of potassium chloride (KCl) in 50mL of distilled water (dH₂O) – 0.2M KCl.

6.1.3.3 Add 5mL of concentrated hydrochloric acid (HCl) to 295mL of distilled water (dH₂O) – 0.2M HCl.

6.1.3.4 Combine the 25mL of 0.2M KCl with 67mL of 0.2M HCl to make a potassium chloride buffer with pH 1.0. Properly label storage and applicator containers

6.2 Preparation of Controls

6.2.1 Positive Control

A copper jacketed bullet from the FTU ammunition room will be wiped across a piece of test material and the material then processed for the expected green color (ranging from forest green to army green/gray) reaction. The results will be recorded in the examiner's notes.

6.2.2 Negative Control

Observing the absence of any color development on the non-wiped portions of the test material is sufficient for a negative control. The results will be recorded in the examiner's notes.

6.3 Direct Application to Light-Colored Items of Evidence

6.3.1 Saturate the questioned item using a spray bottle with the prepared solution of ammonium hydroxide. Allow the item to sit for a minimum of one minute.

6.3.2 Saturate the questioned item using a spray bottle with the prepared solution of DTO. Note the color change immediately after applying. The presence of a yellow color may be attributed to lead and should not be misinterpreted as copper at this step.

6.3.3 Allow to air dry for five minutes before proceeding to additional chemical testing.

6.4 The Method for Dark-Colored Items that Would Mask the Green Coloration of a Positive Test Result

6.4.1 Place a piece of filter paper over the appropriate area of the questioned item.

6.4.2 Index the filter paper relative to the garment or other item to indicate the location of such things as suspected bullet holes, seams, buttons, button holes, pockets, rips, and tears. Indexing in pencil is preferable since ink may bleed during the application of reagents.

6.4.3 Uniformly dampen the filter paper on the questioned item by spraying with a 50% solution of ammonium hydroxide.

6.4.4 Press the saturated filter paper against the surface of the item for approximately two minutes.

6.4.5 Remove the filter paper which was in direct contact with the evidence item, and process it using the steps in 6.3.2 above. Note any positive (green) indications.

6.4.6 Prompt note-taking is essential in that sometimes the color change can be unpredictable and can rapidly fade. When dry, filter paper should be properly marked in ink for future identification and returned to the contributor as secondary evidence.

6.5 The Dithiooxamide Test for use with Modified Griess and Sodium Rhodizonate Test

6.5.1 Perform the Modified Griess Test, see Firearms/Toolmarks Unit (FTU) *The Modified Griess Test for Nitrite Residues* procedure.

6.5.2 Perform the Dithiooxamide Test as outlined in Sections 6.1 through 6.4.6.

6.5.3 Perform the Modified Sodium Rhodizonate Test as outlined below.

6.5.3.1 Saturate the questioned item using a spray bottle with the prepared solution of sodium rhodizonate. Allow the item to sit for one minute. The item should turn a yellowish orange color.

6.5.3.2 Saturate the item with the KCl buffer at pH 1.0 using a spray bottle. Allow the item to sit for a minimum of five minutes. A purple reaction indicates the presence of lead. Note the color change.

6.5.3.3 If a strong yellowish orange color from the sodium rhodizonate persists, apply more KCl buffer at pH 1.0 until it fades.

7 Calculations

Not applicable.

8 Uncertainty of Measurement

Not applicable.

9 Limitations

The Dithiooxamide Test yields results for the presence of copper regardless of whether these are related to the discharge of a firearm or the passage of a bullet.

10 Safety

Since many of the procedures involve the spraying of reagents in an aerosol form. All spraying should be done in an exhaust hood that has an air flow velocity of 60 - 120 feet/minute. Protective latex or vinyl gloves will be worn at all times.

11 References

Lekstrom, A. J. and Koons, R.D., "Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test," J. Forensic Science, 1986; 4:1283-1291.

Schous, C. E., "A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues," AFTE Journal,

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

FBI Laboratory, FTU Quality Assurance Manual

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB-Internati accreditation.
1	02/19/07	Updated section 3 including the use of the FTU Chemistry Log (Appendix C).
2	12/15/09	Removed "modified" from Sections 1 and 9. Added reagents to Section 2. Revised Sections 4, 5, 7 and 8 for consistency. Added new Section 6.1.2 as a heading and renumbered subsections. Added section 6.1.3 including subsections. In Sections 6.1.2.1 added labeling of reagent bottles. Updated language in Section 6.3.1. Removed "that" from second sentence in Section 6.4.5. Revised Section 6.4.6 to reflect secondary evidence policy and removed language that allowed negative results to be discarded. Added section 6.5.
3	07/14/10	Redacted FTU Technical Procedures manual in section 6.1.1 and changed heading in section 6.5.
4	02/08/12	Updated title and page numbering error.

Approval

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FBI Laboratory Firearms/Toolmarks Unit Ejection Pattern Testing

1 Scope

This procedure is designed to provide a basis for defining the approximate position of a shooter's firearm in the reconstruction of a shooting scene environment.

2 Equipment/Materials/Reagents

Steel tape measure; test ammunition; hearing protection; safety glasses; firearm; marking materials for floor (tape, chalk, string, etc.); graph paper; pen; laboratory coat.

3 Standards and Controls

Not applicable.

4 Calibrations

Not applicable.

5 Sampling

Not applicable.

6 Procedures

6.1 General Procedures

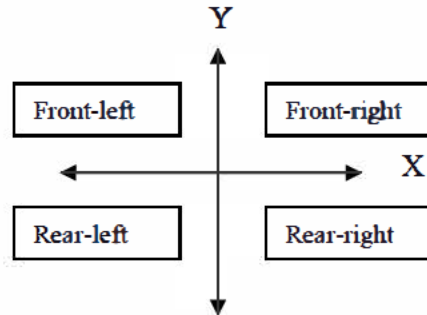
6.1.1 Before conducting this test, ensure that all other requested firearms examinations have been conducted.

6.1.2 The ejection pattern test will be conducted on a firing range that is clear of any previously fired ammunition components.

6.2 Specific Procedures

6.2.1 The floor/ground will be marked in some manner with two intersecting lines to form a

Cartesian coordinate plane. One line is from the shooting line traveling down the center of the shooting lane. The second line will cross this line at a right angle, and these lines may be extended as needed. The suggested "grid" divides the area into four quadrants (front-left, front-right, rear-right, rear-left).



6.2.2 This test requires two people; one person to be the shooter, and the other person to act as the spotter. The shooter will stand so that the intersecting lines on the floor are below the ejection-port of the firearm. The shooter will hold the firearm at a normal height and fire on a level trajectory.

6.2.3 The shooter will fire the suspect firearm a minimum of ten (10) shots.

6.2.4 It is the spotter's responsibility to mark where each ejected cartridge case first strikes the floor/ground. This may be done with tape or some other marking device. The spotter will also make notes as to the shooter's position and firearm height as well as any functional problems.

6.2.5 After all shots are fired and their respective strikes marked, measurements and notes will be made as to the location of the ejected cartridge cases. The ejected position will be determined using the Cartesian coordinate plane (i.e., 3 feet right and 4 feet rear).

6.2.6 Conclusions will be drawn based on the shots fired and the positioning of the ejected cartridge cases.

6.2.7 The ten (10) recorded locations will be calculated three standard deviations from the mean for determining ejection pattern.

7 Calculations

$$\text{Mean} = x_m = (\sum_i x_i) / n$$

$$\text{Standard Deviation} = S =$$



8 Uncertainty of Measurement

If a quantitative numerical measurement result is included in an FBI Laboratory *Report of Examination* (7-1), the uncertainty of measurement must be reported. The method used to determine the estimation of uncertainty can be found in the FTU's Quality Assurance Manual - *Uncertainty of Measurement*.

9 Limitations

Several conditions (orientation of the firearm when fired, walls or intervening objects, floor or ground surface variability, inadvertent movement of cartridge cases by first responders) may affect the final location of fired cartridge cases at a shooting scene. The test results establish an approximate ejection pattern boundary and are only valid for the firearm tested along with the magazine and type of ammunition used.

10 Safety

Hearing and eye protection must be worn by all participants and observers when test firing. Safety protocols and range rules will be followed at all times.

11 References

William J. Lewinski, Ph.D., William B. Hudson, Ph. D., David Karwoski, Christa J. Redmann, "Fired Cartridge Case Ejection Patterns From Semi-Automatic Firearms," Investigative Science Journal, Volume 2, Number 2, November 2010.

Garrison, D.H., "Reconstructing Drive-By Shootings from Ejected Cartridge Case Location," AFTE Journal, 1993;25(1):15.

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

FTU Quality Assurance Manual

Firearms/Toolmarks Unit, FBI Laboratory, FTU Controlled Document FTU007, "Safety Protocol for Handling of Firearms and Ammunition."

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation.
1	07/14/10	Updated references.
2	05/02/13	Section 1 included statement about approximate position a firearm. Section 2 deleted "pencil." Section 6.2.1 added Cartesian plane with diagram. Section 6.2.5 added Cartesian plane with measurement example. Section 6.2.7 added calculation of standard deviation. Section 9 included limitation from report writing language and ejection pattern boundary. Section 11 updated and deleted date from FTU007.

Approval

Redacted - Signatures on File

Firearms/Toolmarks Discipline Standard Operating Procedure for Cartridge Case Examinations

1 Scope

This procedure is designed for the evaluation and examination of cartridge cases and shotshell cases (referred to as cartridge case throughout the remaining document). Cartridge case examinations include the evaluation of submitted items to determine the value of any toolmarks that may be present, and the physical, class and microscopic examination of a cartridge case to determine a source conclusion. In addition, this procedure outlines the methods for virtual comparison microscopy (VCM) that may be performed utilizing an approved three-dimensional toolmark topographical instrument (referred to as 3D instrument in remaining document) by the Firearms/Toolmarks Unit (FTU).

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Firearms

Additionally, the following terms will be used throughout the procedure:

- **Toolmark:** Impressed and/or striated feature(s) created when a tool (harder object) makes forceful contact with an item (softer object) transferring physical and/or microscopic features.
- **Physical Characteristics:** Observable features of a specimen which indicate a restricted group source and are determined prior to manufacture (e.g., shape, color, design).
- **Class Characteristics:** Measureable or discernible features of a specimen which indicate a restricted group source. They result from design features and are determined prior to manufacture.
- **Subclass Characteristics:** Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.
- **Individual Characteristics:** Marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are produced incidental to manufacture and/or caused by use, corrosion, or damage.
- **Unsuitable:** An item bearing no class or individual characteristics for comparison.
- **Suitable:** An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV):** An item that may or may not bear class characteristics and contains individual characteristics having quality and/or quantity for a source conclusion comparison.

- **Limited Microscopic Marks of Value (LMOV):** Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **No Microscopic Marks of Value (NMOV):** Absent of individual characteristics for a source conclusion comparison.
- **Comparison:** The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.
- **Light Comparison Microscopy (LCM):** The use of connected optical microscopes to compare and evaluate microscopic features between two toolmarks.
- **Virtual Comparison Microscopy (VCM):** The use of software to compare and evaluate the digital reproduction of microscopic features between two toolmarks.
- **3D Toolmark Topographical Instrument (3D instrument):** A device that can measure and record the x, y and z positions of microscopic features contained within a toolmark and produce a digital reproduction of the toolmark.
- **Source Conclusion:** An Examiner's conclusion regarding the origin of a toolmark or fracture.

2 Equipment/Materials/Reagents

- 3D instruments, equipment and materials
- Known exemplars
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal protective equipment

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars may include cartridge cases (test fires) produced by a known firearm. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the measurement equipment and calibration on a 3D instrument will be performed as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

5.1 Statistical sampling is not applicable in the FTD.

5.2 Non-Statistical sampling is employed in the FTD. It is based on the training, experience and competence of the examiner. No assumptions are made regarding items/portions that were not selected for examination and Results of Examination in *Laboratory Reports* are specific to the items/portions that were examined.

6 Procedures

6.1 Use of a 3D Instrument

6.1.1 Based upon the discretion of the Examiner and condition of the evidence, a cartridge case may be entered into a 3D instrument if it meets one of the following criteria:

- The incoming request contains multiple cartridge cases for intercomparison.
- The incoming request contains a cartridge case and firearm for comparison.
- The incoming request contains cartridge case evidence with previous inconclusive results, using LCM, for reexamination.

6.1.2 Reexamination requests involving VCM will be handled using the following criteria:

- A submission previously examined by FTU will proceed to Section 6.4. The case file 1A generated during the original examination will be used to populate case information within the 3D instrument.
- A submission previously examined by an external laboratory will be treated as a new submission.

6.1.3 A cartridge case that is selected for VCM will be entered into an approved 3D instrument as outlined in Controlled Document FTU 019.

6.2 Evaluation of a Cartridge Case Bearing Toolmarks

6.2.1 Review all previous observations of the item that were recorded in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.2.2 Ensure that the item and/or container has been properly labeled with the appropriate identifier(s).

6.2.3 Ensure that the item has been reviewed for any trace evidence that could be of probative value. It is at the discretion of the examiner to ensure coordination of the removal and preservation of trace evidence with the appropriate discipline examiner.

6.2.4 If no trace evidence is observed or has no probative value, the item can be cleaned in preparation for examination in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.3 Level 1 Analysis – Evaluation and Classification of a Cartridge Case Bearing Toolmarks

6.3.1 Physical Characteristics

6.3.1.1 If possible, attempt to determine the physical characteristics of the cartridge case:

- Cannelure
- Case/Hull material
- Headstamp information
- Manufacturer
- Primer material

6.3.2 Class Characteristics

6.3.2.1 If possible, attempt to determine the class characteristics of the cartridge case:

- Breechface marks
- Caliber type or gauge
- Other properties (e.g., hand loaded, commercially loaded, condition of case)
- Firing pin impression
- Mechanism marks (e.g., presence, type)

6.3.2.2 Refer to the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment* for guidance on recording any class characteristics.

6.3.2.3 Class differences may result from intentional design decisions made by the manufacturer or from minor variations in tool dimensions or finishing methods that are within acceptable manufacturing tolerances for a particular tool.

6.3.3 Subclass Characteristics

6.3.3.1 Evaluate for any subclass characteristics in the toolmarks.

6.3.3.2 If possible, attempt to determine the impact on the comparison examination.

6.4 Level 2 Analysis (Microscopic) – Evaluation, Classification and Comparison of a Cartridge Case Bearing Toolmarks

6.4.1 During microscopic evaluation, observations may provide further information regarding the class and/or subclass characteristics of the toolmarks.

6.4.2 Individual Characteristics

6.4.2.1 Evaluate the individual characteristics of any observed toolmarks to determine if the microscopic marks are of value for comparison purposes. Value refers to the significant quality and quantity of the individual characteristics present on an item. This evaluation can result in any of the following classifications:

NMOV	Microscopic marks are of <i>no value</i>	No microscopic comparison
LMOV	Microscopic marks are of <i>limited value</i>	Suitable for microscopic comparison
MOV	Microscopic marks are of <i>value</i>	Suitable for microscopic comparison

6.4.3 For test fired cartridge cases, evaluate the working surfaces of the known breechface to determine if any manufacturing characteristics may assist in restricting and/or eliminating the influence of subclass characteristics.

6.4.4 All observations of a cartridge case bearing toolmarks, to include evaluations of physical, class, subclass and individual characteristics, will be recorded on the appropriate *FTD Worksheet* located in Appendix B of *FTD QAM Case Assignment, Records, Results and Verifications*.

6.4.5 For items with no observed class characteristics and NMOV, no further examinations will be performed.

6.4.6 For cartridge cases observed class characteristics and NMOV, additional information may be reported through the use of other Standard Operating Procedures within the FTD (e.g., class characteristic database search, reference materials).

6.5 Level 2 Analysis – Comparison and Pattern Matching

6.5.1 A comparison of cartridge cases bearing toolmarks will be performed in accordance with the *FTD SOP Comparison and Pattern Matching*.

6.5.2 If a cartridge case is submitted with no additional items for comparison or an inconclusive or elimination result is reached between two cartridge cases, a search of the appropriate database (general rifling characteristics file, reference ammunition file or reference firearms collection) may be performed in accordance with the *FTD SOP Class Characteristics Database Entries and Searches* to produce a list of firearms that could have fired the cartridge case.

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

If the cartridge/shotshell case is extremely corroded or mutilated, it may not be possible to determine its physical characteristics. Due to possible changes in firearm operating surfaces from wear, corrosion and ordinary fouling and differences in ammunition design and construction, cartridge/shotshell cases fired in the same firearm are sometimes not identifiable as such. Additionally, some firearm manufacturing methods routinely produce working surfaces that leave limited microscopic marks of value on fired cartridge/shotshell cases.

VCM is restricted to the surface that the three-dimensional toolmark topographical instrument is capable of measuring to produce a digital reproduction. Additionally, individual characteristics may be present on the evidentiary item(s) and may not be reproduced during a scan. This may be due to interference from lacquer/sealant, environmental damage, debris, or measuring limits for an instrument. Furthermore, physical characteristics that are not measurable, such as the metallic qualities of an item, may not be available for evaluation.

In situations where an Inconclusive (No Conclusion) result is initially rendered using VCM, the examination on the evidentiary item(s) will include LCM.

10 Safety

Take standard precautions for handling of all evidence and standards. Personal protective equipment should be used during the handling, use, and operation of a submitted firearm.

11 References

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Hatcher, J.S., Jury, F.J., and Weller, J., Firearms Investigation, Identification and Evidence, The Stackpole Co., Harrisburg, PA (1957).

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<https://forfix.de/>, ForFiX – Forensic Firearms Expert System. Web. Accessed 5 February 2020. |

TopMatch-GS 3D Software and Hardware Manual (latest revision) (Controlled Document, FTU 019) |

Rev. #	Issue Date	History
4	10/05/17	Updated title and expanded section 1 for methods for virtual comparison microscopy. Updated section 2 for incorporation of materials utilized in 3D technology. Updated section 3 to reflect controls used to assess 3D instrument. Updated section 4 title to Performance Check and outlined process to be performed on 3D instrument. Updated all of section 6 and added 6.4 subsection. Section 8 updated title and moved Limitations to section 9 and added virtual comparison microscopy. Updated section 10. Updated section 11 title to Records and moved References to section 12. Additional references added to section 12 for VCM and added Appendix A: <i>Opinion Workflow</i> and Appendix B: <i>TopMatch-GS 3D Sample Acquisition Instructions</i>
5	03/02/20	Updated Title of SOP, Reformatted Scope and added terminology to Section 1. Equipment listing updated in Section 2. Titles for referenced SOPs were updated in Sections 3, 4. Clarified sampling options in Section 5. Procedures were updated throughout Section 6. Removed Section 11 Records and renumbered. Updated references in Section 11. Removed Appendices A and B.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/Toolmarks Discipline Standard Operating Procedure Firearm Examinations

1 Scope

This procedure is designed for the evaluation and examination of firearms and firearm components. Firearm examinations include the safe handling, test firing and recording of information as it pertains to the functionality of an item.

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examination in the following category of testing:

- Firearms

2 Equipment/Materials/Reagents

- Arsenal (static) weights
- Bullet recovery system / water tank
- IMADA force gauge or similar
- Indoor range
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal protective equipment
- Rawhide mallet

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars may include bullets and/or cartridge cases produced by a known firearm. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks on the measurement equipment will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

Not Applicable.

6 Procedures

6.1 Safety Evaluation of a Firearm

6.1.1 An initial safety evaluation must be conducted prior to any examination of a firearm by FTD personnel. Unless exigent circumstances exist, rendering a firearm safe will take precedence over the preservation of evidence, although every effort will be made to preserve as much evidence as possible. A firearm will be considered loaded until it has been inspected and determined to be unloaded by FTD personnel utilizing one of the following inspection procedures:

6.1.2 Revolver

The following should be conducted in the following order:

- a. Open cylinder, check all chambers.
- b. Remove any cartridges and/or cartridge cases remaining in chamber.
- c. Visually inspect bore for obstructions.

6.1.3 Pistol

The following should be conducted in the following order:

- a. Engage safety and remove magazine if present.
- b. Open action and inspect chamber areas.
- c. Remove any cartridges and/or cartridge cases remaining in chamber.
- d. Visually inspect bore for obstructions.

6.1.4 Shotgun

The following should be conducted in the following order:

- a. Engage manual safety, if available.
- b. Remove magazine, if present.
- c. Disengage safety.
- d. Open action and lock open, if possible.
- e. Visually inspect chamber area.
- f. Engage manual safety if action is to be closed.
- g. Press on magazine follower to ensure that no shotshells remain in magazine tube.
- h. Visually inspect bore for obstructions.

6.1.5 Rifle

The following should be conducted in the following order:

- a. Engage safety and remove magazine, if present.
- b. Open action and lock open, if possible.

- c. Inspect chamber and magazine well area and remove any cartridges/cartridge cases remaining in chamber or in magazine tube.
- d. Visually inspect bore for obstructions.
- e. If present, engage manual safety if action is to be closed.

6.1.6 After the initial safety evaluation, anytime a firearm is out of the direct control of FTD personnel, it should be re-inspected to confirm that it is unloaded.

6.2 Firearm Function Examination

A function examination is conducted to determine the condition of the firearm, if it will operate in the manner in which it was designed and whether any modifications have been made.

6.2.1 The firearm should be test fired on the Firearms/Toolmarks Unit (FTU) test range using established safety rules to determine the functionality of a firearm. At the discretion of the examiner, the bullet recovery tank can be used for such testing.

6.2.2 Test firing should be done utilizing the magazine provided with the firearm. If no magazine is provided, a Reference Firearms Collection (RFC) magazine should be substituted if available.

6.2.3 Firearms will be test fired utilizing all modes in which the firearm is capable of firing.

6.2.4 All chambers of firearms having multiple barrels, such as double-barreled shotguns, derringers, etc. should be loaded and fired.

6.3 Collecting Test Fired Specimens

6.3.1 The firearm should be test fired in the bullet recovery tank using established safety rules to obtain known fired bullet and cartridge case specimens.

6.3.2 In those cases where the bullet recovery tank cannot be used, the firearm should be test fired utilizing an alternate bullet recovery/test firing device/system to retrieve the fired specimens.

6.3.3 Test fired bullets and cartridge cases that have been labeled are considered secondary evidence.

6.3.3.1 Secondary evidence will be labeled, packaged and recorded in accordance with the *FTD QAM Marking and Examination of Evidence*.

6.4 Trigger Pull Testing

Trigger pull testing is conducted in the water tank room using static weights or the IMADA, DPS-44 force gauge to determine the amount of force which must be applied to the trigger to release the hammer or firing pin of the firearm.

6.4.1 Trigger pull testing should not be conducted if parts that would directly affect the trigger pull, such as triggers, springs, etc., have been installed by the examiner in order to make the firearm operable for other exams.

6.4.2 Because trigger pull testing involves dry firing of the firearm and poses a threat of damage to firing pins and breech areas, such testing should not be conducted until after the firearm has been test fired and sufficient specimen bullets and cartridge cases have been obtained.

6.4.3 The trigger pull for each mode possible for a firearm (single action, double action, semi-auto, full-auto) should be determined. The static weights hanger shall touch the trigger at a point where the trigger finger would normally rest, and with the force applied approximately parallel to the bore axis.

6.5 Accidental Discharge Test

Accidental discharge testing will be conducted in the FTU indoor range when specifically requested by the contributor or when an examiner determines such a test is necessary.

6.5.1 The accidental discharge test will be conducted in all modes of fire for a particular firearm, utilizing a primed cartridge case.

6.5.1.1 A firearm being held will be struck with a rawhide or similar styled mallet on its six planes:

1. Front of muzzle
2. Butt plate
3. Top of breech and chamber
4. Bottom of trigger guard and frame
5. First side of the receiver/frame
6. Second side of the receiver/frame

6.5.2 Any additional testing undertaken in order to attempt to duplicate the conditions under which the firearm discharged is left to the discretion of the examiner.

6.6 Firearm Drop Test

The firearm drop test will be conducted in the FTU indoor range when specifically requested by the contributor or whenever an examiner determines such a test is necessary.

6.6.1 Prior to a drop test being conducted, the examiner will inform the contributor of the potentially destructive nature of this test and of the risk of significant damage to the firearm and record the notification in the Communication Log. This test should be conducted after all other examinations have been completed.

6.6.2 The drop test will be conducted utilizing a primed cartridge case.

6.6.3 Absent specific information provided by the contributor concerning the discharge of the firearm, the method of testing to be used is left to the discretion of the examiner. If known, the conditions surrounding the discharge of the firearm at a shooting scene, such as height or type of surface, should be duplicated as closely as possible.

6.7 Individual Characteristic Database Search

6.7.1 Individual characteristic database searches, including NIBIN, of known test fired cartridge cases will be performed in accordance with the *FTD SOP Individual Characteristic Database Searches*.

6.8 National Database Search

6.8.1 National database searches, including eTrace and NCIC, of the serial number will be performed in accordance with the *FTD SOP National Database Searches*.

7 Calculations

Not applicable.

8 Measurement Uncertainty

Not applicable.

9 Limitations

Due to damage or other factors, some of or all of the above examinations might not be possible. It is at the discretion of the examiner as to what examinations are necessary and if they should be conducted.

10 Safety

FTD personnel will follow the established policies and guidance located in the FBI Laboratory Safety Manual as outlined by the FBI Laboratory's Health and Safety Group.

10.1 FTU personnel are not permitted to test fire alone in the indoor range or in the bullet recovery tank room and must adhere to the guidelines outlined in the *FTU Safety Protocols for the Handling of Firearms and Ammunition* (Appendix A).

10.2 Additionally, FTU personnel are required to review the *FTU Safety Protocols for the Handling of Firearms and Ammunition* on an annual basis. A signature/date on the sign-off sheet signifies understanding and compliance.

10.2.1 A record of this review will be maintained in the Firearms/Toolmarks Unit quality assurance program records.

10.3 If a request has been made for non-FTU personnel to perform test-firing within the FTU indoor range or bullet recovery tank room, the FTU Chief will be notified, and the request will be evaluated. If the FTU Chief approves this request, the appropriately trained FTU personnel will be present.

11 References

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

Glossary of the Association of Firearm and Tool Mark Examiners, AFTE Training and Standardization Committee, 6th Edition, Version 6.030317.1

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. Accessed 5 February 2020.

Rev. #	Issue Date	History
7	04/30/14	Section 2 added “or similar” to force gauge. Sections 6.1.1 through 6.1.4 redacted “numerical.” Correction made to Section 6.2.5 and added 6.2.5.1. Sections 6.3.3 through 6.3.3.2, 6.3.4 and 6.6.1 were updated for the addition of Forensic Advantage. Updated References.
8	03/02/20	Scope was updated to include FTD personnel who utilize this procedure for FTU initiatives. Section 2 was reformatted. Section 3 and Section 4 updated with new SOP references and grammatical modifications. Section 6 updated to include FTD personnel. Sections 6.1.2 through 6.1.5 were reformatted. Alternate recovery system was added to Section 6.3.2. Section 6.3.3.1 was updated with FTD QAM reference. Reformatted Section 6.5.1.1. Added communication log record to Section 6.6.1. Added Sections 6.7 and 6.8. Updated Section 8 title. Updated Section 10 and clarified where record of annual review will be maintained. Section 11 References updated. Appendix A was added.

Approval

Firearms/Toolmarks
 Unit Chief

Redacted - Signatures on File

Date: 02/28/2020

Firearms/Toolmarks
 Technical Leader

Date: 02/28/2020

Appendix A: FTU Safety Protocols for the Handling of Firearms and Ammunition

1 Purpose

The purpose of this document is to ensure the safety of all Firearms/Toolmarks Unit (FTU) personnel and non-FTU personnel, when handling firearms and ammunition during examinations and firing in the FTU indoor range and bullet recovery tank (BRT).

2 Requirements

- 2.1** In the FTU, when handling a firearm or firearm component, safety is the first concern. Make sure the firearm is unloaded before handling. If there is any doubt about the operability of a firearm, consult with an appropriately trained FTU personnel, protocols, or manufacturer's literature before handling.
- 2.2** FTU personnel are responsible for following proper firearms handling and safety procedures and have a working knowledge on the operation of range equipment while in the FTU.
- 2.3** Firing in the FTU indoor range and BRT on the weekend and after regular business hours, unless previously approved by the FTU Chief, is prohibited. Accommodations can be made for casework examinations that require working after regular business hours and on the weekend.
- 2.4** Firearms that exceed range limitations are not permitted to be fired in the FTU indoor range or BRT unless the proper accommodations have been made to ensure the safety of personnel using the range/equipment and the integrity of the range/equipment.
- 2.5** Prior to exiting the indoor range or BRT, FTU personnel and non-FTU personnel will ensure all firearms are cleared and the safety is engaged.
- 2.6** FTU ranges are not designed or approved by Federal Bureau of Investigation Headquarters (FBIHQ) for the purpose of firearms qualification.
- 2.7** Unsecured ammunition will not be stored in the FTU indoor range or BRT.
- 2.8** No eating, drinking, or smoking is permitted in FBI Laboratory/FTU examination areas that include: indoor range, BRT, examination suites and reloading room.

3 Safety Rules

- 3.1** The muzzle of ALL firearms will be pointed in a safe direction at ALL times.

- 3.2 All firearms will be handled as though they are **LOADED**. The firearm will be inspected and made safe upon being handled.
- 3.3 Keep your finger outside of the trigger group until you have a safe sight picture.
- 3.4 Always be aware of what is behind your target.

4 Safety Procedures for Handling Firearms

- 4.1 Always point the muzzle of the firearm in a safe direction, especially when loading, unloading, firing, or checking a firearm.
- 4.2 Inspect ALL FIREARMS EACH TIME you handle them to ensure they are safe and unloaded.
 - a. Revolvers – open cylinder, check all chambers, and leave action open.
 - b. Pistols – remove magazine, open action, inspect chamber, inspect magazine to ensure empty, engage safety, and lock action open.
 - c. Shotguns – open action/breech, inspect chamber, inspect magazine to ensure empty, engage safety, and lock action open.
 - d. Rifles – remove magazine, open action, inspect chamber, inspect magazine to ensure empty, engage safety, and lock action open.
- 4.3 The safety function within a firearm should be engaged whenever possible, especially while being transported or when left in an examination area.

Note: Anytime the action of a firearm is closed or it is out of the **direct control** of the Examiner or appropriately trained employee, it should be re-inspected before any further handling occurs.

5 Safety Procedures for Firing a Firearm

- 5.1 When transporting a firearm to the BRT or indoor range, the action should be opened, safety engaged and the safety rules followed as outlined in Section 3, above.
- 5.2 Perform a safety check to ensure the firearm is in firing order, the safety is functional, and the headspace is not excessive.
- 5.3 The safety function within a firearm should be engaged whenever possible, especially while being transported or when left in an examination area
- 5.4 The barrel and cylinder/chamber of all firearms will be examined for obstructions, cracks, deformations, residue/rust build-up, etc. prior to firing.
- 5.5 Do not test fire alone.

- 5.6** Do not test fire a firearm if not familiar with its function.
- 5.6.1** When test firing a rifle or shotgun without a shoulder stock, use a magnetic level to ensure proper alignment.
- 5.7** Always wear proper eye and ear protection.
- 5.8** At the shooter's discretion, only one cartridge will be loaded and fired at a time, unless performing a full-automatic function test.
- 5.9** Close action when muzzle is pointed down range or inserted in port of the BRT.
- 5.10** If a misfire occurs, keep the firearm pointed down range or keep inserted in port of the BRT for at least 10 seconds before opening the action or cylinder. Recheck the bore and cylinder/chamber for obstructions.
- 5.11** All observers will stand behind the shooter. The shooter is responsible for informing observers of the line, then allowing several seconds for observers to prepare. The shooter will announce when they are prepared to shoot and when the line is 'clear'.
- 5.12** If a firearm is dropped or bumped, re-inspect it prior to firing.
- 5.13** After test firing ensure the firearm is unloaded, the magazine is removed, and the safety is engaged before leaving the firing position on the indoor range or the firing port of the BRT. Ensure the chamber is empty and announce that the weapon is clear to any observers.
- 5.14** The remote firing device should be used when there is the potential for a firearm to fail when test firing.
- 5.15** Before leaving, clean range area, turn off lights, and reset 'in use/open' sign.
- 5.16** Never give a firearm to or take a firearm from anyone unless the action or cylinder is opened and the safety engaged.
- 5.17** Do not place finger on the trigger of a firearm unless you have a safe sight picture.
- 5.18** Do not fire in the full-automatic mode in the indoor range unless necessary for testing or training.
- 5.19** The indoor range and BRT room will be used only by personnel of the FTU.
- 5.20** If a request has been made for non-FTU personnel to perform test-firing within the FTU indoor range or BRT room, the FTU Chief will be notified and the request will be

evaluated. If the FTU Chief approves this request, the appropriately trained FTU personnel will be present.

6 Pulling Bullets

- 6.1** Examiners or appropriately trained employees will wear eye protection when using inertia bullet pullers as primer ignition and possible propulsion of primer is possible.
- 6.2** Pulling bullets by using pliers or other tools (e.g., rimfired cartridges) should be conducted with extreme caution as primer powder in the rim could be crushed by such tools, resulting in the firing of the cartridge.
- 6.3** Accidental discharge testing of a firearm, which could result in the firing of a firearm, should be done with proper eye and ear protection.
- 6.4** Precautions to prevent dropping firearms and cartridges should be taken. In the event a firearm is dropped, it should be inspected prior to firing to ensure it is in safe working condition.

7 Bullet Recovery Tank (BRT) – Safety Rules and Procedures

- 7.1** Do not test fire alone (See Section 5.5).
- 7.2** Ear and eye protection will be worn by all shooters and observers in the BRT room.
- 7.3** Prior to firing into the BRT, the shooter or observer will:
 - a. Check the BRT for other projectiles or debris.
 - b. Close the top of the BRT.
 - c. Ensure doors to the BRT room are closed.
- 7.4** The firearm should be loaded and made ready to fire (e.g., loaded cylinder or slide/bolt closed) ONLY when the muzzle of the firearm is placed into the firing port of the BRT and is pointed towards the water.
- 7.5** At the shooter's discretion, shotguns and full-automatic firearms should not be fired into the BRT.
- 7.6** After firing, if bullet(s) separate in the BRT, as many pieces as possible should be recovered to prevent clogging of the water filter.
- 7.7** Any hazardous waste generated during test firing should be disposed of in the proper hazardous material container. If there is any question on the proper disposal of hazardous material(s), contact a member of the Health and Safety Group.

8 Reloading – Safety Rules and Procedures

- 8.1** Do not reload unless you are experienced at reloading or have received training on the various aspects of reloading.
- 8.2** Prior to reloading, the appropriate reloading manuals should be consulted to ensure maximum and/or minimum powder load(s) are not being exceeded for bullet weight and proper components are being used. Powders used should be researched as to the pressures and burn rates. **DO NOT START WITH THE MAXIMUM LISTED LOADED** as it might be unsafe in the firearm being test fired. Also be aware that maximum loads vary from manual to manual.
- 8.3** When firing reloads, they should be inspected for signs of excessive pressures such as bulging, cracking, separation, gas leaks or excessive head expansion. Never use brass of unknown origin.
- 8.4** Determine that the correct seating depth is used, as excessive or improper seating depth can cause excessive and unsafe pressures.
- 8.5** Determine that bullets utilized for reloading are the proper dimension and weight for the cartridge and firearm it will be fired in.
- 8.6** Do not use cartridge cases that have signs of wear, deformity, cracks, etc.
- 8.7** Eye protection will be worn when removing bullets from a cartridge case or priming or depriming cartridge cases.
- 8.8** Eye protection will be worn when reloading a cartridge case.
- 8.9** Any hazardous materials generated during reloading should be disposed of in the proper hazardous material container. If there is any question on the proper disposal of hazardous material(s), contact a member of the Health and Safety Group.
- 8.10** Do not substitute smokeless powder for black powder or black powder substitutes (e.g., Pyrodex) as smokeless powder develops more pressure than black powder.
- 8.11** Never mix different powders.

Firearms/Toolmarks Discipline Standard Operating Procedure for Toolmark Examinations

1 Scope

This procedure is designed for the evaluation and examination of items bearing toolmarks (referred to as item in the remaining document). Toolmark examinations include the evaluation of submitted items to determine the value of any toolmarks that may be present, and the physical and microscopic examination of a toolmark (striated and/or impressed) to determine a source conclusion.

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following categories of testing:

- Toolmarks
- Serial Number Restoration

Additionally, the following terms will be used throughout this procedure:

- **Toolmark:** Impressed and/or striated feature(s) created when a tool (harder object) makes forceful contact with an item (softer object) transferring physical and/or microscopic features.
- **Physical Characteristics:** Observable features (e.g., shape, color, design) of a specimen which indicate a restricted group source and are determined prior to manufacture.
- **Class Characteristics:** Measurable or discernible features of a specimen which indicate a restricted group source. They result from design factors and are determined prior to manufacture.
- **Subclass Characteristics:** Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.
- **Individual Characteristics:** Marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are produced incidental to manufacture and/or caused by use, corrosion, or damage.
- **Unsuitable:** An item bearing no class or individual characteristics for comparison.
- **Suitable:** An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV):** Individual characteristics having quality and/or quantity for a source conclusion comparison.
- **Limited Microscopic Marks of Value (LMOV):** Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **No Microscopic Marks of Value (NMOV):** Absent of individual characteristics for a source conclusion comparison.

- **Comparison:** The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.
- **Light Comparison Microscopy (LCM):** The use of connected optical microscopes to compare and evaluate microscopic features between two toolmarks.
- **Virtual Comparison Microscopy (VCM):** The use of software to compare and evaluate the digital reproduction of microscopic features between two toolmarks.
- **3D Toolmark Topographical Instrument (3D instrument):** A device that can measure and record the x, y and z positions of microscopic features contained within a toolmark and produce a digital reproduction of the toolmark.
- **Source Conclusion:** An Examiner's conclusion regarding the origin of a toolmark or fracture.

2 Equipment/Materials/Reagents

- 3D toolmark topographical instruments
- Known exemplars
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal protective equipment (PPE)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars may include toolmarks produced by a known tool and/or casts collected from a toolmarked item. Exemplars produced from the known item will be treated as secondary evidence and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the measurement equipment and calibration on a 3D instrument will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

5.1 Statistical sampling is not applicable in the FTD.

5.2 Non-Statistical sampling is employed in the FTD. It is based on the training, experience and competence of the examiner. No assumptions are made regarding items/portions that were not selected for examination and Results of Examination in *Laboratory Reports* are specific to the items/portions that were examined.

6 Procedures

6.1 Evaluation of an Item Bearing Toolmarks or Known Tools

6.1.1 Review all previous observations of the item that were recorded in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.1.2 Ensure that the item and/or container has been properly labeled with the appropriate identifier.

6.1.3 Ensure that the item has been reviewed for any trace evidence that could be of probative value. It is at the discretion of the examiner to ensure coordination of the removal and preservation of trace evidence with the appropriate discipline examiner.

6.1.4 If no trace evidence is observed or has no probative value, the item can be cleaned in preparation for examination in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.2 Level 1 Analysis – Evaluation and Classification of an Item Bearing Toolmarks or Known Tool

6.2.1 Class Characteristics of a Toolmark

6.2.1.1 Evaluate the class characteristic(s) of a toolmark that may include:

- Features that result from the working surface(s) of the tool
- Observed action(s) of the tool that produced the toolmark
- The type of tool that may have produced the toolmark
- Evaluation for any subclass characteristics and determine the impact on the comparison examination.

6.2.1.2 Class differences may result from intentional design decisions made by the manufacturer or from minor variations in tool dimensions or finishing methods that are within acceptable manufacturing tolerances for a particular tool.

6.2.1.3 Depending on the size and shape of the item bearing toolmark(s), it may be necessary to cast any toolmarks for evaluation of the class characteristics and preservation for future comparisons.

6.2.1.3.1 Casting marked surfaces will be conducted in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.2.1.4 In some instances, it may not be possible to determine the class characteristics due to the properties or conditions of the substrate, or incomplete tool contact with the substrate.

6.2.2 Class Characteristics of a Known Tool

6.2.2.1 Inspect and evaluate the known item to determine the following:

- Observed action(s) of the known item
- Measurable features of the known item
- Evaluate for any subclass characteristics and determine the impact on the comparison examination.

6.3 Level 2 Analysis (Microscopic) – Evaluation, Classification and Comparison of an Item Bearing Toolmarks

6.3.1 Individual Characteristics

6.3.1.1 Evaluate the individual characteristics of any observed toolmarks to determine if the microscopic marks are of value for comparison purposes. Value refers to the significant quality and quantity of the individual characteristics present on an item. This evaluation can result in any of the following classifications:

NMOV	Microscopic marks are of <i>no value</i>	No microscopic comparison
LMOV	Microscopic marks are of <i>limited value</i>	Suitable for microscopic comparison
MOV	Microscopic marks are of <i>value</i>	Suitable for microscopic comparison

6.3.2 Evaluate the working surfaces of the known item to determine if any class and/or manufacturing characteristics may assist in restricting and/or eliminating the influence of subclass characteristics.

6.3.3 All observations of a questioned toolmark, to include evaluations of the physical, class, subclass and individual characteristics, will be recorded on the appropriate *FTD Worksheet* located in Appendix B of *FTD QAM Case Assignment, Records, Results and Verifications*.

6.3.4 For items with no observed class characteristics and NMOV, no further examinations will be performed.

6.3.5 For items with observed class characteristics and NMOV, additional information may be reported using other Standard Operating Procedures within the FTD (e.g., class characteristics database search, reference materials).

6.4 Level 2 Analysis – Comparison and Pattern Matching

6.4.1 A comparison of items bearing toolmarks will be performed in accordance with the *FTD SOP Comparison and Pattern Matching*.

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

In some instances, it may not be possible to determine the class characteristics due to the properties or conditions of the substrate or incomplete tool contact with the substrate.

It should be noted that a tool is defined as any harder object that can leave a mark on a softer object. This may loosely extend to an object not conventionally thought of as a “tool”.

Due to variation in substrate, changes in tool working surfaces from wear, corrosion, and abuse, or the employment of unusual tool/work piece orientations, toolmarks created by the same tool are not always identifiable.

10 Safety

Take standard precautions for handling of all evidentiary items and measurement equipment. PPE should also be utilized.

11 References

Davis, J.E., Tool Marks, Firearms and the Striagraph, Charles C. Thomas, Springfield, IL (1958).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

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“Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions – An AFTE Criteria for Identification Committee Report”, AFTE Journal, 1992; 24 (3), 340.

“Theory of Identification as it Relates to Toolmarks: Revised By: Committee for the Advancement of the Science of Firearm & Toolmark Identification”, AFTE Journal, 2011; 43 (4), 287.

United States. Department of Justice. Office of Legal Policy. Forensic Science. (2019, January) *Department of Justice Uniform Language for Testimony and Reports for the Forensic Firearms/Toolmarks Discipline – Pattern Match Examination*. Retrieved from the Department of Justice Web site: <https://www.justice.gov/olp/page/file/1083671/download>

Rev. #	Issue Date	History
9	04/25/19	Updated Scope with terms and definitions that are applicable to the evaluation and comparison process. Section 3 was updated to include secondary evidence reference. Sections 4.1 and 4.2 were added. Section 5.1.1 was updated to clarify suitability of an item. Sections 5.1.2, 5.3.2, and 5.4.1 were clarified to address Laboratory personnel completing any retention of trace evidence. Section 5.1.3 was updated to address class being an inherent result of the tool's working surface. Added flexibility of class being evaluated within microscopic evaluation and also updated graphic in Section in 5.1.6. Details of comparison were added to Section 5.1.7. Section 5.1.9 was updated to address suitability and microscopic evaluation, which is illustrated in updated graphic. Sections 5.1.9.1 and 5.1.9.2 were added to address possibly avenues for reporting. Section 5.1.10 was added to include an examination workflow and graphic. Format of graphics was updated within Sections 5.2.1, 5.2.2, 5.3.7, 5.3.8, 5.4.3, 5.4.6 and 5.4.9. Combined what was previously 5.4.2 and 5.4.3 into 5.4.2, which resulted in renumbering. The process chart was updated in Section 5.4.8 to include the overall workflow as it relates to fracture marks. Section 5.4.10 was inserted to create a connection with the Association SOP. Limitations were updated in Section 8 to include substrate being a contributor. ULTR references were added to Section 10. Appendix A <i>Opinion Workflow</i> was updated with suitability and comparison of class and individual characteristics.
10	03/02/20	Minor edits throughout for grammar and clarity. Removed comparison portions of document to a new separate document. Updated titles of referenced documents where needed for consistency. Added definitions: Toolmarks, Physical Characteristics, Source Conclusion. Edited definitions: Class, Subclass, and Individual Characteristics. Edited Section 2 Materials/Equipment/Reagents to make equipment list more generic. Section 4 Performance Checks added. Section 5 Sampling updated to reflect current practices. Section 6 Procedures (6.1, 6.2, 6.3, 6.4) restructured for consistency with E3CV methodology and current FTD document structure. Updated references: FBI QAM and LOM, and the current AFTE Glossary

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Scientific & Biometric
Analysis Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

FBI Laboratory

Firearms and Toolmarks Unit

Key Examination and Comparison

1 Scope

This procedure is designed for the examination of keys (manufactured for mechanical locks), including the comparison of keys with each other.

2 Equipment/Materials/Reagents

Stereozoom binocular microscope (magnification range 4X-20X minimum); Caliper capable of measuring lengths up to 3 inches, within + .002 inch; Metal scribe.

3 Standards and Controls

Not Applicable.

4 Calibration

Not Applicable.

5 Sampling

Not Applicable.

6 Procedures

Document the physical design configuration and biting cut sequence of each specimen key. Compare biting sequences of specimen keys having compatible key blade designs.

6.1 Marking for Identification

All keys must be scribed or tagged for identification, being careful to preserve all marks already present on the specimen. The choice of the method used to affix such identifying marks is at the examiner's discretion.

6.2 Determination of Key Blank

Document the physical configuration of the submitted key and note any coined or stamped markings (company logos, manufacturer item numbers, etc) on the specimen. Examine the key for degree of wear, and the presence or absence of toolmarks indicative of key duplication. When possible and pertinent, note whether the key under examination is a lock manufacturer's factory original key, or one cut from an aftermarket key blank. Use catalogs of key blank manufacturers, such as ILCO, JET, and SILCA, to determine the key blank used to cut the key under examination. The characteristics considered in identifying the correct key blank are:

- a. Cross-sectional configuration of the key blade;
- b. Length of the key blade;
- c. Presence (and position) or absence of shoulders on the key blade;
- d. Key bow shape, and the presence or absence of any coatings (such as plastic).
- e. Presence or absence of additional security devices, such as General Motors Vehicle Anti-Theft System (VATS) resistors or transponder chips.

6.3 Examine Biting Cuts and Decode the Key

6.3.1 Document the biting cuts in the key. Determination of cutting positions and depths should be made using a caliper, and when appropriate note the cut angle. Include in the examination notes details such as:

- a. Count of the number of biting cuts; their position and depth relative to the appropriate key blade reference surfaces (blade back, tip, shoulder, side milling surface, etc.);
- b. Note the profile of the individual biting cuts (whether flat bottomed or rounded, machine milled, punched or hand filed, etc);
- c. The angle of each cut (45° Left, 90° , or 45° Right), when the key is made to operate a lock with bi-axial (chisel-pointed) pins.

6.3.2 Compare the data obtained by the procedure 6.3.1 with standard lock industry code references to characterize the type (manufacturer/brand, model, model-year, etc.) of the device the key is designed to access. In the same way, determine which manufacturer's direct biting code is most consistent with the observed biting sequence in the key under examination. These conclusions will be documented in the examiner's notes.

6.4 Determination of Key Blank

In order for two or more keys to operate a lock they must have compatible key blade configurations that permit them to fit into the same lock, and must have the same biting sequence (see step 6.3.1 and 6.3.2 above). Such "associations" are to be recorded in writing in the examiner's notes. In addition the examiner may record such associations using macroscopic photography.

7 Calculations

Not Applicable.

8 Uncertainty of Measurement

Not Applicable.

9 Limitations

The methods set forth in these protocols pertain to the examination of keys designed for key –operated mechanical, rather than devices associated with electro-mechanical (card-access, fingerprint reader, etc) locks.

10 Safety

Not Applicable.

11 References

Paholke, Arthur R., What the Tool Mark Examiner Should Know About Locks (A Guide for the Firearms Examiner), AFTE Newsletter, Number 19 (April 1972).

Sherlock, William E., Forensic Locksmithing Used in a Lock Investigation, AFTE Journal, Vol. 15, Number 3 (October 1983).

Tobias, Marc Weber, Locks, Safes, and Security (An International Police Reference), Chapters 6-17, Charles C. Thomas Publishing, LTD (2000).

HPC CodeSource, HPC Incorporated

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation
1	11/05/07	Updated section 4 to remove stereomicroscope and caliper calibrations.

Approval

Redacted - Signatures on File

Firearms/Toolmarks Unit

Standard Operating Procedure for

The Modified Griess Test for Nitrite Residues

1 Scope

This procedure is designed to provide a specific technique for detecting and preserving patterns of nitrite residues around a suspected bullet hole as a basis for estimating muzzle-to-target distances. Such patterns may be on evidence such as clothing items, furniture, bedding, and wallboard. This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Firearms

2 Equipment/Materials/Reagents

- Scissors
- Zip-lock bags
- Cheesecloth
- Graduated cylinder (500 ml)
- Blotters/brown wrapping paper
- Processing tray
- Photographic paper or similar media
- Filter paper
- Beaker (1000 ml)
- Sodium nitrite (reagent grade or better)
- Sulfanilic acid (reagent grade or better)
- Glacial Acetic acid (reagent grade or better)
- Personal protective equipment
- Laboratory coat
- Tweezers
- Flat Iron
- Micro-spatula
- Exhaust hood
- Polyethylene bottles
- Distilled and/or deionized water
- Cotton swabs
- Alpha-naphthol (reagent grade or better)
- Methanol (reagent grade or better)

3 Standards and Controls

3.1 Standards are not applicable.

3.2 Positive and negative controls are prepared for the Modified Griess test to detect for the contamination of nitrites.

3.2.1 Preparation of Nitrite Test Swabs

3.2.1.1 Prepare a solution of 0.6 grams of sodium nitrite in 100 milliliters of distilled water.

3.2.1.2 Divide a package of cotton swabs into equal amounts. Soak half of the cotton-tipped ends in the nitrite solution. Dispose of any remaining solution.

3.2.1.3 Set the swabs aside to dry, and store in a labeled zip-lock bag. These will serve as the positive control. There is no known limit to the shelf life of these swabs.

3.2.1.4 Retain the other half of the non-treated swabs for the negative control, and store in a labeled zip-lock bag.

3.3 If a chemical reagent must be prepared before an examination, the following information must be recorded on the appropriate Firearms/Toolmarks Unit (FTU) Chemistry Log which can be found in the Firearms/Toolmarks Unit, *Comprehensive Gunshot Residue Examinations in Muzzle-to-Target Distance Determination* procedure: FTU lot number, preparer, date, parent chemical (lot number), FBI Laboratory serial number and the result of the performance check.

3.3.1 The FTU lot number for reagents used during examinations will be recorded in the examination notes.

4 Sampling or Sample Selection

Not applicable.

5 Procedures

5.1 Preparation of Reagents and Test Media

The following instructions apply to the preparation of the reagents and test media for use in the Modified Griess Test for nitrite residues.

5.1.1 Processing of Photographic Paper

5.1.1.1 Prepare a solution of 0.5 grams of sulfanilic acid in 100 milliliters of distilled water.

5.1.1.2 Prepare a solution of 0.28 grams of alpha-naphthol in 100 milliliters of methanol.

5.1.1.3 Combine the above solutions.

5.1.1.4 Pour the combined solution into a non-reactive photo processing tray and briefly dip pre-cut sheets of the photographic paper into the tray. Submerge the sheets completely and remove them. Note: as a substitute for photographic paper, ordinary laboratory filter paper or similar media may be processed in the same manner. (See the suggested method in the specific

test procedure which follows.)

5.1.1.5 Set the sheets aside to dry on a clean surface (a table covered with brown wrapping paper). Dispose of any remaining solution.

5.1.2 Preparation of a 15% Acetic Acid Solution

5.1.2.1 Combine 150 milliliters of glacial acetic acid with 850 milliliters of distilled water. Gently pour the acid into the water to preclude the potential spattering of undiluted acid.

5.1.2.2 Store the solution in a properly sealed and labeled container. There is no known limit to the shelf life of this reagent.

5.2 Procedure for a Standard Modified Griess Test

5.2.1 To ensure the chemically treated photographic paper or similar paper media is functioning properly, test the four corners of the emulsion-coated side with a positive control. This is accomplished by saturating a nitrite test swab (positive control) in a small amount of 15% acetic acid solution and dabbing the four corners of the paper. An orange color should appear at each corner, confirming sensitivity. The results will be recorded in the examination records.

5.2.2 For a negative control, repeat step 5.3.1 above, but use clean, non-nitrite treated acetic acid-saturated test swabs. Ensure that this test follows the positive control test, and that there is sufficient physical separation between test marks to preclude bleeding from one mark to the other. The results will be recorded in the examination records.

5.2.3 Place the evidence or known-distance test (see the Firearms and Toolmarks Unit, *Shot Pattern Examinations in Muzzle-to-Target Distance Determinations* procedure for conducting known-distance tests) questioned side down on the emulsion-coated side of the treated photographic paper. Indicate on the paper or similar media, using a pencil, such objects as seams, buttons, button holes, rips, pockets, suspected bullet holes, tears, cuts, etc., for possible future reference by marking with a pencil.

5.2.3.1 Do not use ink at this point because it may transfer back onto the tested item.

5.2.4 Soak a piece of cheesecloth in the 15% acetic acid solution (in a large beaker) and wring it out. Place the cheesecloth on the questioned item or known-distance test as the third layer of the "sandwich". Press the "sandwich" with a hot iron. On many irons, the setting for "cotton" is appropriate.

5.2.5 Discard the cheesecloth and separate the questioned item or known-distance test-firing from the photographic paper.

5.2.6 When dry, the photographic paper will be marked appropriately (Note: photographic

paper is considered secondary evidence and will be marked with the item identifier associated with the primary evidence item, preceded by an “*f*” indicating *from*, for example: *f* Item 5.) Photographic paper will be properly marked in ink for future identification and returned to the contributor as secondary evidence.

5.3 An Alternative Procedure for a Modified Griess Test Using Treated Filter Paper

5.3.1 Treat the filter paper in the same solutions used for treating the photographic paper. Allow it to dry. See section 5.1.1.

5.3.2 Test for nitrite sensitivity using the positive and negative controls.

5.3.3 Place the filter paper on the questioned surface.

5.3.4 Process the filter paper using one of the following methods:

- Saturate a piece of cheesecloth in the 15% acetic acid solution and wring it out. Place the cheesecloth over the filter paper and apply a hot iron.
- Spray the filter paper with the 15% acetic solution until very damp. Cover with two or three additional layers of filter paper and iron until dry.

5.3.5 Separate the test media and check the results.

5.3.6 When dry, mark and preserve results for retention as in 5.2.6 above.

5.4 Procedure for a Reverse Modified Griess Test.

This procedure is reserved for items that are thick or otherwise non-porous materials. Typically, these materials don't allow for the Acetic Acid solution to penetrate through the item.

5.4.1 Similar to Section 5.2.1, test for nitrite sensitivity using the positive and negative controls, confirming sensitivity. The results will be recorded in the examination records.

5.4.2 Place the photographic paper or similar media emulsion/treated side down on the questioned surface. Use a pencil to indicate on the paper or similar media such objects as seams, buttons, suspected bullet holes, pockets, rips, tears, and cuts for future reference.

5.4.3 Wipe the emulsion/treated side of the photographic paper with a piece of cheesecloth saturated with a 15% acetic acid solution. Lightly apply the solution to the entire surface. (Too much solution will cause indistinct or hazy results due to pigment migration.)

5.4.4 Immediately place the photographic paper or similar media emulsion/treated side down on the questioned surface.

5.4.4.1 Prior to applying a hot iron, attach a piece of material (e.g., filter paper, cheesecloth,

clean twill jean, clean cotton material) to the back of a piece of treated photographic paper or similar media. Failure to attach a piece of material will likely result in the paper or similar media sticking to the iron.

5.4.4.2 Apply a hot iron to the back of the photographic paper or similar media.

5.4.5 Separate the photographic paper and the questioned area. Any orange indications on the photographic paper are the result of a chromophoric reaction specific for the presence of nitrite residues.

5.4.6 When dry, mark and preserve results for retention as in 5.3.6 above.

6 Calculations

Not applicable.

7 Measurement Uncertainty

Not applicable.

8 Limitations

8.1 Based on the chemistry outlined in this procedure, the Modified Griess Test is not suitable for the detection of purely nitrate compounds, such as unburned smokeless powder. It should be noted that unburned powder particles (nitrates) are commonly coated with burned powder residues (nitrites) and positive reactions take place.

8.2 The Modified Griess Test yields results for nitrite residues regardless of whether these are in fact gunshot residues.

9 Safety

Ensure that proper ventilation is provided during both the preparation of the reagents and the procedure itself. When handling clothing that is potentially contaminated with biological hazards or preparing reagents for chemical tests, protective latex or vinyl gloves, safety glasses, and laboratory coat will be worn at all times.

For disposal of the chemicals/hazardous waste used for this procedure, refer to Section 5, titled Hazardous Waste Disposal, of the *FBI Laboratory Safety Manual*.

10 References

Barnes, F.C. and Helson, R.A., "An Empirical Study of Gunpowder Residue Patterns," Journal of Forensic Sciences, Vol. 19, 1974, pp. 448-462.

Dillon, J.H., "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrite Compounds in Gunshot Residues," AFTE Journal, Vol. 22, No. 3, 1990, pp. 243-250.

Dillon, J.H., "A Protocol for Gunshot Residue Examinations in Muzzle-to-Target Distance Determinations," AFTE Journal, Vol. 22, No. 3, 1990, pp. 257-274.

Fiegl, F., Spot Tests in Organic Analysis, 7th ed., Elsevier Publishing Co., New York, 1966.

Hess, Philip A., "The Validation of Several Inkjet Photographic Papers for Use with the Modified Griess Test," AFTE Journal, Vol. 45, No. 2, 2013, pp. 160-165.

Gamboa, Frances A. and Kusumi, Raymond, "Evaluation of Photographic Paper Alternatives for the Modified Griess Test," AFTE Journal, Vol. 38, No. 4, 2006, pp. 339-347.

Malikowski, Shawn G., "Alternative Modified Griess Test Paper," AFTE Journal, Vol. 35, No. 2, 2003, pp. 243.

Watson, D.J., "Nitrites Examination in Propellant Powder," AFTE Journal, Vol. 11, No. 1, 1979, p. 32.

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

FBI Laboratory, FTU Quality Assurance Manual

Rev. #	Issue Date	History
3	08/21/12	Section 3 added cite where Chemistry Logs can be found.
4	04/17/19	Header and document title were updated to conform to the document control requirements. Updated Section 1 to specify category of testing. Updated the formatting of the listed equipment, materials and reagents in Section 2. Included the recording of the FTU lot number as part of Section 3 and included nitrite controls. Removed Section 4 Calibration and renumbered. Renumbered the beginning of Section 5 and completed grammatical updates to Sections 5.2.1 through 5.2.3.1. Removed the listing of a specific type of photographic paper to allow for other media to be used in Section 5.2, 5.2.1, 5.3.1 and 5.5.1. Updated Section 5.3.6 with current terminology for evidence generated in Forensic Advantage. Split 5.3.2 into two separate steps and renumbered remaining section. Updated title for Section 5.4 and renumbered and reordered the remaining requirement. Relocated disposal statement from Section 5.1 to Section 9. Clarified limitations statement in Section 8.1. Additional references were added to Section 10 to include articles relating to the use of various photographic papers that are used in the Modified Griess Test.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
 Technical Leader

Date: 04/16/2019

Firearms/Toolmarks
 Unit Chief

Date: 04/16/2019

QA Approval

Quality Manager

Date: 04/16/2019

Firearms/Toolmarks Discipline
Standard Operating Procedure for
Individual Characteristic Database Searches

1 Introduction

The National Integrated Ballistic Information Network (NIBIN) is an interstate automated ballistic imaging network that uses the Integrated Ballistic Identification Systems (IBIS®) TRAX-HD3D™ | BRASSTRAX™ and MATCHPOINT™ (referred to as IBIS throughout remaining document) for the collection, storage, and correlation of digital images of fired cartridge/shotshell cases. A digital image of a cartridge/shotshell case is searched against existing images in the IBIS correlation servers using an algorithm. The resulting correlation scores provide potential matching candidates according to similarity. This network, utilized in casework, can assist in determining if unsolved shooting crimes are linked and if a firearm or fired cartridge/shotshell case submitted for examination is related to an unsolved crime.

2 Scope

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel (referred to as NIBIN User through remaining document) who’ve received training on the acquisition, storage, and correlation features of the IBIS.

3 Equipment/Materials/Reagents

- Caliper (measurement within ± 0.001 in.)
 - Cleaning solvent
 - IBIS systems
- Known Exemplars
 - Microscope (stereozoom)
 - Personal protective equipment

4 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls.

To evaluate IBIS equipment performance, the following Certified Reference Material is available:

- NIST SRM 2461-118 – Standard Cartridge Case

5 Tune-Up and Maintenance

5.1 A scheduled calibration diagnostic is run automatically by the IBIS.

5.2 However, if a manual tune-up is prompted by the system, the method outlined in the IBIS® TRAX-HD3D™ BRASSTRAX™ User Guide (Chapter 9, revision 1.0) will be followed.

5.2.1 A manual tune-up is performed to adjust the microscope zoom, reset the default position and ring light intensity, and reset the default side light intensity.

5.2.2 When a manual tune-up is performed, the results and description of adjustments must be recorded in the NIBIN Log (Appendix A).

5.2.3 If a successful tune-up cannot be achieved, the results will be recorded on the NIBIN Log. The NIBIN User will contact Forensic Technology Inc.(FTI) and the system will be labeled as out of service until the issue can be resolved. A record of communication with FTI will be recorded on the NIBIN Log.

5.2.4 The NIBIN Log(s) is contained within a binder that is located near the IBIS workstation.

5.2.5 NIBIN Users will not attempt to perform any service/maintenance to the IBIS. If an issue occurs with the IBIS, FTI will be contacted and a record of this communication will be recorded in the NIBIN Log.

6 Performance Checks

6.1 A monthly performance check of the IBIS will be conducted by a NIBIN User prior to a cartridge/shotshell case being entered into the system. If an IBIS performance check has been performed within thirty days of previous image acquisition, an additional performance check is not necessary.

6.2 A performance check is conducted by acquiring and searching an image of the NIST, SRM 2461-118 cartridge case within the North East zone (zone 1). Upon entry and synchronization, a default correlation with the North East zone will be generated and reviewed.

6.2.1 If the NIST cartridge case is ranked among the top returned candidates, the performance check is acceptable. The correlation list for this performance check search will be printed and retained in the NIBIN Log binder.

6.2.2 If the NIST cartridge case does not appear among the top returned candidates, the performance check will be repeated. If the second performance check attempt fails, the issue will be recorded in the NIBIN Log, FTI will be notified, and IBIS will be labeled as out of service until the issue can be resolved. A record of communication with FTI will be recorded on the NIBIN Log.

6.3 Once a record of an acceptable performance check is complete, the captured image(s) and correlation results from the search may be removed from the IBIS.

7 Sampling

Not Applicable.

8 Procedures

8.1 Requirements for Cartridge/Shotshell Case Entry

8.1.1 Submitted cartridge/shotshell cases and test fires from pistols, rifles, and shotguns will be entered and searched against the appropriate correlation sites. Correlation sites are determined by the submitting office and any additional case information that may expand the search parameters.

8.1.2 Cartridge cases and test fires that are not typically entered or searched in the IBIS include revolvers, single shot or bolt action rifles, shotguns, in other gauges besides 12 gauge, weapons never fired, or firearms deemed unsafe, inoperable, or incomplete.

8.2 Administrative and Security

8.2.1 NIBIN Users will have successfully completed IBIS training from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), FTI, or an FTI approved trainer and have an appropriate security clearance prior to independently using the IBIS workstation.

8.2.2 The appropriate case information will be recorded for each entry. At a minimum, the FBI Case ID Number (or a derivative), FBI Laboratory Number, Item Identifier, and Case Supervisor (assigned FTD Examiner) will be entered.

8.3 Cartridge/Shotshell Case Forensic Data Entry

8.3.1 The appropriate FTD procedures will be performed prior to acquiring a digital image into IBIS. Those procedures can include: *FTD SOP Cartridge Case Examinations* and *FTU SOP Firearm Examinations*.

8.3.2 When multiple cartridge/shotshell cases have been identified as having been fired in a single firearm, only the specimen containing the most suitable microscopic marks of value is entered into IBIS.

8.3.3 The procedures listed in the IBIS® TRAX-HD3D™ | BRASSTRAX™ Training Guide (latest version) and the IBIS® TRAX-HD3D™ | MATCHPOINT™ Training Guide (latest version) will be followed for collecting digital images and reviewing correlation requests.

8.3.4 All cases entered into the IBIS will be searched against the appropriate correlation sites. Correlation results will be recorded in the appropriate examination worksheet and/or a copy of the correlation results page will be printed and added to the examination records. Any image(s) that appears to have an association will be reported to the submitting agency.

8.3.5 Correlations requests will be removed from the IBIS once the review is complete.

9 Calculations

Not Applicable.

10 Measurement Uncertainty

Not Applicable.

11 Limitations

IBIS is a multi-user system that has established guidelines. However, variables such as lighting, user experience, cartridge/shotshell case material, and the reproducibility of microscopic marks can affect the appearance of images captured, thus impacting the correlation results within IBIS. Digital images viewed on the IBIS may not have the quality and clarity of those same items that are physically viewed using a comparison microscope and will not be used to make an identification conclusion. If the visual comparison of digital images on IBIS results in an association, the evidence will be physically examined, by a qualified Examiner, using a side-by-side light comparison microscopy to determine if there is an identification.

Additionally, the IBIS algorithm merely provides a sorting capability for potentially associated toolmarks represented on cartridge cases and provides no statistical confidence in possible matching results.

12 Safety

Gloves must be worn when handling cartridge/shotshell cases which may have been exposed to biological hazards.

13 References

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

National Institute of Standards & Technology, Certificate, Standard Reference Material 2461, June 22, 2012 (Controlled Document, FTU 011)

IBIS[®] TRAX-HD3D[™] | BRASSTRAX[™] Training Guide (v1.0) (Controlled Document, FTU 016)

IBIS[®] TRAX-HD3D[™] | MATCHPOINT[™] Training Guide (v1.0) (Controlled Document, FTU 017)

IBIS[®] TRAX-HD3D[™] | BRASSTRAX[™] User Guide (v1.0), secure PDF located on BRASSTRAX terminal.

IBIS[®] TRAX-HD3D[™] | MATCHPOINT[™] User Guide (v1.0), secure PDF located on MATCHPOINT terminal.

NIBIN Training Outline and Guidelines. Retrieved from the ATF website:
<https://www.atf.gov/firearms/nibin-training-outline-and-guidelines>. Web. Accessed 5 February 2020.

Rev. #	Issue Date	History
7	03/02/18	Changed document title, and IBIS® TRAX-HD3D™ BRASSTRAX™ and MATCHPOINT™ were updated throughout document, Section 1 updated NIBIN program details, referenced Correlation Server, summarized correlation scores, and changed cartridge/shotshell cases throughout.; Section 2 added collecting, storing, and comparing, removed NIBIN reference. Included FTD clarifier for type of Examiner. Also added IBIS reference throughout document.; Section 3 modified details regarding gloves and added acetone reference.; Section 5 changed from performance check to tune-up and maintenance throughout document, clarified details regarding manual tune-up and referenced User Guide v1.0, changed notebook to binder and problem to issue, also shortened to NIBIN Log, Section 5.2.4. changed to reflect NIBIN Log being housed within a binder, Section 5.2.5 changed to NIBIN User, added communication reference.; Section 6 created specific to performance check and documentation. Regional 6 server was replaced by CSSVR-EAST/Regional NIBIN Server East 1 (Reg) using the Maryland ATF sites: MD-WAATF1 Through MD-WAATF6, MDWATFBR1 through MDWATFBR4 and MDWATFBU1; Section 7 added sample selection to header.; Section 8.1 referenced correlation site(s), removed NIBIN reference and added IBIS.; Section 8.2.1 clarified training types and sources, added NIBIN User, and outlined case information needed for each entry.; Section 8.2.2 added identifier, laboratory number reference and clarifier on type of Case Supervisor.; Section 8.3 changed title from casing to case, added details about acquiring and submitting digital images and removed NIBIN reference.; Section 8.3.1 was updated with current SOP title.; Section 8.3.2 updated for clarity.; Section 8.3.3 updated training guide versions.; Section 8.3.6 clarified correlation review and documentation within examination records.; Section 11 added established guidelines reference, changed electronic to digital, clarified details captured with microscope, added cartridge/shotshell material.; Section 12 removed three controlled documents: FTU 012, FTU 013, FTU 014, added the following controlled documents to the list of references: FTU 016, FTU 017, added BRASSTRAX™ and MATCHPOINT™ User Guide references, updated Laboratory QAM and LOM and FTU QAM references, Updated Appendix A form and title.
8	03/02/20	Formerly titled NIBIN Examinations. Section 2 updated to include FTD contract personnel. Section 3 updated. Section 4 clarified type of certified reference material. Section 6.2 updated to reflect zone selections. Section 8.1.2 was added. Section 8.3.1 updated to reflect title change in SOP. Removed reference to large primers and renumbered Section 8.3.4. Minor additions to Section 11 Limitations. Section 13 updated. Appendix A NIBIN Log updated.

Approval

Firearms/Toolmarks
Unit Chief

Redacted - Signatures on File

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Appendix A: FTD *NIBIN* Log

Redacted - Form on File

FBI Laboratory Firearms/Toolmarks Unit Silencer Testing

1 Scope

This procedure is designed for the examination of muzzle attachments to determine if they have the design and capability to reduce the sound intensity of a firearm's report.

2 Equipment/Materials/Reagents

Bruel & Kjaer, Model 2231 or Larson-Davis, Model 800B decibel meter (or equivalent decibel meter), including standard tone generator (performance check); the system must feature a rise time of 50 μ sec or better, with a measuring range of 0 to 170 decibels; note pad; hearing and eye protection; pen/pencil; ammunition; measuring tape.

3 Standards and Controls

Standards are not applicable. The tone generator is used as a control to determine if the sound meter is functioning properly.

4 Calibration

Not applicable.

5 Sampling

Not applicable.

6 Procedures

6.1 Before conducting the sound reduction test, ensure that all other tests that were requested by the contributor have been conducted, if possible. The firearms examiner may wish to confer with the latent fingerprint examiner on the processing of the muzzle attachment. After all other exams have been completed, and at the discretion of the examiner, a patch can be passed through the inside of the device, which then can be examined/tested for the presence of gunpowder or lead.

6.2 Visually inspect the muzzle attachment to determine if it can be classified as a silencer by design. This would include looking for design features that are consistent with typical “homemade” silencers. Literature is available in the FTU library to aid in this determination and the use of an X-ray machine may be warranted to allow an internal view of silencer construction (contact the Chemistry Unit for assistance with x-ray machine).

6.3 The sound reduction test should be conducted in an area with as little interfering sounds as possible. Outdoor testing over grass is ideal, but indoors on a firing range with sound absorbing walls is acceptable.

6.4 If possible, the microphone should be situated to the right of the firearm, 1 meter from, and at the same elevation as, the muzzle. A porous foam windshield should be used to cover the microphone if testing is conducted outdoors. The decibel meter should be set on the “A” weighting network, using the peak detector and peak hold circuit, if applicable.

6.5 A performance check of the decibel meter using the tone generator must be performed before each examination. If necessary, refer to manufacturer’s operating manuals (FTU Controlled Document, FTU005). The results of this performance check will be recorded in the examination notes.

6.6 For decibel (db) readings exceeding 160db, and when using the Larson-Davis model 800B with the 160db option, calibrate the meter to read 10db low. This allows for readings up to 170db.

6.7 The submitted or reference firearm should be fired ten (10) times without the muzzle attachment, along the horizontal plane.

6.8 If no ammunition was submitted or no specific ammunition requested, then a major brand of ammunition should be used.

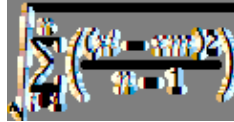
6.9 The readings of the decibel meter will be recorded for each of the ten shots.

6.10 The submitted or reference firearm will be fired using the same ammunition and procedures as were used in steps 6.6 - 6.8, this time with the muzzle attachment.

6.11 The readings recorded from the decibel meter are in decibel units. Calculate three standard deviations from the mean for the first set of ten (10) measurements without muzzle attachment. Calculate three standard deviations from the mean for the second set of ten (10) measurements with muzzle attachment.

7 Calculations

$$\text{Mean} = x_m = (\sum_i x_i)/n$$



$$\text{Standard Deviation} = S =$$

8 Uncertainty of Measurement

For the examination of a muzzle attachment in the FTU, the uncertainty of measurement is not applicable. However, if a quantitative numerical measurement result is requested to be included in an FBI Laboratory *Report of Examination* (7-1), the uncertainty of measurement must be reported. The method used to determine the estimation of uncertainty can be found in the FTU Quality Assurance Manual *Procedure for Estimating Uncertainty for Reported Quantitative Measurements*.

9 Limitations

Sound attenuation tests are not intended to measure an absolute value for sound reduction, but rather the measured difference with and without a silencer installed.

Additionally, excessive wind velocity in outdoor tests could yield inaccurate results. Testing indoors on a small range with no sound absorbing material whatsoever on walls or ceiling could also yield inaccurate results.

10 Safety

Hearing and eye protection must be worn by all participants and observers when test firing. Safety protocols and range rules will be followed at all times. If an X-ray machine from another unit in the Laboratory is needed, their personnel will perform the imaging and ensure that all safety protocols/precautions are followed.

11 References

Stephen Bell, Measurement Good Practice Guide No. 11 (Issue 2), A Beginner's Guide to Uncertainty of Measurement, Crown Publication, 1999, Issue 2 – 2001.

Alan C. Paulson, Silencer: History and Performance, vol. 1. Paladin Press, 1996.

Phillip H. Dater, "Sound Measurement Techniques," Small Arms Review, vol. 3, No. 11, August,

2000.

Manufacturer's Operating Manuals for sound meter kit, FTU Controlled Document FTU005.

FBI Laboratory Safety Manual

FBI Laboratory Quality Assurance Manual

FTU Quality Assurance Manual

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation.
1	01/20/10	In Section 2 added B&K and Larson-Davis decibel meters (or equivalent). Sections 4 and 5 changed for consistency with other SOPs. Added contact Chemistry Unit to Section 6.2 and added Section 6.5.
2	08/19/11	Updated section 8 for consistency with QAM.
3	03/07/12	Updated title. Replaced reference material with literature in section 6.2. Added requirement for recording performance check and added FTU controlled document 005 to section 6.5. For sections 6.7 and 6.10, replaced “suspect or control weapon” with “submitted or reference firearm”. Updated sections 7 and 8 for consistency with uncertainty of measurement in Revision 5, QAM. Section 9 updated for consistency with FTU report writing examples and added conditions when tests could be affected. Updated references in section 11.
4	05/02/13	Section 1 revised. Added Section 6.11 for calculating standard deviation. Section 8 was updated to include when uncertainty of measurement is calculated.

Approval

Redacted - Signatures on File

**FBI Laboratory
Firearms/Toolmarks Unit
Shot Pattern Examinations in Muzzle-to-Target Distance Determinations**

1 Scope

This procedure is to provide a comprehensive protocol when performing muzzle-to-target distance determinations based on shot patterns.

2 Equipment/Materials/Reagents

Stereozoom binocular microscope (magnification range 10X-20X), steel tape measure, target materials, hearing protection, target backing materials, eye protection, and ammunition.

3 Standards and Controls

Lead bullets are used as a positive control for the Sodium Rhodizonate test. Nitrites test swabs are used as a positive control for the Modified Griess test. Copper jacketed bullets are used as a positive control for the Modified Dithiooxamide (DTO) test.

4 Calibrations

Not applicable.

5 Sampling

Not applicable.

6 Procedures

6.1 Microscopic and Visual Examination

6.1.1 Although shot patterns in victim garments and other objects are normally microscopically examined and chemically processed to detect residues such as nitrite compounds, copper and lead due to "pellet wipe," the basis for most distance determinations is the size of the shot pattern and its reproduction. Patterns produced by shot pellets will be elongated in some cases due to the fact that an angle other than 90 degrees existed between the barrel of the weapon and the area of impact. In this situation, the narrower dimension is the significant dimension as a

basis for comparison with the size of known-distance patterns.

6.1.2 It is also important to note that a shot pattern is not necessarily the product of a shotgun having been fired, at least in the case of the smaller shot sizes. Handgun “snake” loads are common in a variety of calibers. In addition, during the microscopic examination it is possible that fine plastic particulate, typically black or white, will be found. This material would be indicative of the discharge of a shotgun as some types of shotshells use it as a filler material.

6.1.3 In the case of a non-circular (off-center) shot pattern, if the examiner determines it to be appropriate, the angle of the pattern should be measured.

6.2 Chemical Residues and their Processing

6.2.1 In the chemical processing of shot patterns, the same procedures used with suspected bullet holes are used, with the additional considerations outlined below. At the examiner’s discretion, the Modified Griess Test, DTO Test and Sodium Rhodizonate Test should be performed because it is possible that a shot pattern may contain another bullet hole or other residues. Although it may be possible to detect vaporous lead and nitrite residues as a result of a shotgun discharge in close range shots, it is normally the pattern of shot which will be the best indicator of the muzzle-to-target distance. Further, attention should be paid the possibility of “pellet wipe” and lead randomly deposited by the impact of wadding materials. Although these types of deposits are not specifically useful in distance determination, they certainly can provide corroboration.

6.2.2 The specific techniques for conducting the Modified Griess Test and the Sodium Rhodizonate Test are the subject of other procedures.

6.3 Known-Distance Tests

6.3.1 When reproducing shot patterns detected on evidence items, it is essential that the suspect weapon and ammunition highly similar to the suspect ammunition be used in the known-distance tests. It is recommended that the known-distance targets be fired in target material affixed to a cardboard backing material.

6.3.2 When reproducing residue patterns, fire known-distance targets to produce patterns that are both smaller and larger than the patterns found on the submitted evidence. Producing smaller and larger residue patterns makes it possible to “bracket” the evidence pattern. The “bracket” should be wide enough to account for differences expected in commercially manufactured ammunition and variations normally expected from shot to shot.

6.3.3 In the case of non-circular patterns, the examiner may attempt to reproduce the pattern by firing at different distances and angles.

7 Calculations

Not applicable.

8 Uncertainty of Measurement

Not applicable.

9 Limitations

While shotguns are known to produce consistent shot pattern results under controlled conditions, variables including barrel length, barrel choke and shotshell design can all influence the size and distribution of shot patterns present on the submitted evidence and test-fired exemplars. Accordingly, shot pattern test results are primarily used to exclude particular muzzle-to-target ranges and should only be considered valid for the particular combination of shotgun and type of shotshell used during testing in the Laboratory.

Distance determinations involving a wound and/or injury are outside the scope of this procedure.

10 Safety

Follow the same procedure set forth in the Modified Griess test and Sodium Rhodizonate test procedures, as well as range safety procedures for the test firing of firearms.

11 References

SWGGUN.org, Guidelines for Gunshot Residue Distance Determinations.

Dillon, J.H., "Graphical Analysis of the Shotgun/Shotshell Performance Envelope in Distance Determination Cases," AFTE Journal, 1989: 21(4):593-594.

Dillon, J.H., "Protocol for Shot Pattern Examinations in Muzzle-to-Target Distance Determinations," AFTE Journal, 1991; 23(1):511-521.

Lekstrom, Julie A., Koons, Robert D. Ph.D., "Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test," *Journal of Forensic Sciences*. JFSCA, Vol.31, No. 4, Oct. 1986. pp. 1283-1291.

Schous E. Clara, "A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues," AFTE Journal, vol. 31, no.1, 1999.

FTU Quality Assurance Manual

FBI Laboratory Safety Manual

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation
1	11/05/07	Removed reference to standards in section 3. Updated Section 4 to remove stereomicroscope calibrations.
2	05/02/13	Section 9 expanded limitations statement. Section 11 added reference.

Approval

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FBI Laboratory

Firearms/Toolmarks Unit (FTU)

The Sodium Rhodizonate Test for Lead Residues

1 Scope

The Sodium Rhodizonate Test is designed for detecting depositions of vaporous and particulate lead around a suspected bullet hole as a basis for estimating muzzle-to-target distances. Such depositions may be on evidence items such as clothing, furniture, bedding, and wallboard.

2 Equipment/Materials/Reagents

Electronic balance (minimum weighing range must exceed 0-50 grams, but not exceed 0-3000 grams; the linearity specification must not exceed 0.1 gram); Microspatula; Filter paper; Aerosol spray equipment; Blotters/brown wrapping paper; Glass stirring rod; Disposable PVC gloves; Hot plate/magnetic stirrer; Polyethylene bottles; Laboratory coat; Glass beaker (500 ml); Exhaust hood; Concentrated hydrochloric acid (reagent grade or better); Sodium bitartrate (reagent grade or better); Tartaric acid (reagent grade or better); Sodium rhodizonate (reagent grade or better); De-ionized and/or distilled water; Glacial acetic acid (reagent grade or better).

3 Standards and Controls

A lead bullet is used as a positive control for the Sodium Rhodizonate Test (SoRho). If a chemical reagent must be prepared before an examination, the following information must be recorded on the appropriate FTU Chemistry Log which can be found in the Firearms/Toolmarks Unit, *Comprehensive Gunshot Residue Examinations in Muzzle-to-Target Distance Determination* procedure: chemical produced, preparer, date (lot number), parent chemical, FBI Laboratory serial number and the performance check. The chemical lot number for reagents used during examinations will be recorded in the examination notes.

4 Calibration

Not Applicable.

5 Sampling

Not Applicable.

6 Procedures

6.1 Preparation of Reagents and Test Media

6.1.1 Storage of prepared chemicals and test media should be such that contamination is not possible. Storage containers should be kept sealed until the contents are needed. Fractions or multiples of the weights and volumes indicated may be used as appropriate to the amount of work to be done. For disposal of the chemicals used for this procedure, refer to the Guideline for Hazardous Waste Management in the Firearms-Toolmarks Unit (FTU), copies of which are maintained in the Chemistry Room.

6.1.2 Preparation of the Sodium Rhodizonate Solution

Place a small amount of sodium rhodizonate in a small beaker and add sufficient de-ionized and/or distilled water to make a saturated solution approximately the color of strong tea. The solution is saturated if slight sediment is noted on the bottom of the beaker after stirring with a clean glass stirring rod. Make only enough solution for immediate use.

6.1.3 Preparation of 2.8 pH Buffer Solution

6.1.3.1 Dissolve 1.9 grams of sodium bitartrate and 1.5 grams of tartaric acid per 100 milliliters of distilled water. This usually requires both heat and agitation. A combination hot plate/magnetic stirrer can be used for this.

6.1.3.2 Store the solution in a properly labeled and sealed container (the latter to prevent clouding). There is no known limit to the shelf life of this reagent.

6.1.4 Preparation of the Dilute (5%) Hydrochloric Acid Solution

6.1.4.1 Combine 5 milliliters of concentrated acid with 95 milliliters of distilled water. Pour the acid into the water to preclude potential spattering of undiluted acid.

6.1.4.2 Store the solution in a properly labeled and sealed container. Solution can be stored indefinitely.

6.1.5 Preparation of a 15% Acetic Acid Solution

6.1.5.1 Combine 150 milliliters of glacial acetic acid with 850 milliliters of distilled water. Gently pour the acid into the water to preclude the potential spattering of undiluted acid.

6.1.5.2 Store the solution in a properly sealed and labeled container. There is no known limit to the shelf life of this reagent.

6.1.6 Preparation of Controls

6.1.6.1 Positive Control

A lead bullet from the FTU ammunition room will be wiped across a piece of test material and the material then processed for the expected blue-violet reaction. The results will be recorded in the examiner's notes.

6.1.6.2 Negative Control

Observing the absence of any blue-violet color development on the non-wiped portions of the test material is sufficient for a negative control. The results will be recorded in the examiner's notes.

6.2 Direct Application to Light-Colored Items of Evidence

6.2.1 Spray the appropriate area of the questioned item with the previously prepared saturated solution of sodium rhodizonate.

6.2.2 Spray the same area of the questioned item with the previously prepared tartaric acid/sodium bitartrate buffer solution. This solution will eliminate the general yellow background color caused by the sodium rhodizonate and will establish a local pH of 2.8, turning any lead, as well as other metals that may be present, a pink color.

6.2.3 Spray the same area with the previously prepared dilute hydrochloric acid solution. The presence of lead is specifically determined wherever the previous pink color fades out and leaves a blue-violet color in its place; this indicates lead and only lead. Be very aware that a positive (blue-violet) result may abruptly fade. Note the results immediately after applying the dilute hydrochloric acid solution.

6.3 The Reverse Transfer Method for Dark-Colored Items that Would Mask the Blue-Violet Coloration of a Positive Test Result

6.3.1 Place a piece of filter paper over the appropriate area of the questioned item.

6.3.2 Index the filter paper relative to the garment or other item to indicate the location of such things as suspected bullet holes, seams, buttons, button holes, pockets, rips, and tears. Indexing in pencil is preferable since ink may bleed during the application of reagents.

6.3.3 Uniformly dampen the filter paper on the questioned item by spraying with a 15% solution of glacial acetic acid.

6.3.4 Cover the dampened filter paper with several layers of dry filter paper. Apply a hot iron to the filter paper and iron until the paper is dry.

6.3.5 Remove the filter paper which was in direct contact with the evidence item, and process

it using the steps in 6.2 above. Note that any positive (blue-violet) indications are a mirror image of the deposition on the questioned item.

6.3.6 Prompt note-taking is essential in that sometimes the color can fade rapidly and unpredictably. When dry, filter paper exhibiting positive results should be properly marked in ink for future identification, and retained in the case file or returned to the contributor. Filter paper exhibiting no results can be discarded.

6.4 The Standard Transfer Method, Normally a Last Resort

6.4.1 Process the questioned item by following all steps in 6.2 above.

6.4.2 Blot the appropriate area of the questioned item using untreated filter paper.

6.4.3 Note any positive results. Such transfers usually reflect positive results which are very vague and indistinct in form. See 6.3.6 for proper handling.

7 Calculations

Not Applicable.

8 Uncertainty of Measurement

Not Applicable.

9 Limitations

The Sodium Rhodizonate and Modified Sodium Rhodizonate Tests yield results for the presence of lead regardless of whether these are related to the discharge of a firearm or the passage of a bullet.

10 Safety

Since many of the procedures involve the spraying of reagents in an aerosol form. All spraying should be done in an exhaust hood that has an air flow velocity of 60-120 feet/minute. Protective latex or vinyl gloves will be worn at all times.

11 References

Barnes, F.C. and Helson, R.A., "An Empirical Study of Gunpowder Residue Patterns," Journal of Forensic Sciences, Vol. 19, 1974, pp. 448-462.

Dillon, J.H., "A Protocol for Gunshot Residue Examination in Muzzle-to-Target Distance Determinations," AFTE Journal, Vol. 22, No. 3, 1990, pp. 257-274.

Dillon, J.H., "The Sodium Rhodizonate Test: A Chemically Specific Chromophoric Test for Lead in Gunshot Residues," AFTE Journal, Vol. 22, No. 3, 1990, pp. 251-256.

Fiegel, F. and Anger, V., Spot Tests in Inorganic Analysis, 6th ed, Elsevier Publishing Co, New York, 1972.

Lekstrom, A.J. and Koons, R.D., "Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test," Journal of Forensic Sciences, Vol. 31, No. 4, 1986, pp. 1283-1291.

Schous, C.E., "A Sequence of Chemically Specific Chromophoric Tests for Nitrite Compounds, Copper, and Lead in Gunshot Residues," AFTE Journal, Vol. 31, No.1, 1999, pp. 3-8.

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

FBI Laboratory, FTU Quality Assurance Manual

Rev. #	Issue Date	History
0	07/10/06	Original issue for ASCLD/LAB- <i>International</i> accreditation
1	02/17/07	Updated section 3 including use of FTU Chemistry Log (Appendix C)
2	11/05/07	Potassium Chloride (KCl) deleted from section 2. Deleted section 6.1.6 and renumbered section, and sections 6.5 and 6.6 were deleted due use of KCl. See DTO procedure sections 6.2 and 6.3 for method. Removed reference to standards in section 3. Updated section 4 by removing calibration information.
3	08/21/12	Section 3 added cite where Chemistry Logs can be found. Section 6.1.2 added de-ionized and/or distilled water.

Approval

Redacted - Signatures on File

FBI Laboratory Firearms/Toolmarks Unit Firearm Barrel and Overall Length Measurements

1 Scope

This procedure is designed to provide a technique for the measurement of a barrel and the overall length of a firearm in the Firearms/Toolmarks Unit (FTU). This procedure is necessary when a measurement is reported as requested by a contributor or is probative to a case.

2 Equipment/Materials/Reagents

National Institute of Standards and Technology (NIST) traceable steel rulers, Hott Rods[®] (measuring rod), measuring platform, and square.

3 Standards and Controls

Steel ruler(s) and measuring rod(s) that are calibrated to a National Institute of Standards and Technology (NIST) standard.

4 Calibrations

Not applicable.

5 Sampling

Not applicable.

6 Procedures

6.1 Safety

6.1.1 When handling a firearm for the purpose of measuring, safety is the first concern. Make sure the firearm is unloaded before conducting measurements. If there is any doubt about the operability of a firearm, consult with a qualified firearms instructor (if available), protocols or manufacturers' literature before handling a firearm for measuring.

6.2 Measuring

6.2.1 When measuring barrel or overall length the following should be considered before measuring: ensure the firearm/barrel is free from movement and stable for measuring, measure in an area with proper lighting, and the proper calibration certificates are current and traceable to a National Institute Standards and Technology (NIST) standard. When a measurement is made where the uncertainty of that measurement will be reported, the calibration date and unique identifier for the ruler being used will be recorded in the examination notes.

6.3 Barrel Length Measurements

6.3.1 Revolvers

6.3.1.1 When measuring a revolver barrel, the distance parallel to the bore axis from the muzzle end to the end of the forcing cone represents the length of the barrel.

6.3.1.2 A steel ruler or measuring rod will be used to measure the length of a revolver barrel. When using a steel ruler, the ruler is placed on the exterior of the barrel parallel to the bore axis for measuring. A measuring rod can be used to measure barrel length, however it may be difficult to determine the start point for the measuring rod. Consideration must be taken to determine how the starting point can be accurately achieved. A block at the muzzle or forcing cone end of the firearm, which is perpendicular to the axis of the bore can represent the starting point for the measuring rod to determine barrel length.

6.3.2 Integral Chamber Barrels

6.3.2.1 When measuring the barrel of a firearm that has an integral chamber, the distance parallel to the bore axis from the muzzle end to the breechface (with the action closed) represents the length of a barrel.

6.3.2.2 Before measuring an integral chamber barrel, ensure that the firing pin is not impeding the measuring rod from making contact with the breechface. It may be necessary to cock the firearm to remove a protruding firing pin. In the case of a fixed firing pin, be certain it is not reducing the barrel length measurement. Ensure that the measuring rod, when inserted in the barrel, is parallel to the bore axis.

6.3.2.3 When using a measuring rod to determine the barrel length measurement, read the increments perpendicular to the bore axis at the furthest point of the barrel.

6.3.2.4 Barrel length will be measured to the nearest sixteenth of an inch.

6.3.2.5 When a barrel length measurement is being reported, the serial number of the measuring rod used will be recorded in the examination notes.

6.4 Overall Length Measurements

6.4.1 The overall firearm length is measured using the measuring platform located in the water tank room.

6.4.2 When measuring the overall length of a firearm, the measurement is taken along a line which is parallel to the axis of the bore from a perpendicular tangential line which touches the rearmost point of the firearm to the muzzle.

6.4.2.1 With the firearm positioned in the measuring platform, a square is placed at a right angle to the measuring platform touching the muzzle to determine the overall length.

6.4.3 Overall lengths will be measured to the nearest sixteenth of an inch.

6.4.4 When an overall length measurement is being reported, the serial number of the ruler used will be recorded in the examination notes.

7 Calculations

Not applicable.

8 Uncertainty of Measurement

If a quantitative numerical measurement result is included in an FBI Laboratory *Report of Examination* (7-1), the uncertainty of measurement must be reported. The method used to determine the estimation of uncertainty can be found in the FTU Quality Assurance Manual – *Procedure for Estimating Uncertainty for Reported Quantitative Measurements*. The uncertainty budget for barrel length and overall length measurements for the FTU is located in the Estimating Uncertainty of Overall and Barrel Length Measurements for Firearms binder located in the FTU library.

9 Limitations

Barrel length measurements are dependent on the straightness of the measuring device and the assessment of the muzzle end in relation to the measuring device. Overall length measurements are dependent on proper alignment of the firearm in the measuring platform.

10 Safety

For the proper handling of firearms, consult the Safety Protocols for Handling of Firearms and Ammunition located in the FTU range, bullet recovery tank room and reloading room.

11 References

SWGGUN.org

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FTU Quality Assurance Manual

FBI Laboratory Safety Manual

Firearms/Toolmarks Unit, FBI Laboratory, Controlled Document FTU 007, “Safety Protocol for Handling of Firearms and Ammunition”, August 8, 2004.

Department of the Treasury Bureau of Alcohol, Tobacco and Firearms, Federal Regulations Reference Guide

Sporting Arms and Ammunition Manufacturers’ Institute Inc., Glossary of Terms

Rev. #	Issue Date	History
0	05/07/08	Original issue for ASCLD/LAB- <i>International</i> accreditation.
1	07/14/10	Added “with action closed” to section 6.1.3. Updated references.
2	02/23/11	Added sections 6.1.5 and 6.2.4.
3	08/19/11	Updated section 8 for consistency with QAM.
4	12/19/12	Revised for the introduction of new measuring rods and measuring platform. Updated references.
5	05/02/13	Section 1 added more guidance when this procedure will be used. Section 2 deleted “ruler.” Updated Section 6.3.1.2 and included the use of measuring rod. Section 6.3.2.2 changed “perpendicular” to “parallel.” Section 6.3.2.3 gave more guidance on where to measure. Section 6.3.2.5 deleted “ruler” and added “measuring rod.” Section 6.4.2 defined the process of overall length measurement and section 6.4.2.1 outlines how measuring is performed in the FTU. Section 6.4.4 deleted “barrel” and added “overall.” Section 8 added location of FTU uncertainty budget. Section 11 added reference.

Approval

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Firearms/Toolmarks Discipline Standard Operating Procedure for Class Characteristic Database Entries and Searches

1 Introduction

The General Rifling Characteristics (GRC) database is comprised of observed and measured class characteristics collected from known test-fired bullets and cartridge cases. Test-fired bullets and cartridge cases used for the GRC database are received from forensic laboratories and cooperating law enforcement agencies both within and outside the United States. The purpose of the GRC database is to provide investigative information to law enforcement agencies on the make and model of a firearm that could have fired a questioned bullet or cartridge case based on observed and measured class characteristics.

2 Scope

These procedures are for collecting GRC information for entry into and performing database searches of the FBI Laboratory GRC database produced by Firearms/Toolmarks Unit (FTU) personnel.

3 Equipment/Materials/Reagents

- | | |
|--|--------------------------------------|
| • Alicona InfiniteFocus SL with rotational bullet mount, movable stage, and appropriate lighting and magnification lenses. | • Measurement equipment |
| • Computer with Windows Office Professional [®] operating system running Microsoft Access [®] . | • Microscope (stereozoom/comparison) |

4 Standards and Controls

- National Institute of Standards and Technology Standard Reference Material bullet (NIST SRM 2460)
- Alicona IF-Verification Tool G2
- Alicona 6mm Calibration Pin

5 Performance Checks

5.1 Performance checks of the measurement equipment and Alicona will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

6 Sampling

Not Applicable.

7 Procedures

7.1 GRC Measurements of Bullets and Observable Class Characteristics on Cartridge Case for Entry into the GRC Database

7.1.1 Each entry into the GRC database will be assigned a unique identifier.

7.1.2 For specimens generated internally for entry into the GRC database, the GRC Program Manager (PM) will record the observable class features and conduct the necessary measurements for specimen(s) being entered into the GRC database. At a minimum, the GRC unique identifier, number of lands and grooves (L/G), direction of twist, L/G widths, and observable class characteristics on the cartridge cases will be recorded on the container for the specimen being entered into the database.

7.1.3 For specimens submitted from forensic laboratories and cooperating law enforcement agencies, the GRC PM will determine if the necessary materials have been submitted: a minimum of two test-fired bullets and/or cartridge cases or suitable casting material from barrel, and completed GRC Test-fire Entry Sheet (located on the GRC database CD).

7.1.4 Specimens for entry into the GRC database must be in suitable condition for accurate measurements - no fragments or interference from expansion and land and groove edges are acceptable.

7.1.5 The primary method for obtaining measurements will be analysis of three dimensional (3D) scan data acquired from the 3D Toolmark Topographical Instrument, the Alicona InfiniteFocus (AIF) SL. When using AIF SL, only one measurement is necessary for each specimen entered into the GRC database.

7.1.5.1 If the Alicona instrument is not available or not functioning properly, measurements can be obtained using methods described in Section 6.1.7 and two sets of measurements are necessary if using these methods.

7.1.6 3D Toolmark Topographical Instrument Measured GRCs

7.1.6.1 The instrument instructions on how to obtain scans and perform measurements, using a 3D Toolmark Topographical Instrument, are located with the instrument and labeled FTU Control Document 020.

7.1.6.2 Appropriately trained personnel will use the AIF SL to scan the surface of the test-fired bullet, and save the scans for future measurements.

7.1.6.3 The GRC PM will perform the measurements on the acquired scans. The high and low values of the range of measurements will be recorded on the specimen container.

7.1.7 Microscope Measured GRCs

The GRC PM will use the appropriate *FTD SOP Bullet Examinations* and/or *FTD SOP Cartridge Case Examinations* to determine the GRC information for the specimen(s).

7.1.8 The GRC PM will measure the chord (width) of each land impression (LIMP) and groove impression (GIMP) for all the submitted test-fired bullets. The high and low values of the range of measurements will be recorded on the specimen container.

7.1.9 The maximum and minimum measurement from both sets of measurements will be used to establish the LIMP and GIMP boundaries for the GRC database.

7.2 GRC Database Entry and Management

7.2.1 The data acquired from steps 7.1.1 through 7.1.9 will be entered into the database by the GRC PM and saved for use by the FTU and for future distribution.

7.2.2 After entries have been put into the GRC database, a confirmation will be performed to ensure the correct information has been recorded for each specimen by qualified FTU personnel. The initials of the confirmer on the specimen container will indicate the information has been correctly recorded into the database. If the information has been incorrectly entered, the confirmer will make the necessary correction(s) and note the correction on the specimen container.

7.2.3 The information collected from the specimens entered into the GRC database will be maintained by the GRC PM.

7.2.4 Screen shots demonstrating the step-by-step method for specimen entry into the GRC database will be maintained on the FTU shared drive for future users (see FTU Controlled Document FTU_010).

7.3 Distribution of the FBI GRC Database

7.3.1 Approximately every two years, an updated version of FBI GRC database will be distributed to forensic laboratories and cooperating law enforcement agencies.

7.3.2 The GRC PM will facilitate the production and distribution of the GRC database. The list of participating and recipient agencies will be maintained by the GRC PM.

7.3.3 Prior to distribution to forensic laboratories and cooperating law enforcement agencies, the GRC PM will conduct a performance check on the GRC database using *Appendix A*, GRC Database Performance Check Form. This performance check will determine if the information contained in the database is present and retrievable. The total number of hits for each search field will be recorded; this record will be maintained by the GRC PM.

7.3.4 If the performance check fails, a second attempt will be made. If the second performance check fails, the GRC PM will contact the FBI Laboratory Database Programmer for assistance. The updated GRC database will not be distributed until a successful performance check has been completed.

7.3.5 Each distributed updated version of the GRC database will include operating instructions, a GRC Test-fire Entry Sheet, a copy of the completed GRC Database Performance Check Form, and instructions on how to perform a performance check with instructions on how to proceed if the performance check fails.

7.4 GRC Database Search

7.4.1 The examiner/technician will use the appropriate FBI LOM and FTD SOP(s) to determine the GRC information for the specimen(s).

7.4.2 The examiner/technician will conduct a search through the GRC database using a range of land and groove widths.

- a. At the discretion of the examiner or condition of the evidence, the range for the widths can be adjusted to expand or narrow the search results.
- b. Additional search criteria, such as cartridge case information, may be added to further narrow the search results.

7.4.3 The examiner will review the search results to ensure the GRC information is complete and that no obvious errors are present.

8 Calculations

To convert measurements of large lands and grooves from chord (L_c) length to arc (L_a) length the following equation can be used (D : bullet diameter):

$$L_a = \pi D \left(\frac{2 \sin^{-1} \left(\frac{L_c}{D} \right)}{360^\circ} \right)$$

9 Measurement Uncertainty

Not Applicable.

10 Limitations

The GRC database does not include every firearm produced by each manufacturer. Variations in manufacturing methods, use, neglect, and/or environmental effects may cause the GRCs to vary within a single firearm. The GRCs for a specific make/model of a firearm from a single manufacturer may vary slightly from one firearm to the next due to acceptable manufacturing tolerances. Different manufacturers may produce firearms of a specific caliber with similar GRCs and a specific make/model of a firearm could be chambered in more than one caliber. The addition of aftermarket components to a firearm can have varying GRCs from the original manufacturer's design. Furthermore, some data entry errors may exist in the database.

11 Safety

When handling firearms the FTU *Safety Protocol for Handling of Firearms and Ammunition* will be followed. Protective gloves must be worn when handling bullets that have been possibly exposed to blood, tissue, or other body fluids.

12 References

Mathews, J.H., Firearms Identification, Vols. I-III, Charles C. Thomas, Springfield, IL (1977).

Gunther, J.D., and Gunther, C.O., The Identification of Firearms, John Wiley, New York (1935).

Hatcher, J.S., Jury, F.J., and Weller, J., Firearms Investigation, Identification and Evidence, The Stackpole Co., Harrisburg, PA (1957).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

"FTU Safety Protocols for Handling of Firearms and Ammunition", Appendix A, *FTD SOP
Firearm Examinations*.

Firearms/Toolmarks Unit, S drive/FTU QA Folder/ GRC Screen Shots (FTU, Controlled Document FTU010).

Rev. #	Issue Date	History
1	03/02/18	Issuing unit name changed to Firearms/Toolmarks Discipline in title and on header on all pages. New hardware added to Section 3 and measureable standards added to Section 4. Procedural changes made to Section 6 due to the use of the 3D Measurement system. Minor changes to the distribution and use within the unit added to Section 6. Additional limitations added to Section 9 for clarification. Added safety protocol footnote to Section 10. Added Appendix B.
2	03/02/20	Updated title, which was formerly General Rifling Characteristics (GRC). Reformatted Section 3. Added Section 5 and renumbered. Indicated location of instrument instructions in Section 7.1.6.1. Updated SOP titles in Sections 7.1.7 and 12. Updated Appendix A. Removed Appendix B.

Approval

Firearms/Toolmarks
 Unit Chief

Redacted - Signatures on File

Date: 02/28/2020

Firearms/Toolmarks
 Technical Leader

Date: 02/28/2020

Appendix A: *FTU GRC Database Performance Check Form*

Redacted - Form on File

Firearms/Toolmarks Discipline Standard Operating Procedures for Disposition of Firearms

1 Introduction

The Firearms/Toolmarks Unit (FTU) is responsible for the destruction of weapons that have been declared abandoned, court-ordered for destruction, and purchased with FBI case funds. The FTU may request firearms for official use and add them to the Reference Firearms Collection (RFC). The FTU maintains the RFC, which contains over 7,000 handguns, rifles, and shotguns that are used to support casework, training, intelligence, research, and investigative objectives. All firearms—including but not limited to real, inoperable, replica, BB-guns, toy guns, water guns—as well as silencers /suppressors, are required to be sent to the Laboratory for disposition as stated by the *Field Evidence Management Policy Guide*. Though not required, non-firearm weapons and items such as ammunition, knives, holsters, gun cases, tasers, and brass knuckles may also be sent to the Laboratory for disposition. Firearm disposition is currently tracked through the VISI-TRAC[®] software (referred to as Visi-Trac throughout remaining document), and the Firearms Disposition Database for assets entered prior to July 2013. The Bureau of Alcohol, Tobacco, Firearms, and Explosives (BATFE) is responsible for the destruction of forfeiture weapons if not requested for official use through the FBI's Forfeiture and Seized Property Unit (FSPU). The Defensive Systems Unit (DSU) in the Training Division is responsible for the destruction of FBI issued weapons and "Special Case Weapons," which include any weapon used for operational purposes listed under DSU's cost code.

2 Scope

These procedures apply to the Reference Firearms Collection Program Manager (RFCPM) and other FTU personnel for the disposition of firearms, either their destruction or inclusion into the RFC.

3 Responsibilities

The Reference Firearms Collection Program Manager and other FTU personnel will:

- Ensure the RFC and Visi-Trac software are updated and maintained.
- Ensure the disposition process is properly applied to all firearms.
- Add firearms to the RFC when deemed appropriate and necessary.
- Test fire all firearms received and enter and review cartridge cases, where appropriate, in the National Integrated Ballistics Information Network (NIBIN).
- Witness (or designate a witness) the destruction of firearms.

- Ensure that the Visi-Trac record for every firearm received for official use is made available to the FTU Management and Program Analyst (MAPA) immediately upon entry.
- Assist in the performance of the annual 100% audit of the RFC.
- Update the status of items in Sentinel when those items are received or disposed.
- Regularly review assets available through the Consolidated Asset Tracking System (CATS) and request assets for official use.

The FTU Management and Program Analyst (MAPA) will ensure:

- The Visi-Trac record is used to update the Laboratory Property Management System, currently the Asset Management System (AMS), within 48 hours of receipt.
- Finance Division (FD) is notified of all firearm additions to AMS.

4 Equipment/Materials/Reagents

Computer with ChemNet access to Visi-Trac, radio frequency identification (RFID) barcode scanners, RFID tags with barcode (attached to firearms/non-firearm weapons), NIBIN access, and FBINET Access is required to utilize Sentinel and the Asset Management System, and UNET access for CATS.

5 Standards and Controls

Not Applicable

6 Sampling

Not Applicable

7 Legal Statutes of Firearms

7.1 Court Order Destruction

7.1.1 Firearms may be received with a court order, signed by a judge, that states the submitted firearms **MUST** or **SHALL** (or other language of equal weight) be destroyed. These firearms cannot be added to the RFC. If the court order language states a firearm **MAY** be destroyed (or other similar non-imperative language), then it is at the discretion of the RFCPM to retain or destroy the submitted firearm.

7.1.2 A Court Order Number should be included in the documentation received and recorded in the "Seizure Number" section of Visi-Trac.

7.1.3 Leads in Sentinel may only be covered when a court order destruction firearm has been physically destroyed or retained for official use. The lead may be partially covered to indicate to the Field Office (FO) that the firearm was received in the FTU for destruction.

7.2 Abandonment

7.2.1 Firearms seized in the field are considered abandoned when an owner is unknown, or known but unwilling to take possession of the firearm.

7.2.2 Abandoned firearms are obtained through the FSPU. The RFCPM will regularly review firearms seized by the FBI and available for official use. The paralegal specialist assigned to the asset will be emailed and provided with the pertinent information regarding firearms requested for official use. At the completion of the abandonment process, the paralegal specialists will notify the RFCPM to submit an official EC for the requested firearm(s) in Sentinel which will be approved by the Firearms/Toolmarks Unit Chief. EC distribution will include the FO and FSPU contact on the abandonment documentation and the Laboratory Division Planning and Budget Unit Chief.

7.2.3 Abandoned firearms will be received with a Declaration of Abandonment including the abandonment number. The Abandonment Number should be included in the documentation received and be noted in the "Source Document" section of Visi-Trac. Asset value in the Declaration of Abandonment will match asset value in Visi-Trac. Any missing information may be found in Sentinel, or by contacting the contributor directly.

7.2.4 Leads are covered by the RFCPM when an abandoned firearm is allocated to a designated container for destruction or included in the RFC.

7.3 Forfeiture

7.3.1 Firearms seized in the field are considered forfeit when the owner is known and has relinquished their legal right to own the firearm(s).

7.3.2 The RFCPM will regularly review firearms seized by the FBI and available for official use. The paralegal specialist assigned to the asset will be emailed and provided with the pertinent information regarding firearms requested for official use. At the completion of the Forfeiture Process, FSPU will notify the RFCPM to submit an official EC request. EC distribution will include the FSPU contact on the abandonment documentation and the Laboratory Division Planning and Budget Unit Chief. EC approval is by the Firearms/Toolmarks Unit Chief.

7.3.3 The Field Office will send forfeited firearms to the BATFE for destruction when not requested for official use by FTU or DSU.

7.3.4 Forfeiture firearms must be received with a Declaration of Forfeiture and a Forfeiture Number. The Forfeiture Number should be included in the documentation received and be noted

in the “Source Document” section of Visi-Trac. Asset value in the Declaration of Forfeiture will match asset value in Visi-Trac. Any missing information may be found in Sentinel, or contacting the contributor directly.

7.3.4.1 Leads are covered by the RFCPM when a forfeit firearm is allocated to a designated container for destruction or included in the RFC. Forfeited firearms can only be destroyed by the FTU in special cases with approval of FSPU.

7.4 FBI Purchase

7.4.1 FBI Purchase firearms are those purchased with case funds, and must be forwarded to FTU for disposition following the adjudication of all legal proceedings. This section does not include intentional requisitions of firearms for official use by the RFCPM or FTU.

7.4.2 FBI Purchase firearms must be received with an EC from the submitting field office, unit, or individual detailing the circumstances of the related case.

7.4.3 Leads are covered by the RFCPM when the FBI Purchase firearm is allocated to a designated container for destruction or included in the RFC.

7.5 Gift/Donation

7.5.1 Firearms donated by an individual or group will be received with an FD-1082a, Federal Bureau of Investigation Gift Acceptance Form.

7.5.2 An FD-1082a initiated by the FTU will go through the proper approval chain before the assets may be transferred to the FTU.

7.5.3 The Asset Management Unit (AMU) will notify the RFCPM via EC of any firearms donated to the FBI by other means.

7.6 Transfer

7.6.1 Firearms transferred from another federal agency will be received with a SF-122 Property Transfer form. The SF-122 is automatically generated when firearm(s) are requested through the General Services Administration (GSA). The SF-122 is manually generated when the firearm(s) transfer is initiated by the FTU based upon liaison with other government agencies.

7.6.2 An SF-122 initiated by the FTU will be approved by Finance Division prior to the transfer of any listed assets to the FTU.

7.6.3 The SF-122 should clearly indicate item description, quantity, monetary value, and Transfer Order Number(s). The Transfer Order Number will be recorded in the “Source Document” section of Visi-Trac.

8 Procedures

8.1 Firearm Safety Inspection

An initial safety inspection must be conducted prior to the handling of any firearm. Refer to FTU SOP – Examination of Firearms for details.

8.2 Firearm Receiving

An EC to the RFCPM should precede or be included with the delivery of every abandoned, forfeited, court ordered, or FBI Purchased firearm. Firearms are directly delivered or shipped by the submitting field office, court, or agency. The submitted firearms should match the items listed on the accompanying documentation, which will include the EC date, legal status, make, model, caliber, serial number, Universal Case File Number (UCFN), submitting agency, and Court Order, Abandonment, Forfeiture, or Transfer Order Number where appropriate. Items shipped to the Laboratory for destruction will have their status changed in Sentinel to disposed by the Field Office.

8.2.1 If documentation is not submitted with the firearm(s), it is the responsibility of the RFCPM or designee to obtain it through Sentinel or direct contact with the contributor. If documentation can not be obtained or discrepancies cannot be resolved, the package will be resealed and returned to the sender. All transaction records, including the return shipping receipt, will be retained by the RFCPM. Any discrepancies should be recorded in an e-mail to the contributor and the RFCPM.

8.2.2 Firearms received will be test fired, and the cartridge cases will be entered into NIBIN and searched against the appropriate region (refer to the FTU SOP- NIBIN). If no association is found, the test-fired cartridge case may be destroyed, and the correlation request deleted from the system. If an association is found, the RFCPM will contact the appropriate Field Office or Case Agent through email to provide the relevant information, and serialize that communication to the case record in Sentinel. Rimfire, shotgun, typical revolver cartridges, and uncommon calibers of ammunition do not need to be test fired and entered into NIBIN. Test-fire status and NIBIN results will be recorded for each firearm in Visi-Trac.

8.3 Determination of Disposition

The final disposition for any received items are inclusion into the RFC or destruction. That determination is based on the RFCPM's evaluation of firearm and the needs of the RFC.

8.4 RFC Inclusion Procedures

8.4.1 Allowed legal statuses retained in the RFC are Abandonment, Forfeiture, FBI Purchase, Gift/Donation, and Transfer.

8.4.2 Clearly mark accompanying documentation with the associated RFC and RFID identifiers. RFC identifiers are a concatenation of an Alpha character representing caliber/type (see table below), followed by a sequential numerical character. The RFID identifier is a unique barcode/RFID tag provided through Visi-Trac.

Reference Firearms Collection Label Nomenclature			
A	.22/5.56mm Handguns	O	.33 & Larger Shoulder Firearms
B	.25/6.35 Handguns	P	U.S. Military Shoulder Firearms
C	.30/7.65mm-.32/8mm Handguns	Q	Foreign Military Shoulder Weapons
D	.357/9mm - .40 Handguns	R	Specialty Weapons, Silencers
E	10mm-.45-11.43mm Handguns	S	12 Gauge Shotguns
F	Flare Guns, Rocket Launcher, RPG	T	Rifle/Shotgun Combination Firearms
G	Gas Guns	U	Machine and Sub-Machine Guns
H	Air Guns	V	Miscellaneous Bore Shotguns
I	Blank and Replica Firearms	W	16 Gauge Shotguns
J	.22 & Smaller Rimfire Shoulder Firearms	X	20 Gauge Shotguns
K	.22/5.56mm-.28/7mm Shoulder Firearms	Y	28 Gauge Shotguns
L	.30-7.65mm-.32/8mm Shoulder Firearms	Z	.410 Bore Shotguns
M	.22/5.56mm Handguns	>Z900	FTU School Firearms
N	.25/6.35 Handguns	FTU	Cutaway Firearms

8.4.3 Enter the firearm into the Visi-Trac, including courier tracking number, UCFN, EC date, Source Document number (Court Order/Abandonment/Forfeiture/Transfer Order Number), Source Document date, caliber, make, model, type, action, serial number, and disposition type.

8.4.4 Enter the firearm into the Asset Management System.

8.4.4.1 The following acquisition codes and vendors are applicable:

- Acq. Code A- Federal Transfer using SF-122; vendor: submitting agency
- Acq. Code C- Forfeited item; vendor: DOJ
- Acq. Code E- FBI Purchase item using case funds; vendor: UCFN
- Acq. Code I- Foreign Gift/Donation; vendor: source

- Acq. Code W- Domestic Gift/Donation; vendor: source
- Acq. Code Z- Abandonment item; vendor: Abandonment

8.4.4.2 Firearms retained under court order must have a digital copy of the court order uploaded and attached to the AMS entry.

8.4.5 All related leads should be covered regarding the transfer of the firearms to complete the disposition process.

8.4.6 FD will be notified via email of any firearms added to AMS, to include property number and abandonment/forfeiture/court order numbers.

8.5 Firearm Destruction Procedures

8.5.1 The legal statuses that may be processed for destruction by FTU are Court Order Destruction, Abandonment, FBI Purchase, and Transfer. Occasionally, forfeited firearms may be destroyed by FTU if already requested for the RFC and transferred to FTU, but approval must be obtained and recorded by the FSPU and FD.

8.5.2 Enter the firearm into Visi-Trac, including courier tracking number, UCFN, EC date, Source Document number (Court Order/Abandonment/Forfeiture/Transfer Order Number), Source Document date, caliber, make, model, type, action, serial number, and other relevant information.

8.5.3 Clearly mark accompanying documentation with the RFID identifier(s). Documentation will be retained by the RFCPM.

8.5.4 Store firearm in a designated temporary destruction container, both physically and virtually through Visi-Trac.

8.5.5 In an effort to support the mission of other FBI groups such as the Defensive Systems Unit, or other government agencies, the FTU may choose to offer firearms available for official use. Firearms transferred within the FBI will be documented in Visi-Trac, on a FD-597 form, and through emails which will be serialized to the relevant case file in Sentinel. Those internally transferred firearms must be added to AMS by the receiving entity. Firearms to be transferred to other federal agencies must undergo the following process:

- FTU will ensure that the requested firearms are available for transfer. The receiving agency will review the available assets to verify the request.
- FTU will add the firearms to AMS, status listed as EXCESS, and Condition Code =4.
- FTU will complete a SF-122, listing the assets, property numbers, and receiving agency information including department. The SF-122 will be submitted for approval, in order, to the following entities:
 - The receiving agency (Section 9)
 - GSA (Section 14)
 - Finance Division, Asset Management Unit

- Upon approval of the SF-122, the assets may be transferred and documented by hand on the SF-122. The signed SF-122 will then be forwarded to AMU. A Service Request must be entered for each asset in AMS to update the record.

8.6 Container Destruction Procedures

8.6.1 When the temporary destruction container is full, a permanent container must be created in Visi-Trac. Physical inventory and transfer of the firearms must be completed by two FTU personnel. Firearm barcodes will be inventoried with the handheld RFID barcode scanner and verified. All non-firearm accessories in the temporary container will be transferred to the permanent container. The permanent container will be sealed and the inventory recorded.

8.6.2 The RFCPM will generate an EC to the Finance Division, requesting approval for the destruction of the permanent container. The container inventory will be included in that EC. Upon EC approval, the RFCPM will coordinate the destruction of the container(s) with the appropriate facilities.

8.6.3 Container(s) to be destroyed will be escorted and under the control of FBI personnel at all times. Destruction will be witnessed and recorded.

8.6.4 Visi-Trac will be updated to reflect the container destruction and all assets within.

8.6.5 All leads associated with destroyed firearms must be covered.

8.6.6 Any firearms listed in AMS that were destroyed must have those records amended, and an FD-519 created for each asset.

- The asset is listed as “Surplus”
- The destruction date and details are entered into AMS in the Disposal Details tab.
- A FD-519 form is created in AMS through a service request. This form must be signed by the Firearms/Toolmarks UC. The signed form is then uploaded and attached to the relevant record(s).

8.6.7 Generate a final EC to the Finance Division memorializing the destruction. The inventory and associated FD-519 forms will be included.

8.6.8 Notify the Field Evidence Unit (FEU) that a destruction has been completed. Include the UCFN and serial for reference in Sentinel. FEU will, at their discretion, notify the field such that they may update any records.

9 Calculations

Not Applicable.

10 Measurement Uncertainty

Not Applicable.

11 Limitations

Not Applicable.

12 Safety

When handling firearms the *Safety Protocol for Handling of Firearms and Ammunition* (Appendix E from FTU QAM *Mission Statement, Administrative, and Operational Guidelines*) will be followed. If a submitted item indicates a HAZMAT risk, personal protective equipment must be worn during processing. Protective gloves must be worn when handling firearms, non-firearm weapons, or bullets that have been possibly exposed to blood, tissue, or other body fluids.

13 References

FBI Field Evidence Management Policy Guide, 0780PG, 4/10/2015

FBI Laboratory Quality Assurance Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Operations Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Safety Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

Visi-Trac Firearms Destruction Process, Mobile Operation Instructions, and Report Builder Quick Start Guide (Controlled Document, FTU 018)

Rev. #	Issue Date	History
0	03/02/2018	Original issue.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Technical Leader

Date: 03/01/2018

Firearms/Toolmarks
Unit Chief

Date: 03/01/2018

QA Approval

Quality Manager

Date: 03/01/2018

Firearms/Toolmarks Discipline Standard Operating Procedure for Expedited National Integrated Ballistics Information Network (eNIBIN) Search Initiative

1 Purpose

To establish the procedures for receiving items, processing a request for national database searches, and returning items for which only the Firearms/Toolmarks Unit (FTU) will perform NIBIN searches in accordance with this initiative approved by the FBI Laboratory Director.

These procedures are designed to provide expedited investigative and intelligence information to law enforcement agencies to determine if an authorized recovery of a firearm (pistols, rifles, and shotguns) might be associated with an open/unsolved shooting case.

2 Scope

These procedures apply to FTU employees who receive items, perform national database queries, complete correlation searches and return items submitted for this initiative.

3 Responsibilities

3.1 The person initially receiving the item(s) will:

- Ensure the case is created in Forensic Advantage (FA).
- Initiate the submission and Chain-of-Custody in FA, as appropriate.
- Create an FTU Case Record in FA.

3.2 The person inventorying and identifying the item(s) will:

- Ensure that an inventory of the submitted item(s) is conducted.
- Ensure that each item is assigned a unique item identifier.
- Ensure that the item(s) or its container(s) is properly labeled and properly sealed.
- Ensure that the integrity of the item(s) is maintained during the breakdown and identifying process.
- Ensure the contributor is notified of the receipt of the item(s).

3.3 An Examiner or Technician will:

- Ensure that the necessary national database searches are conducted.
- Delete correlation results from the NIBIN database as appropriate.

3.4 An Examiner will:

- Cover the requesting lead in Sentinel.
- Review the correlation requests.
- Upload appropriate supporting records.

3.5 The person returning the item(s) will:

- Ensure the item(s) is properly sealed, packaged, and labeled.
- Ensure the item(s) is returned to the contributor.

4 Procedures

4.1 Case ID and Laboratory Number Assignment

The FTU eNIBIN initiative (referred to as eNIBIN in the remaining document) will be associated with a Case ID Number that is established by the contributing Field Office. Each submission under the eNIBIN initiative will also be associated with a reference eNIBIN Case ID Number. A Laboratory number will be assigned to each submission received for the eNIBIN initiative. All subsequent submissions under this initiative with the same Field Office Case ID will be a sequential submission generated in FA.

4.2 Prior to Submission of Item(s)

Once FTU is made aware of a possible submission associated with the initiative, personnel in FTU will contact the contributor and inform him/her of the labeling requirements for the shipping container(s). Additionally, the contributor will be required to generate an Electronic Communication (EC) or Laboratory Examination Request (LER) to provide the following information regarding the submitted item(s):

- Request for NIBIN entry
- Make, model, caliber and serial number of the firearm(s)
- Search region(s)
- National database search result(s)

4.3 Initial Receipt of Item(s)

4.3.1 eNIBIN containers may be identifiable as such by pre-arranged labeling of the shipping container (e.g., eNIBIN notation on the container) and will be forwarded directly to FTU upon receipt by the FBI Laboratory.

4.3.2 FTU personnel are responsible for opening the shipping container, initiating the Chain-of-Custody in FA, and creating a Case Record.

4.3.3 If the shipping container is opened by evidence management personnel, they will initiate the Chain-of-Custody, assign a Case Record to FTU and forward the submission to FTU.

4.4 Item(s) Inventory

4.4.1 A Container will be opened for break down and the individual item(s) added to FA.

4.4.2 Documentation of the packaging and condition of the items will be generated during the break down process and recorded in FA.

4.4.3 Once the FA Chain-of-Custody is established, the item(s) may be transferred to an FTU storage area. All subsequent transfers within FTU will be tracked in FA.

4.5 Recording and Acknowledging Item(s)

FTU personnel are responsible for contacting the contributor to acknowledge receipt of the item(s) in the submission and confirm no additional examinations are requested. This communication will be recorded in the Case Communication Log in FA.

4.6 eNIBIN Process

4.6.1 Submitted items will be inspected for safety prior to test firing as described in the *FTD SOP Examination of Firearms*. Test fired samples will be collected and designated as secondary evidence. A minimum of two test fires will be produced and inspected to determine which is suitable for entry into NIBIN.

4.6.2 Each NIBIN entry will have general case information recorded. At a minimum, the Case ID number, FA Laboratory number, Item number and a point of contact (eNIBIN Program Manager) will be recorded in the case notes for each item searched in NIBIN.

4.6.3 Items will be searched against the NIBIN regional database requested by the contributor as described in the incoming EC/LER.

4.6.4 Using the serial number of the submitted item(s), a query of the National Crime Information Center (NCIC) and electronic tracing system (eTrace) databases may also be performed as described in the *FTD SOP Examination of Firearms*. If additional information is obtained through these database queries, other regions may be searched using NIBIN.

4.6.5 Results of NCIC and eTrace queries will be uploaded to the Case Object Repository.

4.7 NIBIN Search Results

4.7.1 An FTU examiner will review the correlation results.

4.7.2 The dates of acquisition and correlation review are recorded on the correlation results print out.

4.7.3 The correlation results will be scanned into the Case Object Repository.

4.8 Lead Coverage and Closure

4.8.1 Dictation for lead coverage will be uploaded to the Case Object Repository.

4.8.1.1 An administrative review will be conducted on the dictation for lead coverage and will be recorded as a Case Record-Administrative review type. A technical review will not be conducted.

4.8.2 All search results will be recorded in Sentinel via the comments section of the lead coverage for the assigned eNIBIN lead.

4.8.3 A 1A (combined Case Record and Case 1A) for the assigned Laboratory number will be uploaded in Sentinel.

4.8.3.1 The serial number of the EC/LER will be referenced within the uploaded records.

4.8.4 The item(s) and secondary item(s) will be returned to the contributor by the examiner or technician using shipping labels generated from FA.

4.8.5 Following lead coverage and shipping, the FA Case Record status will be changed to 'Complete'.

4.8.6 In addition to lead coverage, the contributor will be telephonically advised of associations in NIBIN.

5 Methods and Limitations

5.1 The methods and limitations are located on the BUNET/FTU website along with the description of the eNIBIN program.

5.2 The lead coverage by the examiner represents the result of examination and is the opinions and interpretations of the examiner covering the lead and is supported by records retained in the FBI files.

6 Records

The following records may be generated and/or retained in the 1A as a result of these procedures:

- Chain(s)-of-Custody.
- Case Communication Log.
- Search results from NIBIN, NCIC, and eTrace.
- Shipping invoice(s).

- Case Record report.

7 References

FBI Laboratory Quality Assurance Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Operations Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FBI Laboratory Safety Manual, Federal Bureau of Investigation, Laboratory Division, latest revision.

FTD Quality Assurance Manual, latest revision

FTD Standard Operating Procedures Manual, latest revision.

ASCLD/LAB-International Supplemental Requirements for the Accreditation of Forensic Science Testing Laboratories, American Society of Crime Laboratory Directors/Laboratory Accreditation Board, Garner, NC, 2011.

ISO/IEC 17025 - General Requirements for the Competence of Testing and Calibration Laboratories, International Organization for Standardization, Geneva, Switzerland, 2005.

Rev. #	Issue Date	History
0	12/09/14	Original document issued.
1	03/02/18	Entire document was modified. Document moved from quality manual to procedure manual.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Technical Leader

Date: 03/01/2018

Firearms/Toolmarks
Unit Chief

Date: 03/01/2018

QA Approval

Quality Manager

Date: 03/01/2018

Firearms/Toolmarks Discipline Standard Operating Procedure for Criminal Investigative Division (CID) Initiative

1 Purpose

To establish the procedures for processing National Integrated Ballistics Information Network (NIBIN) requests based upon the CID initiative, which has been approved by the FBI Laboratory Director. This initiative is intended to assist with the backlog of firearms that were identified to exist within FBI Field Offices that require NIBIN entry only. These procedures are designed for test-fired cartridge case entry into NIBIN for FBI forfeited evidence that has not been previously entered into NIBIN.

2 Scope

These procedures apply to Firearms/Toolmarks Unit (FTU) personnel who receive firearm(s), complete NIBIN acquisitions, review correlation results and return items submitted for this initiative.

3 Equipment/Materials/Reagents

- Cleaning solvent
- FBINet access to Sentinel
- Known exemplars
- Microscope (stereozoom)
- NIBIN access to IBIS
- Personal Protective equipment (PPE)

4 Standards and Controls

Known exemplars produced from firearms during test firing serve as controls.

5 Sampling

Not Applicable.

6 Responsibilities

- 6.1** The person initially receiving the container(s) will:
- Ensure a case is created in Forensic Advantage (FA).

- Initiate the submission and Chain-of-Custody in FA.
- Create an FTU Case Record in FA.

- 6.2** The person inventorying and identifying the container(s) will:
- Ensure that each container is assigned a unique identifier.
 - Ensure that an inventory of the submitted container contents is conducted using the CID request spreadsheet.
 - Ensure that each container and contents are properly labeled and properly sealed.
 - Ensure that the integrity of the container(s) and contents are maintained during the breakdown.
 - Ensure the contributor is notified of the receipt of the container and contents.
- 6.3** FTU personnel will:
- Ensure that the NIBIN acquisitions and correlation requests are conducted.
 - Generate an FTU NIBIN spreadsheet.
 - Review the correlation results.
 - Delete correlation results from the NIBIN database as appropriate.
- 6.4** FTU Examiner will:
- Contact CID and case agent with any positive NIBIN association results.
 - Upload appropriate supporting records into the proper subfile of the CID control file in Sentinel.
- 6.5** FTU personnel returning the container(s) and contents will:
- Ensure the contents are properly sealed and packaged.
 - Ensure the container(s) and contents are returned to the contributor.

7 Procedures

7.1 Case ID and Laboratory Number Assignment

7.1.1 The CID initiative (referred to as CID in the remaining document) will be associated with a Control File Number established by CID containing subfiles for each contributing Field Office. These subfiles will be used as the source for the creation of Laboratory numbers in FA.

7.1.2 FTU will collaborate with the Field Evidence Unit (FEU) to schedule submissions under this initiative and FTU will notify CID of the schedule.

7.1.3 CID will be responsible for notifying each Field Office of their scheduled submission date via Electronic Communication (EC).

7.1.3.1 The CID generated EC will include instructions for shipping and the expected timeline for shipment to the Laboratory.

7.1.3.2 The EC will also include a CID review spreadsheet listing the items to be shipped along with their respective Universal Control File Number (UCFN); evidence barcode; 1B number; date of seizure/collection; and the caliber, make, model or type, and serial number of the firearm.

7.1.4 FTU personnel will add columns to the CID request spreadsheet to indicate the appropriate shipping container.

7.2 Initial Receipt of Item(s)

7.2.1 FTU personnel will receive each shipment and create a case in FA. The subfile will determine the Field Office of origin.

7.2.2 FTU personnel will open the container, assign each container a barcode, initiate the Chain-of-Custody in FA, and create a Case Record.

7.3 Item(s) Inventory

7.3.1 Each container will receive a separate identifier in FA. Each firearm will not receive a separate item identifier in FA. The description in FA of the container will include the number of firearms.

For example: Container A (65 firearms)

7.3.2 The CID request spreadsheet will be broken down by container, and the spreadsheet will function as an inventory for each container. FTU personnel will add columns to the spreadsheet to reflect the shipping container as well as columns to update this spreadsheet to reflect any discrepancies.

7.3.3 Once the FA Chain-of-Custody is established, the container may be transferred to an FTU storage area. All subsequent transfers within FTU will be tracked in FA.

7.3.4 FTU personnel will create and print test-fire envelopes.

7.4 Recording and Acknowledging Item(s)

7.4.1 FTU personnel will contact CID and the contributor to acknowledge receipt of the item(s). This communication will be recorded in the Case Communication Log in FA.

7.4.2 Once inventory of the container is completed, FTU will facilitate the evidence transfer in Sentinel.

7.5 CID NIBIN Process

7.5.1 Firearm(s) will be inspected for safety prior to test firing as described in the *Firearms/Toolmarks Discipline SOP Firearm Examinations*. Test fires collected for the CID initiative are not considered evidence.

7.5.2 NIBIN administrative fields will contain the Field Office Investigative Case ID number, without the investigative classification and the Laboratory point of contact. NIBIN evidence entry fields will contain the 1B number for the firearm.

7.5.3 Test fire(s) will be searched against the appropriate NIBIN region(s) based upon the geographic location that the firearm was submitted from.

7.6 NIBIN Correlation Results

7.6.1 FTU personnel will review the NIBIN correlation results and determine if there is an association.

7.6.2 The FTU NIBIN spreadsheet will be derived from the CID request spreadsheet. It will contain information about the NIBIN search, to include:

- NIBIN acquisition date.
- Name of FTU personnel who reviewed the correlation results.
- Handwritten initials of FTU personnel who reviewed the correlation results.
- Date correlation results were reviewed.
- NIBIN result.

7.6.2.1 If NIBIN acquisition is not possible or appropriate, the reason will be recorded on the FTU NIBIN spreadsheet.

7.6.3 Record(s) of any positive NIBIN associations will be added to the Case Object Repository.

7.6.4 Once all NIBIN correlations have been reviewed, the FTU NIBIN spreadsheet will be scanned and added to the Case Object Repository.

7.7 Reporting Results and Closure

7.7.1 FTU examiner will provide positive NIBIN associations via BUNET email to CID and the assigned case agent. The email will be serialized into the appropriate investigative file and CID subfile.

7.7.1.1 Per agreement with CID, negative NIBIN results will not be reported.

7.7.1.2 The FTU NIBIN spreadsheet, detailing the results for each affected Field Office, will be provided to CID.

7.7.2 All submitted items will be returned to the contributor by FTU personnel using shipping labels from FA.

7.7.2.1 The CID request spreadsheet that was used for container inventory will be used as a shipping invoice for each container.

7.7.3 All test-fired samples will be destroyed.

7.7.4 FTU Examiner will close the Case Record in FA by changing the case status to "Complete."

7.7.5 FTU personnel will create an electronic 1A (combined Case and Case Record) containing the case records generated (e.g., spreadsheets, chain of custody, positive NIBIN associations) and upload the 1A to the CID Control File Number in Sentinel.

8 Methods and Limitations

8.1 The methods and limitations are located on the BUNET/FTU website.

8.2 The email notification and the FTU NIBIN spreadsheet returned to CID represent the search results and are the opinions and interpretations of the examiner listed on the spreadsheet.

9 Records

The following records may be generated and/or retained in the electronic 1A as a result of these procedures:

- Chain-of-Custody.
- Communication Log.
- CID request spreadsheet.
- FTU NIBIN spreadsheet.
- Positive NIBIN association.
- Shipping invoice.

10 Calculations

Not Applicable.

11 Measurement Uncertainty

Not Applicable.

12 Safety

Refer to the “FTU Safety Protocols for Handling of Firearms Ammunition”, which is in Appendix A, *FTD SOP Firearm Examinations*.

13 References

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

FBI Laboratory Safety Manual

Rev. #	Issue Date	History
0	07/13/18	Original issue for Firearms/Toolmarks Unit.
1	03/02/20	Updated title to reflect FTD. Added Sections 3, 4 and 5 and renumbered. Incorporated the review and deletion of correlation results to the responsibility of FTU personnel in Section 6.3. Changed examiner to personnel in Section 7.6.1, second and third bullet points in Section 7.6.2. Changed responsibility to examiner in Section 7.7.1. Added Sections 10, 11 and 12 and renumbered. Updated References.

Approval

Redacted - Signatures on File

Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/Toolmarks Discipline Standard Operating Procedure for National Database Searches

1 Scope

This procedure applies to the query and submission of the firearm serial numbers (referred to as SN throughout the remaining document) into the national databases. The term requestor refers to the FTD personnel who maintain account access through the relevant databases.

2 Equipment/Materials/Reagents

- Computer with internet access
- Database account access
- Stereozoom microscope
- FBINet access to Sentinel

3 Standards and Controls

Not applicable

4 Sampling

Not applicable

5 Procedures

5.1 Electronic Tracing System (eTrace)

5.1.1 A query of the eTrace will be performed on the SN for existing trace submissions. Hyphens or spaces are included as part of the query.

5.1.2 If the query results in a previous trace submission are found or the trace number is located in the incoming laboratory examination request or Sentinel, no further action is required.

5.1.2.1 It may be at the discretion of the examiner to maintain a copy of the previously traced SN.

5.1.3 If the query results in no previous submissions being found, the requestor will proceed in creating a new trace submission by using the minimum case information required to generate an eTrace request:

- Firearm manufacturer
- Firearm caliber
- Firearm type
- Serial number
- Importer, if applicable
- Recovery date
- Recovery state
- Recovery city
- Name of contributor/ case agent
- NCIC crime code

5.1.3.1.1 In situations where there are multiple different SN located on a single firearm (i.e. frame, barrel, slide), a trace request will be submitted for each SN.

5.1.3.1.2 The location of the SN may be indicated in the database field 'Identifying Marks'.

Example: slide and barrel only.

5.1.3.2 There may be instances where the entry of case information (firearm manufacturer, caliber, type, serial number and importer) results in a notice of the SN being previously traced. This may occur due to an outside agency submitting the initial request.

5.1.3.2.1 It is at the discretion of the examiner to maintain a screenshot of the previously traced submission.

5.1.4 Upon submission by the FTD, the trace number will be recorded in the appropriate *FTD Worksheet* located in Appendix B of the *FTD QAM Case Assignment, Records, Results and Verifications*. The trace number is a twelve-digit alpha-numeric number that starts with the letter T.

5.1.4.1 A copy of the FTD generated trace report will be retained.

5.1.4.2 The examiner will include the FTD generated trace number as part of the Results of Examinations of the *Laboratory Report*.

5.1.5 Incomplete SN will not be submitted into eTrace.

5.2 National Crime Information Center (NCIC)

5.2.1 A query of the NCIC gun records will be performed on the SN. Hyphens or spaces are not included as part of the query.

5.2.1.1 The NCIC query will be recorded in the appropriate *FTD Worksheet* located in Appendix B of the *FTD QAM Case Assignment, Records, Results and Verifications*.

5.2.2 If the query results in no records being found, no further action is required.

5.2.3 If the query results in gun record(s) being found, the requestor and/or examiner will proceed in reviewing the details of the record.

5.2.3.1 For recovered gun record(s), the requestor and/or examiner will review the record and no further action is required.

5.2.3.2 For stolen gun record(s), the requestor and/or examiner will review the record and retain the search as an examination record.

5.2.3.2.1 The requestor and/or examiner may communicate the stolen gun record(s) with the contributor, which will be recorded in the examination record(s) and/or Communication Log. During this discussion, the contributor may have knowledge of the stolen gun record(s) and no further action is required.

5.2.3.2.2 The examiner will include the stolen gun record, not previously acknowledged, as part of the Results of Examinations of the *Laboratory Report*.

6 Calculations

Not Applicable.

7 Measurement Uncertainty

Not Applicable.

8 Limitations

Due to damage, time of manufacturer or other factors, some information may not be available.

9 Safety

Consult the applicable sections regarding safe firearm handling located in the Appendix A, titled *Safety Protocols for Handling of Firearms and Ammunition* of the *FTD SOP Firearm Examinations*.

10 References

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

eTrace User Guide Manual

NCIC Gun File Training Manual

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0	03/02/20	Original issuance. Created from FTD SOP Examination of Firearms.

Approval

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Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/ Toolmarks Discipline Standard Operating Procedure for Documentation and Preparation of Evidentiary Items

1 Scope

This procedure is designed for the documentation, evaluation and preparation of evidentiary items. In addition, this procedure outlines the methods for evidence workflow. This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following categories of testing:

- Firearms
- Toolmarks
- Serial Number Restoration
- Gunshot Residue Distance Determination

2 Equipment/Materials/Reagents

- 3D toolmark topographical instruments
- Caliper (measurement within ± 0.001 in.)
- Camera
- Casting material
- Cleaning solvent
- Computer
- Cotton swabs
- Known exemplars
- Measurement equipment
- Metal Scribe / Marker
- Microscope (stereozoom/comparison)
- Modeling clay or equivalent
- Non-abrasive cleaning tools
- Personal protective equipment (PPE)
- Bullet recovery/test firing device/system
- Stage micrometer or measuring reticle
- Test media (e.g., lead, brass, copper)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the measurement equipment and calibration on a 3D instrument will be performed and recorded in accordance with the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

5.1 Statistical sampling is not applicable in the FTD.

5.2 Non-Statistical sampling is employed in the FTD. It is based on the training, experience and competence of the examiner. No assumptions are made regarding items/portions that were not selected for examination and Results of Examination in *Laboratory Reports* are specific to the items/portions that were examined.

6 Procedures

6.1 Itemizing Evidentiary Items

6.1.1 Ensure the evidence received reflects the item descriptions in FA and/or what is listed on the request for examination.

6.1.1.1 If a discrepancy is noted between what is received and what is listed in FA and/or on the request for examination, refer to *LOM – Processing a Submission and Evidence Breakdown*.

6.1.2 The person inventorying the item for further examination will begin recording details in the appropriate *FTD Worksheets* located in Appendix B of the *FTD QAM Case Assignment, Records, Results and Verifications*.

6.1.2.1 Non-evidentiary items will be inventoried, transferred appropriately, but will not be described in *FTD Worksheets*.

6.1.2.2 If items need to be subdivided, refer to *LOM – Practices for Assigning Cases and Conducting Examinations*.

6.1.3 Any observations that are recorded regarding the condition of the item and/or packaging will be recorded in the appropriate *FTD Worksheets*.

6.1.3.1 Personnel will employ universal precautions, including wearing the appropriate PPE, when itemizing and subdividing packaging that contains a biohazard label, or when packaging descriptions suggest the potential for biohazard.

6.2 Labeling Evidentiary Items

6.2.1 Ensure the item is labeled with the appropriate item identifiers. Examples include:

- Metal scribe used to etch identifiers onto a surface that does not interfere with areas of interest.
- Marker used to label identifiers onto a surface that does not interfere with areas of interest.

- A tag, labeled with the identifiers, is attached to the item.
- A container, labeled with the identifiers, used to preserve the item.

6.2.2 Ensure the electronic evidence, when printed or copied, is labeled with the appropriate item identifiers.

6.3 Creating Case Notes

6.3.1 Depending on the evaluation of physical characteristics of an item, an *FTD Worksheet* will be started.

6.3.2 The minimum required fields when starting an *FTD Worksheet* include:

- Description of packaging
- Item Identifier
- Laboratory number
- Name of preparer(s)
- Start date of examinations

6.3.3 The remaining required fields in the *FTD Worksheets* may be completed when examinations continue.

6.4 Photographing Evidentiary Items

6.4.1 Photographs may be added to the *FTD Worksheets* that represent detail(s) about the item that cannot otherwise be described in the required fields.

6.4.2 Prior to cleaning an item, a photograph should be collected of the evidence being examined.

6.4.3 Photographs that are printed as an attachment to *FTD Worksheets* or incorporated into the case file 1A will include:

- Date of examinations
- Identifier(s)
- Laboratory Number
- Name of preparer or examiner

6.5 Cleaning Evidentiary Items

6.5.1 Cleaning an item of debris or biohazard material can be done using the following methods:

- Cloth or cotton swab to loosen debris
- Non-abrasive cleaning tool, brush or wooden toothpick to loosen debris
- Cleaning solvent, such as water, alcohol or acetone can be used to remove paint and other debris.
- For corrosion or heavily stained items, CLR™ or an equivalent cleaner can be used to facilitate the restoration of the original surface.

- Note: Due to the deleterious effects of prolonged exposure of metal to this type of cleaner, this method should be used as a last resort and/or monitored.

6.5.1.1 Wire brushes or other abrasive materials should not be used to clean the area as these items can alter the surface features.

6.5.2 A cleaning technique that was used can be described in the appropriate *FTD Worksheets*.

6.5.3 Following cleaning, it may be necessary to acquire additional photographs of the items or surfaces being examined.

6.6 Casting of Marked Surfaces

6.6.1 Depending on the size and shape of the evidentiary item, it may be necessary to cast any marked surfaces for the evaluation and preservation for future comparisons.

6.6.2 It may also be necessary to cast an evidentiary item which contains multiple marked surfaces.

6.6.3 Prior to casting, thoroughly examine the marked surfaces and make specific notations of what is observed, to include any trace material. This can include taking measurements of characters, known items or marked surfaces.

6.6.3.1 Measurements will be recorded in accordance with the *FTD SOP Measurement, Calibration, Performance Check and Equipment Maintenance*.

6.6.3.2 It is at the discretion of the examiner to ensure coordination of the removal and preservation of trace evidence with the appropriate discipline examiner.

6.6.3.3 Treat each marked surface area independently and record accordingly.

6.6.4 If an item contains multiple areas for casting, those areas should be labeled appropriately and visible in the photographs.

6.6.5 Casting material may be tested on an inconspicuous area of the item to ensure:

- Casting material performs/replicates the casted substrate/item.
- Casting material does not alter the item.

6.6.6 If necessary, build a dam around the area of interest using modeling clay or suitable substrate. The dam should be constructed to retain the casting material in place until it has fully hardened.

6.6.7 Place casting material into the dam and allow time to harden. Casts may set at varying times depending on multiple factors. Variables such as temperature may result in prolonged cast curing time. Casting materials designed to be used within a specific temperature range should be used if possible.

6.6.7.1 Identifiers may be placed on the substrate to become a permanent part of the cast, or a paper label may be placed in the back of the cast. See Section 6.7 of this document for the minimum required information.

6.6.8 Once the cast has fully set, remove the clay dam and remove the cast. Examine the cast for deposits of any debris that might have been missed during the cleaning process.

6.6.8.1 It may be necessary to make multiple casts of each area to remove debris and capture the microscopic detail and to facilitate undistorted comparisons.

6.6.9 Retained cast material is considered secondary evidence and will be marked or labeled using procedures detailed in Section 6.7.

6.6.9.1 It is at the discretion of the examiner as to whether unused casts are retained.

6.7 Generating Secondary Evidence

6.7.1 Secondary evidence derived from an examination process on an item of evidence will be labeled, packaged and recorded in accordance with the *FTD QAM Marking and Examination of Evidence*.

6.7.1.1 FTD secondary evidence scanned for Virtual Comparison Microscopy (VCM) will be labeled, at a minimum, with the following:

- Item identifier associated with the primary evidentiary item, preceded by an ‘f’
- Laboratory number
- Initials
- Unique identifier for instrument acquisition (e.g., *f* Item 4-a, *f* Item 4a, or *f* I4a)

7 Calculations

Not Applicable.

8 Measurement Uncertainty

When a measurement of a firearm or barrel will be reported as requested by a contributor or is probative to a case, the measurement will be recorded in accordance with the *FTD SOP Firearm Barrel and Overall Length Measurements*.

9 Limitations

The composition of the substrate being cast may not be suitable for obtaining microscopic features for comparison purposes. (Porous material (e.g. bone))

10 Safety

Take standard precautions for the handling of all evidentiary items, certified reference materials and working standards. Personal protective equipment should be also be utilized.

11 References

Cadigan, James J. and Klees, Gregory S., “A Casting Vehicle Identification Numbers – A Technical Aid in Auto Theft Investigation”, FBI Law Enforcement Bulletin, Vol. 47, No. 6, August, 1978.

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

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Klees, G., “A Casting Material Update on Toolmark Reproduction”, AFTE Journal, 1988; 20(4): 463.

Miller, Jerry, “An Introduction to the Forensic Examination of Toolmarks”, AFTE Journal, 2001; 33 (2): 233 through 247.

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. Accessed 5 February 2020.

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Approval

Redacted - Signatures on File

Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Scientific & Biometric
Analysis Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

FTD Standard Operating Procedure for Measurement, Calibration, Performance Checks and Maintenance of Equipment

1 Scope

This procedure establishes requirements for calibration, performance checks, and maintenance of equipment to ensure the accuracy and reliability of measurement results that have an impact on the quality of an examination. This procedure also satisfies the FBI Quality Assurance Manual (QAM) and Laboratory Operations Manual (LOM) requirements, as well as requirements of the applicable accrediting body. This procedure applies to all Firearms/Toolmarks Discipline (FTD) personnel in the Firearms/Toolmarks Unit (FTU) and the Scientific and Biometrics Analysis Unit-Toolmark Group (SBAU-TG) who use the listed equipment to make and record measurements on evidentiary items when those measurements may be utilized to make judgements regarding the further examination, classification, or comparison of an item, or to form conclusions regarding the item.

This procedure does not address Measurement Uncertainty, which is the subject of the FTD Quality Manual document *Estimating Uncertainty for Reported Quantitative Measurements*.

2 Equipment / Materials / Reagents

- Calipers (measurement within ± 0.001 in / 0.01mm.)
- Microscope (stereozoom/comparison)
- Micrometers (measurement within ± 0.001 in / 0.01mm.)
- Balances (measurement within ± 1 grain / ~ 0.065 grams)
- Alicona® Infinite Focus microscope
- GelSight/Cadre TopMatch® Instrument
- Arsenal weights for trigger pull
- NIST Standard bullet
- National Institute of Standards and Technology (NIST) traceable gauge blocks
- Measuring reticle
- NIST traceable weights
- NIST traceable steel rulers
- Alicona®-IF Verification tools
- GelSight/Cadre TopMatch® calibration tools
- Balance - 10 pound (lb.) capacity
- NIST Standard cartridge case

3 Standards and Controls

All equipment having an effect of the quality of an examination is properly maintained per manufacturer's guidelines and calibrated. The FTD ensures that equipment used for

measurement is capable of achieving the measurement accuracy required to provide a valid result.

3.1 Prior to being placed into service, and when necessary, equipment that has a direct effect on the quality of an examination is calibrated and/or performance checked to verify that it meets any specifications required by the method.

3.2 Personnel in the FTD handle and operate equipment in accordance with manufacturer's guidelines. Equipment and standards are properly stored when not in use to prevent contamination and damage. Equipment or standards that leave the control of the laboratory are properly packaged, inspected and performance checked and/or recalibrated upon their return.

3.2.1 Due to differences in instrument resolutions, variations from manufacturer's guidelines exist as to how the instruments can be utilized, (e.g. camera settings, lenses, calibration standards, etc.)

3.2.2 Personnel in the FTD are not qualified or authorized to make adjustments to calibrated equipment, and are prohibited from doing so.

3.3 Damage or changes to equipment or NIST traceable standards will be recorded by written notification to the Calibration and Maintenance Administrator (CMA) of the laboratory/location. The CMA will follow the *LOM Practices for Calibration and Maintenance of Equipment*.

3.3.1 A copy of the notification will be maintained by the CMA.

3.3.2 The CMA will ensure that the replacement item is acquired as soon as practicable, and will follow the *LOM Practices for Calibration and Maintenance of Equipment* to place the new item into service.

3.4 Microscopes are serviced annually by qualified maintenance personnel to ensure proper functioning, and to prevent contamination and deterioration.

4 Sampling

Not Applicable

5 Procedures

5.1 Calibration

5.1.1 NIST traceable steel rulers, gauge blocks, and weights are recertified every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.1.1 The NIST traceable steel ruler utilized for measurements of **Redacted** Hott Rods® and rulers used for barrel and overall length measurements are recertified annually by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certification performed.

5.1.2 Calipers/micrometers and balances are calibrated annually by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the calibration.

5.1.2.1 Calipers/micrometers or rulers that fail calibration are removed from service and replaced.

5.1.2.2 Balances that fail calibration are removed from service and repaired or replaced.

5.1.3 The Alicona® IF Verification tool is handled according to manufacturer's specifications. Recertification of the calibration status of the tool will be performed every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.3.1 If the verification tool is damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the verification tool is found to be defective, manufacturer's guidance will be followed.

5.1.3.2 If a verification tool fails to obtain the required measurements based on the calibration requirements, it will be recalibrated or pulled from use.

5.1.4 The Cadre TopMatch/GelSight® calibration tool is handled according to manufacturer's specifications. Recertification of the calibration status of the tool will be performed every 5 years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certifications performed.

5.1.4.1 If the calibration tool is damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the calibration tool is found to be defective, manufacturer's guidance will be followed.

5.1.4.2 The Cadre TopMatch/GelSight® system used at the Terrorist Explosive Device Analytical Center (TEDAC) utilizes a standard ball-grid array to “set” the instrument prior to use. If the array is damaged or visibly changed, it will be replaced.

5.1.5 The NIST Standard bullet and cartridge case will be recertified prior to expiration as provided for in NIST guidelines. If damaged or visibly changed, a performance check will be run. Should the instrument fail the performance check, factory qualified maintenance personnel will be called in to assess and repair the instrument and/or make any adjustments needed. If the NIST Standard bullet or cartridge case are found to be defective, NIST guidance will be followed.

5.2 Performance Checks

5.2.1 Prior to using listed equipment, performance checks must be completed in order to ensure the accuracy and reliability of measurement results that have an impact on the quality of an examination.

5.2.2 Records of performance checks will be included in the examination records, except as provided for in the remainder of this document.

5.2.2.1 Information that is required to be recorded includes:

- the type or name of equipment
- the equipment serial number or other unique identifier
- the Reference item used for the performance check
- the result of the performance check
- the date of the performance check
- the identity of the person performing the performance check.

5.2.3 Any instrument that fails to pass the performance check will be taken out of service and marked as such. See Section 3.3 above.

5.2.3.1 Instruments that are taken out of service due to a failed performance check will be assessed by the CMA to determine if they will be repaired, recalibrated, or replaced.

5.2.4 When making measurements that have an impact on the quality of an examination, micrometers/calipers, to include stage micrometers, must be performance checked on the day of usage.

5.2.5 When making measurements that have an impact on the quality of an examination, balances must be performance checked on a semi-annual basis.

5.2.5.1 Performance check records for balances will be maintained by FTU and SBAU-Toolmark Group.

5.2.6 Performance check procedures and records for the Alicona® Focus variation microscope are located at the instrument.

5.2.7 Performance check procedures and records for the GelSight/Cadre TopMatch® are located at the instrument.

5.2.7.1 Performance checks on 3D instruments are carried out based on the manufacturer's specifications.

5.2.7.2 Performance checks of the calibration on a 3D instrument (referred to as calibration check in the remaining document) will be performed as outlined in the *TopMatch User Manual* (Controlled Document FTU 019 / SBAU Controlled Document #SAU-1).

5.2.7.3 The calibration check interval for a 3D instrument is based on the manufacturer's specifications as outlined the *TopMatch User Manual*.

5.2.7.4 Performance checks of the status of a 3D instrument in FTU will be performed using the NIST SRM 2461-118. Performance checks of the status of a 3D instrument in SBAU Toolmark Group will be performed using the GelSight Ball Grid Array.

5.2.8 Arsenal weights will be performance checked annually.

5.2.8.1 Inspect each weight and hanger for damage. Weigh each arsenal weight three times, calculate the average weight and record the average weight in the annual arsenal weight performance check record located in the Maintenance and Calibration binder in the FTU.

5.2.8.2 If an arsenal weight has a difference greater than +/- 0.10 lb. from its designated measured weight, it will be removed from service and labeled as such. The removal will also be recorded on the performance check record.

5.3 Methods for Measuring General Rifling Characteristics (GRCs) of bullets

5.3.1 Air gap method: The fired bullet is mounted on one stage of the comparison microscope. A micrometer/caliper is mounted on the other stage. Both stages must be at the same magnification level and in focus. Measure the land or groove impression using the micrometer/caliper and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.2 Stereo microscope-micrometer/caliper method: The fired bullet is either held or mounted on a steady surface beneath the stereo microscope. Measure the land or groove impression using the micrometer/caliper and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.3 Stereo microscope–grid method: The fired bullet is either held or mounted on a steady surface beneath the stereo microscope. Measure the land or groove impression using the ocular alignment grid and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.4 Comparison microscope with built-in micrometer: The fired bullet is mounted on the stage with a built-in micrometer. Align the horizontal edge of the crosshair at one of the anchor points for a land or groove impression, move the horizontal edge of the crosshair to the corresponding anchor point. Measure the land or groove impression and record the measurement to the nearest hundredth or thousandth of an inch.

5.3.5 3D Toolmark Topographical Instrument: See the *FTD SOP Class Characteristic Database Entries and Searches* for guidance on the use of the Alicona® instrument for obtaining scans and performing measurements.

5.4 Methods for Measuring Toolmarks (items or casts of toolmarks)

5.4.1 Visual method: For items that are large enough to be viewed by the naked eye, align the edges of the micrometer with opposing edges of the toolmark and record the measurement using appropriate units.

5.4.2 Stereo microscope-micrometer/caliper method: Hold the toolmark or cast, or mount on a steady surface beneath the stereo microscope. Using a micrometer/caliper, measure the appropriate dimensions of the toolmark and record the measurement(s) using appropriate units.

5.4.2 Comparison microscope with built-in micrometer: Mount the toolmark or cast on the stage with the built-in micrometer. Align the horizontal edge of the crosshair at one edge of the toolmark, move the horizontal edge of the crosshair to the opposite edge of the toolmark, and record the measurement using appropriate units.

5.2.3 Instructions for using the Alicona® Infinite Focus are located at the instrument.

5.2.4 Instructions for using the GelSight/Cadre TopMatch® are located at the instrument.

5.3 Method for Measuring Trigger Pull of Firearms

5.3.1 Instructions for measuring the trigger pull of firearms are found in the *FTD SOP Firearm Examinations*.

6 Records

6.1 Records of calibrations that are to be maintained in Forensic Advantage Resource Manager are specified in the *FBI LOM Calibration and Maintenance of Equipment*.

6.2 For FTU, calibration certificates are maintained by the Unit and via digital upload onto the Forensic Analysis Support Unit (FASU) Sharepoint site. For SBAU-Toolmark Group, hard copies of calibration certificates are maintained by SBAU-Toolmark Group via the SBAU-Instrument Operations Group (IOG), and via digital upload onto the FASU Sharepoint site.

6.3 Performance check records are maintained in examination documentation.

6.3.1 Performance check records for the Alicona Infinite Focus microscope and GelSight Cadre TopMatch instruments are maintained at the instruments.

6.3.1.1 Performance and/or calibration check records for a 3D instrument will be maintained and stored within the system and/or externally by the FTU.

6.3.2 Performance check records for arsenal weights are maintained in the arsenal weight performance check record in the Balances and Trigger Pull Binder in the FTU library.

6.4 Records of damaged or changed equipment are maintained in FA Resource Manager.

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

Not Applicable.

10 Safety

Not Applicable.

11 References

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories, International Organization for Standardization, Geneva, Switzerland, 2017.

ISO/IEC 17025:2017 – Forensic Science Testing and Calibration Laboratories Accreditation Requirements (AR3125), ANAB, Milwaukee, WI, April 29, 2019.

Alicona Infinite Focus microscope, User's Manual.

GelSight GSCapture Users' Guide for the GelSight Benchtop Scanner, Jan 2018, SBAU Controlled Document #SAU-1

TopMatch-GS 3D: Software and Hardware Manual v0.9.19 Legacy, Cadre Research Labs, Feb 2018, SBAU Controlled Document #SAU-2

TopMatch-GS 3D: Software and Hardware Manual v0.9.19, Cadre Research Labs, September 2017, FTU Controlled Document 019

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Approval

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Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Scientific & Biometric
Analysis Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/ Toolmarks Discipline Standard Operating Procedure for Comparison and Pattern Matching

1 Scope

This procedure is designed for the comparison of items bearing toolmarks (referred to as toolmark in the remaining document). In addition, this procedure outlines the methods for comparison microscopy. Pattern matching includes the evaluation of submitted items to determine the value of any toolmark that may be present, and the physical and microscopic examination of a toolmark (striated and/or impressed) to determine a source conclusion. (i.e. excluded as having been fired in the same pistol, fired from the same barrel, produced by the submitted tool, no conclusion could be reached as to whether the questioned toolmarks were created by the same tool, etc.)

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following categories of testing:

- Firearms
- Toolmarks

Additionally, the following terms will be used throughout this procedure:

- **Toolmark:** Impressed and/or striated feature(s) created when a tool (harder object) makes forceful contact with an item (softer object) transferring physical and/or microscopic features.
- **Class Characteristics:** Measurable or discernable features of a specimen which indicate a restricted group source. They result from design features and are determined prior to manufacture.
- **Subclass Characteristics:** Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.
- **Individual Characteristics:** Marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are produced incidental to manufacture and/or caused by use, corrosion, or damage.
- **Suitable:** An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV):** Individual characteristics having quality and/or quantity for a source conclusion comparison.
- **Limited Microscopic Marks of Value (LMOV):** Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **Comparison:** The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.

- **Light Comparison Microscopy (LCM):** The use of connected optical microscopes to compare and evaluate microscopic features between two toolmarks.
- **Virtual Comparison Microscopy (VCM):** The use of software to compare and evaluate the digital reproduction of microscopic features between two toolmarks.
- **3D Toolmark Topographical Instrument (3D instrument):** A device that can measure and record the x, y and z positions of microscopic features contained within a toolmark and produce a digital reproduction of the toolmark.
- **Source Conclusion:** An Examiner's conclusion regarding the origin of a toolmark or fracture.

2 Equipment/Materials/Reagents

- 3D toolmark topographical instruments
- Known exemplars
- Microscope (stereozoom/comparison)
- Measurement equipment
- Personal protective equipment (PPE)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the calibration on a 3D instrument will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

Not Applicable.

6 Procedures

When a comparison is performed between two toolmarks, like material should be used. When casts are produced for questioned toolmarks, any test marks produced from a tool for comparison must also be cast.

6.1 Level 1 Analysis – Comparison of Items Bearing Toolmarks

6.1.1 Review the class characteristic(s) and determine the following:

- Disagreement in Class Characteristics – **Elimination** opinion can be rendered.
- Agreement in Class Characteristics or could not determine – Pattern Matching continues in Level 2.

6.1.1.1 An elimination result, when required, will be verified in accordance with the *FTD QAM Case Assignment, Records, Results and Verifications*.

6.2 Level 2 Analysis – Comparison of Individual Characteristics

6.2.1 Using comparative microscopy, compare the individual characteristics in the questioned toolmarks and render one of the following decisions:

- **Identification**; the questioned toolmarks were created by the same tool.
- **Inconclusive**; due to a lack of sufficient corresponding microscopic marks of value, no conclusion could be reached as to whether the questioned toolmarks were created by the same tool.

6.2.1.1 If an inconclusive result is rendered using VCM (cartridge cases), LCM will be used to compare individual characteristics.

6.2.1.2 If an inconclusive result is rendered using LCM (cartridge cases), it is at the discretion of the examiner to use VCM.

6.2.1.2.1 The examiner will record in the Communication Log the reason for not using VCM.

6.2.1.3 For an inconclusive result between items, additional information may be reported through the use of other Standard Operating Procedures within the FTD (e.g. class characteristic database search, physical and visual examination results, individual characteristic database search).

6.2.1.4 When no known tool is submitted, careful consideration is given for the presence of subclass characteristics. If a considerable degree of gross marks exists within a toolmark, where subclass cannot be eliminated, identification may not be possible.

6.2.1.5 An identification result will be verified in accordance with the *FTD QAM Case Assignment, Records, Results and Verifications*.

6.3 Level 1 and Level 2 – Conclusions Rendered

6.3.1 The following opinion workflow will aid in reviewing the details pertaining to the opinion(s) rendered:

Level 1 Conclusions	Level 2 Conclusions
<ul style="list-style-type: none"> • Comparison of Class Characteristics: <ul style="list-style-type: none"> - Disagreement - Agreement - CND • Conclusion: <ul style="list-style-type: none"> - <i>Elimination</i> <ul style="list-style-type: none"> ○ Difference in class characteristics • Verification: <ul style="list-style-type: none"> - <i>Elimination</i> <ul style="list-style-type: none"> ○ Measurable difference in class characteristics 	<ul style="list-style-type: none"> • Comparison of Individual Characteristics: <ul style="list-style-type: none"> - Suitable <ul style="list-style-type: none"> ○ LMOV ○ MOV • Conclusions: <ul style="list-style-type: none"> - <i>Identification</i> <ul style="list-style-type: none"> ○ Sufficient agreement in individual characteristics - <i>Inconclusive</i> <ul style="list-style-type: none"> ○ Sufficient agreement not observed in individual characteristics • Verification: <ul style="list-style-type: none"> - <i>Identification</i>

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

It should be noted that a tool is defined as any harder object that can leave a mark on a softer object. This may loosely extend to an object not conventionally thought of as a “tool”.

Pattern Matching is an empirical science that relies on objective measurements and a subjective comparison of individual characteristics.

Due to variation in substrate, changes in tool working surfaces from wear, corrosion, and abuse, or the employment of unusual tool/work piece orientations, toolmarks created by the same tool are not always identifiable.

10 Safety

Take standard precautions for the handling of all evidentiary items, certified reference materials and working standards. PPE should be also be utilized.

11 References

Davis, J.E., Tool Marks, Firearms and the Striagraph, Charles C. Thomas, Springfield, IL (1958).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

“Forensic Optical Topography, Landscape Study, December 2016”, Forensic Technology Center of Excellence, NIJ Award Number 2011-DN-BX-K564.

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“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. Accessed 5 February 2020.

“Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions – An AFTE Criteria for Identification Committee Report”, AFTE Journal, 1992; 24 (3), 340.

“Theory of Identification as it Relates to Toolmarks: Revised By: Committee for the Advancement of the Science of Firearm & Toolmark Identification”, AFTE Journal, 2011; 43 (4), 287.

United States. Department of Justice. Office of Legal Policy. Forensic Science. (2019, January) *Department of Justice Uniform Language for Testimony and Reports for the Forensic Firearms/Toolmarks Discipline – Pattern Match Examination*. Retrieved from the Department of Justice Web site: <https://www.justice.gov/olp/page/file/1083671/download>

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Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

Scientific & Biometric
Analysis Unit Chief

Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/ Toolmarks Discipline Standard Operating Procedure for Fracture Examinations

1 Scope

This procedure is designed for the evaluation and classification of fractured items of evidence (referred to as item in the remaining document). Fracture match examinations are the physical and microscopic examination of surface contours of two objects to determine if they were once joined.

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following categories of testing:

- Toolmarks

Additionally, the following terms will be used throughout this procedure:

- **Fracture**: three-dimensional surface contour variations that were produced due to the separation of an object under the action of stress.
- **Physical Characteristics**: Observable features of a specimen which indicate a restricted group source and are determined prior to manufacture (e.g., shape, color, design).
- **Class Characteristics**: Measurable or discernable features of a specimen which indicate a restricted group source. They result from design factors and are determined prior to manufacture.
- **Unsuitable**: An item bearing no class or individual characteristics for comparison.
- **Suitable**: An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV)**: Individual characteristics having quality and/or quantity for a source conclusion comparison.
- **Limited Microscopic Marks of Value (LMOV)**: Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **No Microscopic Marks of Value (NMOV)**: Absent of individual characteristics for a source conclusion comparison.
- **Comparison**: The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.
- **Light Comparison Microscopy (LCM)**: The use of connected optical microscopes to compare and evaluate microscopic features between two toolmarks.

2 Equipment/Materials/Reagents

- Known exemplars (casts)
- Measurement equipment
- Microscope (stereozoom/comparison)
- Personal protective equipment (PPE)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars produced from a fractured surface will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

4.1 Performance checks of the measurement equipment will be performed and recorded as outlined in the *FTD SOP Measurement, Calibration, Performance Check and Maintenance of Equipment*.

5 Sampling

5.1 Statistical sampling is not applicable in the FTD.

5.2 Non-Statistical sampling is employed in the FTD. It is based on the training, experience and competence of the examiner. No assumptions are made regarding items/portions that were not selected for examination and Results of Examination in *Laboratory Reports* are specific to the items/portions that were examined.

6 Procedures

6.1 Evaluation of an Item Bearing Fractured Surfaces

6.1.1 Review all previous observations of the item that were recorded in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.1.2 Ensure that the item and/or container has been properly labeled with the appropriate identifier.

6.1.3 Ensure that the item has been reviewed for any trace evidence that could be of probative value. It is at the discretion of the examiner to ensure coordination of the removal and preservation of trace evidence with the appropriate discipline examiner.

6.1.4 If no trace evidence is observed or has no probative value, the item can be cleaned in preparation for examination in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.2 Level 1 Analysis – Evaluation and Classification of the Fractured Surfaces

6.2.1 Physical and/or Class Characteristics

6.2.1.1 Evaluate the properties of the questioned item containing the fracture mark, treating each fracture mark independently, to determine any class and/or physical characteristics that may be present, such as, but not limited to:

- Shape
- Size of material
- Method of separation
- Color/paint surface
- Extrusion/manufacturing marks
- Physical composition of material
- Patterns
- Surface impressions

6.2.1.2 Depending on the size and shape of the fractured surfaces, it may be necessary to cast the fracture mark for evaluation of the class/individual characteristics and for preservation for future comparisons.

6.2.1.2.1 Casting marked surfaces will be conducted in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items*.

6.3 Level 2 Analysis – Evaluation, Classification and Comparison of Fractures Surfaces

6.3.1 Individual Characteristics / Surface Contours

6.3.1.1 Evaluate the individual characteristics of the observed fracture mark to determine if the surface contours are of value for comparison purposes. Value refers to the suitable quality and quantity of the individual characteristics represented. This evaluation can result in the following classifications:

NMOV	Microscopic marks are of <i>no value</i>	No microscopic comparison
LMOV	Microscopic marks are of <i>limited value</i>	Suitable for microscopic comparison
MOV	Microscopic marks are of <i>value</i>	Suitable for microscopic comparison

6.3.2 All observations of the fracture mark, to include evaluations of the physical, class and individual characteristics, will be recorded on the appropriate *FTD Worksheet* located in Appendix B of *FTD QAM Case Assignment, Records, Results and Verifications*.

6.3.3 The following fracture process chart will aid in determining the comparison examination workflow for fracture marks:

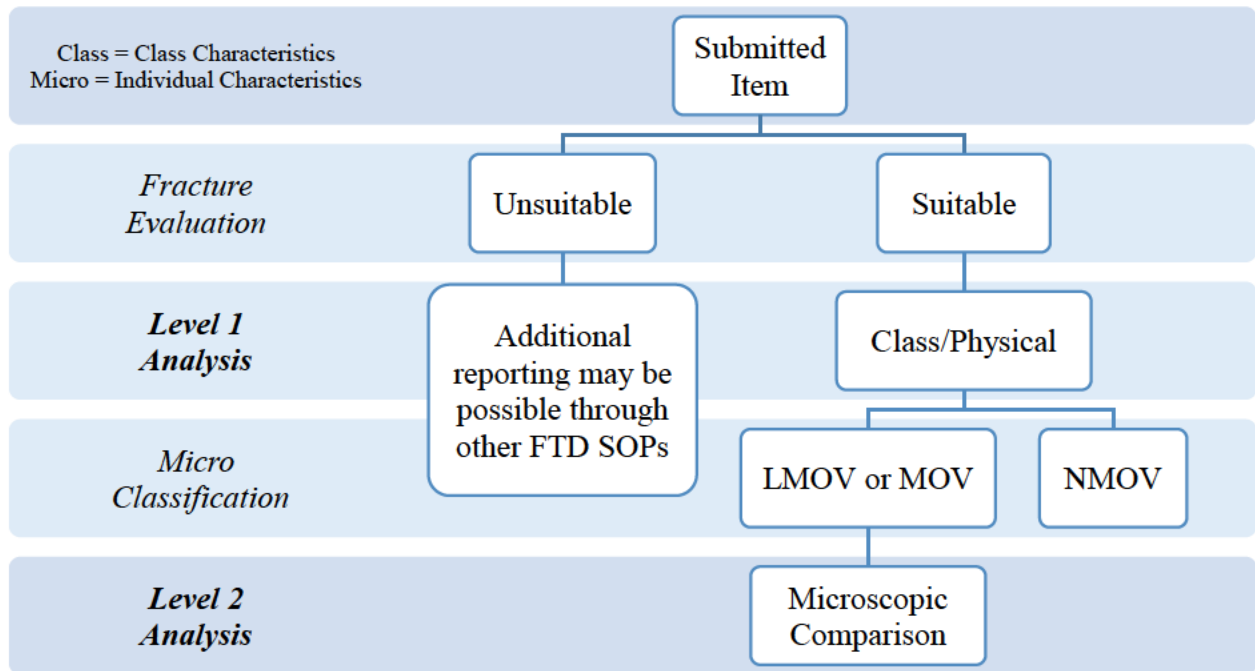


Figure 1. Fracture Process Chart

6.4 Level 2 Analysis – Comparison and Fracture Matching

6.4.1 A comparison of fractured items of evidence will be performed in accordance with the *FTD SOP Comparison and Fracture Matching*.

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

Due to wear, corrosion, abuse or substrate type, surface contours created from the fracture of an object are not always identifiable.

10 Safety

Take standard precautions for the handling of all evidentiary items and measurement equipment. Personal protective equipment should also be utilized.

11 References

Davis, J.E., Tool Marks, Firearms and the Striagraph, Charles C. Thomas, Springfield, IL (1958).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

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Orench, Jose A., “A Validation Study of Fracture Matching Metal Specimens Failed in Tension”, AFTE Journal, 2005; 37(2):142 through 149.

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United States. Department of Justice. Office of Legal Policy. Forensic Science. (2019, January) *Department of Justice Uniform Language for Testimony and Reports for the Forensic Firearms/Toolmarks Discipline – Fracture Match Examination*. Retrieved from the Department of Justice Web site: <https://www.justice.gov/olp/page/file/1083666/download>

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Firearms/Toolmarks
Unit Chief

Date: 02/28/2020

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Date: 02/28/2020

Firearms/Toolmarks
Technical Leader

Date: 02/28/2020

Firearms/ Toolmarks Discipline Standard Operating Procedure for Comparison and Fracture Matching

1 Scope

This procedure is designed for the comparison of fractured items of evidence (referred to as fracture in the remaining document). In addition, this procedure outlines the methods for comparison microscopy. Fracture matching includes the evaluation of submitted items to determine the value of any fracture that may be present, and the physical and microscopic examination of surface contours of two objects to determine if they were once joined.

This procedure applies to Firearms/Toolmarks Discipline (FTD) personnel conducting forensic examinations in the following category of testing:

- Toolmarks

Additionally, the following terms will be used throughout this procedure:

- **Fracture**: three-dimensional surface contour variations that were produced due to the separation of an object under the action of stress.
- **Physical Characteristics**: Observable features of a specimen which indicate a restricted group source and are determined prior to manufacture (e.g., shape, color, design).
- **Class Characteristics**: Measurable or discernible features of a specimen which indicate a restricted group source. They result from design factors and are determined prior to manufacture.
- **Suitable**: An item bearing class and/or individual characteristics for comparison.
- **Microscopic Marks of Value (MOV)**: Individual characteristics having quality and/or quantity for a source conclusion comparison.
- **Limited Microscopic Marks of Value (LMOV)**: Individual characteristics that are limited in quality and/or quantity for a source conclusion comparison.
- **Comparison**: The evaluation of two or more items bearing class and/or individual characteristics of value during an examination.
- **Light Comparison Microscopy (LCM)**: The use of connected optical microscopes to compare and evaluate surface contour variations between two fractured items.
- **Source Conclusion**: An Examiner's conclusion regarding the origin of a toolmark or fracture.

2 Equipment/Materials/Reagents

- Microscope (stereozoom/comparison)
- Measurement equipment
- Personal protective equipment (PPE)

3 Standards and Controls

Known exemplars produced from evidentiary items during examination serve as controls. Exemplars produced from the known item will be treated as secondary evidence in accordance with the *FTD SOP Documentation and Preparation of Evidentiary Items* and marked in accordance with the *FTD QAM Marking and Examination of Evidence*.

4 Performance Checks

Not Applicable.

5 Sampling

Not Applicable.

6 Procedures

When a comparison is performed between two surface contours, like material should be used. When casts are produced from surface contours of one item, any subsequent surface contours must also be cast.

6.1 Level 1 Analysis – Comparison of Fractured Surfaces

- 6.1.1 Review the class characteristic(s) and determine the following:
- Disagreement in Class Characteristics – **Exclusion** opinion can be rendered.
 - Agreement in Class Characteristic(s) or could not determine – Fracture Matching continues in Level 2

6.1.1.1 An exclusion result will be verified in accordance with the *FTD QAM Case Assignment, Records, Results and Verifications*.

6.2 Level 2 Analysis – Comparison of Individual Characteristics

- 6.2.1 Using comparative microscopy and/or physical fit, compare the individual characteristics in the random surface contours and render one of the following decisions:
- **Fracture Match**; two or more fracture items were once joined.
 - **Inconclusive**; due to a lack of sufficient corresponding microscopic marks of value, no conclusion could be reached as to whether two or more fractured items were once joined.

6.2.1.1 A fracture match result will be verified in accordance with the *FTD QAM Case Assignment, Records, Results and Verifications*.

6.2.1.2 For an inconclusive fracture examination result, additional information may be reported using other Standard Operating Procedures within the FTD.

6.3 Level 1 and Level 2 – Conclusions Rendered

6.3.1 The following opinion workflow will aid in reviewing the details pertaining to the opinion(s) rendered:

Level 1 Conclusions	Level 2 Conclusions
<ul style="list-style-type: none"> • Comparison of Physical and Class Characteristics: <ul style="list-style-type: none"> - Disagreement - Agreement • Conclusion: <ul style="list-style-type: none"> - <i>Elimination</i> <ul style="list-style-type: none"> ○ Difference in physical/class characteristics 	<ul style="list-style-type: none"> • Comparison of Individual Characteristics: <ul style="list-style-type: none"> - Suitable <ul style="list-style-type: none"> ○ LMOV ○ MOV • Conclusions: <ul style="list-style-type: none"> - <i>Fracture Match</i> <ul style="list-style-type: none"> ○ Sufficient agreement in individual characteristics - <i>Inconclusive</i> <ul style="list-style-type: none"> ○ Sufficient agreement not observed in individual characteristics • Verifications: <ul style="list-style-type: none"> - <i>Identification – Fracture Match</i>

7 Calculations

Not Applicable.

8 Measurement Uncertainty

Not Applicable.

9 Limitations

Fracture Matching is an empirical science that relies on objective measurements and a subjective comparison of individual characteristics.

Due to variation in substrate, changes in tool working surfaces from wear, corrosion, and abuse, or the employment of unusual tool/work piece orientations, toolmarks created by the same tool are not always identifiable.

10 Safety

Take standard precautions for the handling of all evidentiary items. PPE should be also be utilized.

11 References

Davis, J.E., Tool Marks, Firearms and the Striagraph, Charles C. Thomas, Springfield, IL (1958).

FBI Laboratory Quality Assurance Manual

FBI Laboratory Operations Manual

“Forensic Optical Topography, Landscape Study, December 2016”, Forensic Technology Center of Excellence, NIJ Award Number 2011-DN-BX-K564.

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Orench, Jose A., “A Validation Study of Fracture Matching Metal Specimens Failed in Tension”, AFTE Journal, 2005; 37(2):142 through 149.

“SWGGUN Admissibility Resource Kit (ARK).” Resources, The Association of Firearm and Tool Mark Examiners. Web. Accessed 5 February 2020.

“Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions – An AFTE Criteria for Identification Committee Report”, AFTE Journal, 1992; 24 (3), 340.

“Theory of Identification as it Relates to Toolmarks: Revised By: Committee for the Advancement of the Science of Firearm & Toolmark Identification”, AFTE Journal, 2011; 43 (4), 287.

United States. Department of Justice. Office of Legal Policy. Forensic Science. (2019, January) *Department of Justice Uniform Language for Testimony and Reports for the Forensic*

Firearms/Toolmarks Discipline – Fracture Match Examination. Retrieved from the Department of Justice Web site: <https://www.justice.gov/olp/page/file/1083666/download>

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