

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

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).

“FTU Safety Protocols for Handling of Firearms and Ammunition”, Appendix E, *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.

FBI Laboratory Quality Assurance Manual, latest revision

FBI Laboratory Operations Manual, latest revision

FBI Laboratory Safety Manual, latest revision

FBI Corporate Policy Directive 0989D, Laboratory Division Statement of Authorities and Responsibilities, Federal Bureau of Investigation, latest revision.

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

<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
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Date: 02/28/2020