

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

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Approval

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