Standard Scale of Source Conclusions and Criteria for Toolmark Examinations

Firearms and Toolmarks Subcommittee
Physics/Pattern Interpretation Scientific Area Committee
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

Standard Scale of Source Conclusions and Criteria for Toolmark Examinations

Prepared by
Firearms & Toolmarks Subcommittee
Version: 1.0

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This document has been developed by the Firearms & Toolmarks Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science through a consensus process and is *proposed* for further development through a Standard Developing Organization (SDO). This document is being made available so that the forensic science community and interested parties can consider the recommendations of the OSAC pertaining to applicable forensic science practices. The document was developed with input from experts in a broad array of forensic science disciplines as well as scientific research, measurement science, statistics, law, and policy.

This document has not been published by a SDO. Its contents are subject to change during the standards development process. All interested groups or individuals are strongly encouraged to submit comments on this proposed document during the open comment period administered by the Academy Standards Board (http://www.asbstandardsboard.org/).

Foreword

This standards document was proposed by the Firearms and Toolmarks Subcommittee of the Organization of Scientific Area Committees (OSAC) by submitting a request to the American Academy of Forensic Sciences (AAFS) Academy Standards Board (ASB). This document is intended to provide a standardized scale of source conclusions and underlying criteria for use by forensic firearm and toolmark examiners.

Additional documents which contain information related to this standards document include:

- Standard for Supporting Documentation of Source Conclusions in Toolmark Examinations
- Best Practice Recommendations for Peer Review of Source Conclusions in Toolmark Examinations
- Best Practice Recommendations for Expression of Source Conclusions in Toolmark Examinations

Keywords: *firearm and toolmark source conclusions, scale of conclusions, criteria*

This document was developed to provide a standard scale of conclusions and criteria to be used for all microscopic toolmark examinations and comparisons by forensic firearm and toolmark examiners.

All hyperlinks and web addresses shown in the document are current as of the publication date of this draft standard.

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1 Scope

This document provides a standard scale of conclusions and criteria to be used for all microscopic firearm and toolmark examinations and comparisons conducted for the forensic purpose of determining if two or more toolmarks were or could have been created by the same tool. This document takes into consideration the current state of professional practices and scientific research[1]. The scope of this document is limited to the process of developing source conclusions and does not address or consider other types of conclusions possible in the analysis of firearm and toolmark evidence. Throughout this document, the term "toolmark" is used to refer to both firearm-produced and non-firearm toolmarks.

2 Normative References

3 Terms and Definitions

For the purposes of this document, the following definitions and abbreviations apply:

3.1
Class Characteristics
Observable features of a specimen which indicate a restricted group source. They result from design decisions made by a manufacturer that are within acceptable manufacturing tolerances and are, therefore, determined prior to manufacture.

3.2
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.

3.3
Known Matching Toolmarks
KM
Toolmarks known to have been made by the same tool.

3.4
Known Non-Matching Toolmarks
KNM
Toolmarks known to have been made by different tools or different working surfaces of the same

[1] Numerous scientific studies have demonstrated the ability of firearm and toolmark examiners to make reliable and accurate source conclusion judgements; some of these studies are listed as references 3 through 9, 11, 13 through 16, 23, 24, and 28. A listing and summary of additional supportive research and validation studies pertaining to non-firearm toolmarks can be found in the SWGGUN Admissibility Resource Kit (ARK). https://afte.org/resources/swggun-ark/testability-of-the-scientific-principle.

tool.

3.5
Subclass Characteristics
Toolmarks produced by a single tool during the manufacturing process that repeat virtually unchanged from the same tooling operation on a series of sequentially-manufactured items. These types of characteristics are not determined prior to manufacture and may originate from a source that is more restrictive (i.e., a subset) than that of the overall class to which they belong.

4 Requirements

4.1 Value Determinations

4.1.1 No Value (Unsuitable) for Source Conclusion

A judgement that the item under consideration is inadequate to form any source conclusion due to insufficient quality or quantity of features, size, damage, or clarity of the item (i.e., any object that does not bear any class, subclass and/or individual toolmarks of value for source conclusion). However, the item may have value to other paths of forensic inquiry (e.g., crime scene reconstruction).

4.1.2 Of Value for Source Conclusion

A preliminary judgement that the item under consideration has potentially sufficient class, subclass and/or individual characteristics for further evaluation, examination, or comparison with other known-source or questioned-source items for potential source conclusion.

4.2 Scale of Source Conclusions and Related Criteria

4.2.1 Exclusion

An expert opinion that two items of toolmark evidence were marked by different tools. Source exclusion is the strongest statement of non-association expressed in forensic firearm and toolmark examination.

4.2.1.1 Criteria for Exclusion

An Exclusion is justified when the observed characteristics of the items in question provide extremely strong support for the proposition that they were marked by different tools *and* extremely weak or no support for the proposition that the two were marked by the same tool. This conclusion is based on 1) demonstrable differences in class, subclass or individual characteristics, 2) task-relevant information, and 3) the cumulative results of training and casework examinations that have either been performed, peer reviewed, and/or published in peer-reviewed journals.

4.2.1.1.1 An Exclusion shall be reached when there is a clear, demonstrable incompatibility in

class characteristics between the items in question. A source exclusion may only be expressed as a certainty if it is physically impossible (i.e., zero probability) for the examined items to have been marked by the same source tool based on an incompatibility in class characteristics.

4.2.1.1.2 If the class characteristics are compatible or possibly compatible, source exclusion is only justified if it is the examiner's opinion that there are demonstrable differences in individual or subclass characteristics such that the excluded toolmarks fall outside the range of variability of marks produced by the same tool (KM) and are consistent with the amount of disagreement demonstrated by toolmarks known to have been produced by different tools (KNM).

The following task-relevant factors should be considered when determining if differences observed in the comparison of two toolmarks are sufficient for exclusion [18]:

If a suspect tool is available for examination:

- Evidence of alteration to the tool working surface
- Ability of the tool to consistently reproduce individual characteristics
- Condition of the tool working surface or substrate
- Relative hardness of the tool working surface or substrate
- Any known time interval between deposition of questioned toolmark(s) and collection of the tool, during which changes to the tool could have occurred due to use, abuse, or corrosion[2]
- The history of the tool, to the extent it can be established[2]

If a suspect tool is unknown or otherwise unavailable for examination:

- Time interval between the production or collection of the questioned toolmarks, if related to different events
- The quantity and quality of any additional questioned toolmarks available for analysis, to the extent it can be determined that they represent a reliable range of variability of individual characteristics arising from the same source tool
    - Example: A group of four questioned bullets that can be identified as having been fired from the same unknown firearm based on consistently reproduced individual characteristics in the rifling impressions is compared to a bullet having the same class characteristics but displaying

[2] For the purpose of determining if an Exclusion is warranted based on differences in individual characteristics, investigative details relating to the possible use or non-use of the suspected tool during the time interval between the criminal incident and the collection of the tool as evidence may be contextual task-relevant information because it may help the examiner draw an accurate forensic conclusion [18].

almost no agreement of individual characteristics with the aforementioned group; in this example, the fifth bullet could justifiably be excluded (per the criteria in 4.2.1.1.2) as having been fired from the same firearm that marked the group of four bullets, if it can be assumed there are no mitigating factors (e.g., a lengthy time interval between the crime scenes, difference in ammunition) that could possibly account for the observed disagreement.

4.2.2 Insufficient Support for Exclusion

An expert opinion that the observed similarities and differences in characteristics of the items in question are insufficient for conclusive exclusion but provide substantial support for the proposition that the two items were marked by different tools and weak support for the proposition that they were marked by the same tool.

4.2.2.1 Criteria for Insufficient Support for Exclusion

An Insufficient Support for Exclusion conclusion is justified when, in the examiner's opinion, there is agreement of all discernible class characteristics and some disagreement of individual characteristics similar to that which has been demonstrated by KNM toolmarks, but insufficient for Exclusion (as previously defined in 4.2.1).

4.2.3 Insufficient Support for Either Exclusion or Identification

An expert opinion that the observed similarities and differences in characteristics of the items in question neither substantially support nor substantially refute the proposition that the items were marked by the same source tool.

4.2.3.1 Criteria for Insufficient Support for Either Exclusion or Identification

An Insufficient Support for Either Exclusion or Identification conclusion is justified when, in the examiner's opinion, there is agreement of all discernible class characteristics, but, due to an absence, insufficient agreement and/or disagreement, or lack of reproducibility of individual characteristics, no other conclusion can be reached.

4.2.4 Insufficient Support for Identification

An expert opinion that the observed similarities and differences in characteristics of the items are insufficient for conclusive identification, but provide substantial support for the proposition that the two items were marked by the same tool and weak support for the proposition that the two were marked by different tools.

4.2.4.1 Criteria for Insufficient Support for Identification

An Insufficient Support for Identification conclusion is justified when, in the examiner's opinion,

there is agreement of all discernible class characteristics and some agreement of individual characteristics but not exceeding the best KNM and is therefore insufficient for Identification.

4.2.5 Identification

An expert opinion that two items of toolmark evidence were marked by the same tool. Source identification is the strongest statement of association expressed in forensic firearm and toolmark examination.

4.2.5.1 Criteria for Identification

An Identification conclusion is justified when, in the examiner's opinion, the observed similarities in characteristics of the items in question provide extremely strong support for that proposition and negligible support for the proposition that the two items were marked by different tools.

In this context, "negligible support" means that based on 1) known empirical research and validation studies, and 2) the cumulative results of training and casework examinations that have either been performed, peer reviewed, or published in peer-reviewed scientific literature, it is the examiner's opinion that it is extremely unlikely any firearms or tools other than those identified are capable of producing marks exhibiting sufficient agreement for identification.

4.2.5.1.1 An Identification conclusion is based on an examiner's determination that all discernible class and individual[3] characteristics agree such that the extent of agreement exceeds that which has been demonstrated by toolmarks made by different tools (KNM) and is consistent with the agreement demonstrated by toolmarks known to have been made by the same tool (KM).

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[3] The use of the term "individual characteristics" here implies the marks being compared cannot be *subclass characteristics*. Subclass characteristics are manufactured toolmarks that sometimes repeat virtually unchanged from one manufactured item to another over a limited run of manufactured items. When these characteristics are present on or near the working surfaces of tools, it is possible for these toolmarks to be mistakenly interpreted as individual characteristics (thus resulting in the identification of a toolmark to a tool other than the one that produced the mark) if they are not carefully evaluated by the examiner. Therefore, subclass influences must be recognized so the toolmarks they produce can be appropriately considered. It is important to note that although subclass toolmarks may be present near the working surface of the tool, they may, either because of their position or manner in which the tool is normally used, have no influence on the individuality of toolmarks made by this working surface or edge.

Before rendering a conclusion regarding the individuality of an examined toolmark or tool, all examined toolmarks and tool working surfaces (if available) that are used as a basis for the conclusion must be evaluated for the possible presence of subclass characteristic influence. Reference [20] offers a practical description of how such evaluations can be conducted. Any agreement of microscopic characteristics that is observed between two toolmarks that can be attributed to the presence of potential subclass influences must not be used as the basis for a conclusion of identification.

5 Qualifications and Limitations [27]

5.1 An examiner shall not assert that two toolmarks originated from the same source to the exclusion of all other sources. This may wrongly imply that an Identification conclusion is based upon a statistically derived or verified measurement or an actual comparison to all other toolmarks in the world, rather than an examiner's expert opinion.

5.2 An examiner shall not assert that examinations conducted in the forensic firearms and toolmarks discipline are infallible or have a zero error rate.

5.3 An examiner shall not provide a conclusion that includes a statistic or numerical degree of probability except when based on relevant and appropriate data.

Annex A
(informative)

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