FEU 02 – The Examination of Ammunition and Ammunition Components

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1. Scope

1.1. To document the procedures for the microscopic and macroscopic examination of cartridge(s), cartridge case(s), shotshell(s) and shotshell case(s), fired bullets, and other projectiles (pellets, slugs and wads), including but not limited to the examination and comparisons of ammunition components to firearm(s) tests.

2. Background

2.1. To establish the practices for documenting the examination of evidence to conform to the requirements of the Department of Forensic Sciences (DFS) Forensic Science Laboratory (FSL) *Quality Assurance Manual*, the accreditation standards under ISO/IEC 17025:2017, and any supplemental standards.

2.2. This procedure has been updated and aligned with recommendations and response by the Scientific Advisory Board (SAB) of the Department of Forensic Sciences to the PCAST report.

3. Safety

3.1. Staff members should use universal precautions with evidentiary materials.

3.2. Use the correct caliber ammunition for the firearm being test fired. Staff will only use ammunition from the Ammunition Reference Collection.

4. Materials Required

4.1. Not applicable

5. Standards and Controls

5.1. Staff will only use ammunition from the Ammunition Reference Collection.

6. Calibration

6.1. Measurements from balances, calipers and micrometers that have a significant impact on test results will be calibrated to establish measurement traceability.

7. Procedures

7.1. General

7.1.1. Prior to an examination of ammunition or ammunition components, examiners will ensure that all additional testing for trace evidence has been completed.

7.1.2. Before any examinations are conducted, ensure that evidence items are properly sealed and labelled. Document the packaging, seal as received, and record any discrepancies in the technical work notes.

7.1.3. Label all evidence with the DFS laboratory number, item number and initials, if the size of the evidence permits. Evidence will be labeled appropriately according to analyst discretion. Evidence packaging will be labeled as required by LOM01.

7.2. Labeling marks are most commonly placed on the sides of the cartridge(s), cartridge case(s), shotshell(s) and shotshell case(s) including, but not limited to, inside the case mouth or on the case body. The nose and base of a bullet most often provide areas suitable for labeling. If sufficient space is not available, label the packaging.

7.3. Determine and document the physical characteristics of the ammunition and/or ammunition components.

7.3.1. All items will be documented in overall photographs to support technical notes. These photographs will be stored in Mideo CaseWorks.

7.3.2. The headstamp information of cartridges and cartridge cases will be depicted in a photograph and included in the case notes.

7.4. Physical Characteristics

7.4.1. As received, document the condition of any trace evidence found on the bullets/fragments.

7.4.1.1 Caution will be used not to damage areas suitable for microscopic and macroscopic examinations.

7.4.1.2 Do not label bullets and fragments on the land and groove impressions. If the item is too small, label the container as per LOM 01.

7.4.1.3 Biohazardous bullets should be cleaned at the discretion of the examiner e.g. soft bristle brush and ethanol/acetone.

7.4.1.4 Petals from hollow-point type projectiles/ammunition can be folded to expose land and groove impressions for microscopic and macroscopic examinations.

7.4.2. The physical characteristics may include but are not limited to:

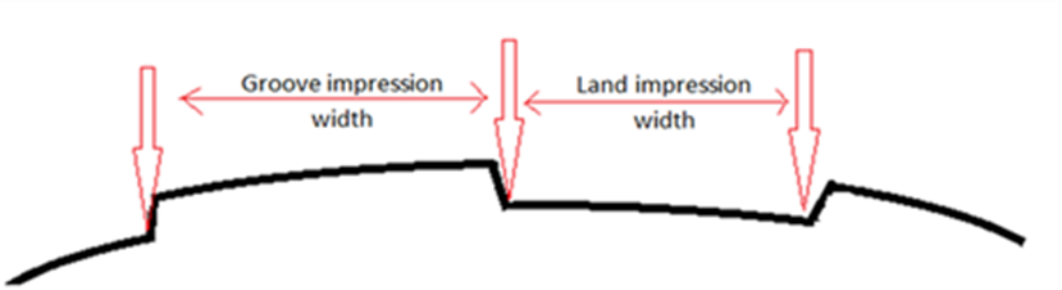
7.4.2.1 Design characteristics e.g. weight, composition, type, condition.

7.4.2.2 Class characteristics e.g. caliber, number of lands and grooves, type and direction, measurements and headstamp.

7.4.3. The physical characteristics are documented on the required Mideo worksheets fields for bullets and fragments, cartridge cases and cartridges.

7.5. Land and Groove Impression Measurements

7.5.1 Land and groove impression widths should be measured according to the diagram below:



7.5.2 Comparison microscope-stage caliper method: Hold or mount the fired bullet on a steady surface beneath the microscope. Measure the land and groove impressions using the ocular alignment grid and record the measurement to the nearest hundredth or thousandth of an inch.

7.5.3 Calibrated software method: Hold or mount the fired bullet on a steady surface beneath the microscope. Measure the land and groove impressions using the calibrated software that connects to the microscope-mounted camera and record the measurement to the nearest hundredth or thousandth of an inch.

7.6. General Rifling Characteristics File

7.6.1. The examiner will use the Association of Firearm and Toolmark Examiners (AFTE) general rifling characteristics (GRC) file to determine a list of possible firearms that could have fired an evidence bullet when no firearm was submitted or when the evidence specimen does not match test fires from the submitted firearm. The GRC file can be accessed at the following site: https://afte.org/members/databases/grc-search

7.6.2 When GRC list results will be reported, the version of the GRC used to generate the list must be validated. Validations of the GRC are performed according to the below procedure, recorded on the GRC Validation Log found on the FSL drive, and validation results are saved.

7.6.3 Perform three searches of the GRC file, one search for each of the validation sets below. Clear all fields of the form, then enter the relevant data for each validation set with a search range of +/- 0.003, select "Make and Model" for Custom Report Fields, and "PDF" for Output Format at the bottom of the search form, then select the Search button for the results page.

7.6.4 For each validation set, check for the expected result listed below to appear on the generated GRC list; if it does appear, the set will be recorded as a Pass (P); if it does not appear, the set will be recorded as a Fail (F). If any set fails, the input data should be checked again for accuracy, and the GRC file results will not be used in casework until the version passes all three validation sets.

Set 1

Caliber: 38

Number of Lands/Grooves: 7

Direction of Twist: Right

Land Impression Width: .056-.059"

Groove Impression Width: .099-.100"

Expected List Result: SCCY CPX-1 9mm Luger

Set 2

Caliber: 38

Number of Lands/Grooves: 6

Direction of Twist: Left

Land Impression Width: .073-.077"

Groove Impression Width: .095-.099"

Expected List Result: Polymer80 PF940C 9mm Luger

Set 3

Caliber: 40

Number of Lands/Grooves: 7

Direction of Twist: Left

Land Impression Width: .090-.093”

Groove Impression Width: .080-.084”

Expected List Result: Hi Point JCP 40 S&W

7.6.5 For each updated version that is validated, create a version subfolder and save the PDF files from all three sets to the GRC validation folder. In the GRC Validation Log spreadsheet: Record the date, complete version number as it appears in the footer of the results PDF, pass/fail results of validation sets, your initials, and any relevant notes or comments regarding the validation sets and results.

7.7. Range of Microscopic Examination Conclusions (Department Of Justice Uniform Language)

7.7.1. From an examination, standards for interpretation and the criteria for a microscopic result in the technical work notes shall be clear and descriptive.

7.7.2. A conclusion will reflect one of four possibilities with the criteria:

7.7.2.1 Identification – An examiner’s conclusion that two toolmarks originated from the same source. This conclusion is an examiner’s decision that all observed class characteristics and sufficient individual characteristics are in agreement. The identification is justified when in an examiner’s opinion, observed the quality and quantity of corresponding individual characteritics provide extremely strong support (significant duplication) and negligible support for the proposition that the two items were marked by different tools. The support for an identification may be qualified by demonstrating reproducibility using another source. In the absence of other sources or a firearm, at least two regions of interest shall be used to demonstrate strong support for an identification.

7.7.2.2 Elimination – An examiner’s conclusion that two toolmarks did not originate from the same source. The basis for a ‘source exclusion’ conclusion is an examiner’s decision that two toolmarks can be differentiated by their class characteristics and/or individual characteristics. An elimination is justified when an examiner’s opinion, observed the quality and quantity of characteristics 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. The support for an elimination may be qualified by demonstrating reproducibility using another source. In the absence of other sources or a firearm; class characteristics; subclass characteristics, at least two regions of interest shall be used to demonstrate strong support for an elimination based on individual characteristics.

7.7.2.3 Inconclusive – An examiner's conclusion that all observed class characteristics are in agreement but there is insufficient quality and/or quantity of corresponding individual characteristics such that the examiner is unable to identify or exclude the two toolmarks as having originated from the same source. An inconclusive is justified when in an 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.

7.7.2.4 Unsuitable – marks on the evidence ammunition components may not be present, or if present, may lack comparative value; specimens are not appropriate for a microscopic comparative examination. An unsuitable is justified when in an examiner's opinion, observed insufficient value to reach a finding due to lack of quality or identifiable features, size, damage or lack of characteristics e.g. rifling impressions.

7.7.3. In addition, cycling marks on fired and/or unfired ammunition components may be present. In these circumstances a determination may be made whether or not cartridge(s)/cases(s) was/were cycled in a particular firearm.

7.7.4. Identification conclusions must be supported in the case file by at least one photomicrograph. Photomicrographs will be contemporaneously annotated in the photographic field using the microscopy software to indicate DFS number(s), item numbers, magnification, caliber, initials, and date, and will be stored in Mideo CaseWorks.

7.8. Verifications

7.8.1. General

7.8.1.1 All conclusions reached through microscopic comparison will be verified by a qualified examiner. The verifier will use designated equipment to independently analyze the evidence to reach a microscopic conclusion, in the absence of the reporting examiner.

7.8.1.2 Multiple verifications may be requested at different times.

7.8.1.3 The case as a whole does not need to be complete at the time of verification.

7.8.2. Evidence transfer

7.8.2.1 The evidence will be transferred in LIMS if the verification cannot be completed and returned on the same day as requested by the reporting examiner.

7.8.3. Documentation

7.8.3.1 Examination documentation described in Section 7.5.1.3 in the Forensic Science Laboratory (FSL) Quality Assurance Manual (QAM). The details of the case documentation shall be to the extent necessary to ensure the following:

7.8.3.1.1 Refresh memory of observations documented during an examination for court purpose and;

7.8.3.1.2 Audit/Review purposes, for another qualified examiner or assessor to review and understand the technical notes to determine how findings/results were reached.

7.8.3.2 The reporting examiner will document his/her results on the verification worksheet, along with the foundational basis for his/her conclusion(s).

7.8.4. Results

7.8.4.1 If the reporting and verifying examiner reach different results, they will discuss and provide objective support of how the results were reached.

7.8.4.2 If the examiners cannot come to an agreement, the following steps will be taken:

7.8.4.2.1 The FSL Quality Assurance specialist and FEU Management will be notified in writing, and review the results and objective support provided by examiners.

7.8.4.2.2 FEU Management will select a third examiner presenting only the relevant evidence to limit potential bias.

7.8.4.2.3 The Verifying Examiner will perform an examination and document his/her findings on the verification worksheet.

7.8.4.2.4 No Report of Examination or preliminary results will be issued until verification is complete.

7.8.4.2.5 Documentation reflecting the disagreement will be retained.

7.8.5. Witness verifications are conducted periodically by FEU Management or designee. Both primary (assigned) analyst and verifying analyst will be required to document their conclusions electronically in LIMS. The FEU Supervisor or designee will serve as a witness to the verification. The witness will be required to electronically document their initials and date of the witness verification in LIMS.

8. Sampling

8.1. Not applicable

9. Calculations

9.1. Using the following equations, the diameter of a damaged bullet can be determined using the land and groove measurements:

L = land impression width (in.)

G = groove impression width (in.)

TX = total impression width (in.)

$TX = L + G$

N = # land/groove impressions

c = circumference

$\pi = 3.14$

d = diameter

$d = c / \pi$

$N * TX = c$

10. Uncertainty of Measurement

10.1. Weight, diameter and general rifling characteristics of bullets are quantitative measurements, however, the measurements are not included in reports; therefore, the uncertainty of measurement will not be calculated.

11. Limitations

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

11.2. If the ammunition components are extremely damaged, it may not be possible to determine some physical characteristics. Some evidence may lack microscopic marks of value for examination/comparison purposes.

11.3. Differences in ammunition caliber, brand, and composition could have an effect on the observable marks of value necessary to reach a microscopic conclusion.

11.4. Identifiable microscopic marks may not be reproduced 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 and/or cartridge cases to each other.

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

11.6. Reports are written with the understanding that firearms identification is an empirical science that relies on objective observations and a subjective interpretation of microscopic and macroscopic marks of value. Since it is not possible to collect and examine samples of all firearms, statements of identification are considered a practical certainty. All scientific research and testing to date and the continuous inability to disprove the principles of toolmark analysis have demonstrated that firearms produce unique, identifiable characteristics which allow examiners to reliably make identifications.

12. Documentation

12.1. Cartridge Case Worksheet

12.2. Cartridge Worksheet

12.3. Bullet Worksheet

12.4. Fragment/Misc Worksheet

12.5. GRC Validation Log

13. References

13.1. Forensic Science Laboratory Quality Assurance Manual (Current Version)

13.2. DFS Departmental Operations Manuals (Current Versions)

13.3. FSL Laboratory Operations Manuals (Current Versions)

13.4. ISO/IEC 17025:2017 – General Requirements for the Competence of Testing and Calibration Laboratories, International Organization for Standardization, Geneva, Switzerland.

13.5. FEU-LIMS-01 Guide to Firearms Analysis

13.6. ANAB, Guidance on reporting uncertainty of Measurement for calibration laboratories (March 2018).

13.7. An examination of How the ANAB ISO17025:2005 Forensic Testing Accreditation Requirements (AR 3028 relates to the Firearms and Toolmarks Community (Knapp, et al AFTE J, Vol 50, No 2, Spring 2018).