
Technical Procedure for Unfired Cartridge/Shotshell Examination

- 1.0 Purpose** – To outline the procedures for examination and comparison of unfired cartridge and shotshell evidence.
- 2.0 Scope** – This procedure applies to cases submitted to the Firearm and Tool Mark Section that contain unfired cartridges or shotshells.
- 3.0 Definitions**
- **Caliber (Ammunition)** – A numerical term, without the decimal point, included in a cartridge name to indicate the nominal bullet diameter.
 - **Cannelure** – A circumferential groove generally of a knurled or plain appearance on a bullet or cartridge case that is typically used for crimping, lubrication, and identification.
 - **Cartridge** – A single unit of ammunition consisting of the case, primer, and propellant with one or more projectile(s).
 - **Centerfire** – Any cartridge that has its primer central to the axis in the head of the case.
 - **Chambering detail** – Individual microscopic marks placed upon a cartridge case by the chamber wall as a result of inserting a cartridge into the chamber of a firearm.
 - **Class characteristics** – Measurable features of a specimen which indicate a restricted group source. They result from design factors, and are therefore determined prior to manufacture.
 - **Comparison microscope** – Essentially two microscopes connected to an optical bridge which allows the viewer to observe two objects simultaneously with the same degree of magnification.
 - **Ejection port** – An opening in the receiver or slide to allow ejection.
 - **Ejector** – A portion of a firearm's mechanism which ejects or expels cartridges or cartridge cases from a firearm.
 - **Extractor** – A portion of a firearm's mechanism which withdraws a cartridge or cartridge case from the chamber of a firearm.
 - **Gauge** – A term used in the identification of a shotgun bore. The number of round lead balls of bore diameter that equal one pound. Thus, 12 gauge is the diameter of a round lead ball weighing 1/12 pound.
 - **Headstamp** – Numerals, letters and symbols (or a combination thereof) stamped into the head of a cartridge case or shotshell to identify the manufacturer, caliber, gauge, or give additional information.
 - **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. They are unique to that tool and distinguish it from all other tools.
 - **Objective** – The lens or lenses in an optical instrument which form the image of an object.
 - **Oblique lighting** – A method of illumination where the light source is placed at an angle, generally to produce shadows or enhance edges.
 - **Primer** – The ignition component of a cartridge.
 - **Rimfire** – A flange-headed cartridge containing the priming mixture inside the rim cavity.
 - **Shell latch** – The part of a shotgun that holds live shotshells in the magazine tube.
 - **Shotshell** – A cartridge containing projectile(s) designed to be fired in a shotgun. The cartridge body may be metal, plastic, or paper.
 - **Stereomicroscope** – An optical instrument which provides three dimensional viewing of an object through paired objectives and eyepieces. Some models share a common main objective.

- **Sufficient agreement** – Agreement is sufficient when it exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent with the agreement demonstrated by tool marks known to have been produced by the same tool.

4.0 Equipment, Materials, and Reagents

- Comparison microscope
- Stereomicroscope
- Caliper
- Balance
- Ammunition Reference Collection
- Engraver
- Bullet puller
- Cotton-tipped swabs
- Cleaning solutions such as Terg-A-Zyme, Hibiclens, ethanol, acetone and cartridge case cleaner (5 % v/v dilution of Birchwood Casey Concentrate in water)
- Magnet
- Personal protective equipment
- Soft bristle brush

5.0 Procedure

5.1 Unfired Cartridge/Shotshell Examination

5.1.1 Item Preparation

- 5.1.1.1 Prior to examination, ensure that any additional service requests (e.g., Forensic Biology, Trace, Latent, etc.) that shall be completed before analysis by the Firearm and Tool Mark Section have been completed. This can be verified by examining one, or a combination, of the following:
 - 5.1.1.1.1 The status of other case records in Forensic Advantage (FA).
 - 5.1.1.1.2 The chain of custody.
 - 5.1.1.1.3 Markings from other Forensic Scientists on the evidence packaging.
- 5.1.1.2 Wear appropriate personal protective equipment, such as gloves, lab coat, and/or safety glasses, if the item may be contaminated with a biohazardous material (blood or other potentially infectious material).
- 5.1.1.3 Visually inspect the item for possible trace evidence such as hair, fibers, wood, etc. Note the location on the item where the trace material was found. Carefully remove the material and place in a container suitable for return to the submitting agency or submission to the appropriate Laboratory Section for further examination.

- 5.1.1.3.1** If the trace material is not to be retained, indicate as such in the case notes.
- 5.1.1.4** Unfired cartridges or shotshells contaminated with blood, body matter or other biological material shall be cleaned with a soft bristle brush and a disinfectant such as Terg-A-Zyme, Hibiclens, and/or ethanol.
- 5.1.1.5** Unfired cartridges or shotshells may generally be cleaned with a cotton-tipped swab saturated with ethanol, acetone, and/or cartridge case cleaner.
- 5.1.1.6** Mark all evidence cartridges and shotshells for identification.
 - 5.1.1.6.1** Do not mark on the head or rim or mark on possible extractor or chambering marks. Find an area devoid of markings.
 - 5.1.1.6.2** Mark with the item designation number (K number), the Laboratory case number, and the Forensic Scientist's initials.
 - 5.1.1.6.3** If cartridges and shotshells are examined for manufacturing information only and not used for further testing, the evidence container may be properly marked in lieu of marking the items themselves.

5.1.2 Physical Characteristics Examination

- 5.1.2.1** A Cartridge Case Worksheet shall be completed in FA for unfired cartridges if they are to be microscopically examined. Cartridges of similar class characteristics may be grouped together on the same worksheet. Similar information as applicable for unfired shotshells shall be recorded on a Shotshell Worksheet. Cartridges/shotshells submitted with a firearm and without a specific request for microscopic examination may be included with the firearm on its worksheet. Each worksheet shall contain the item designation number (K number) assigned to the item by the Forensic Scientist.
- 5.1.2.2** Features of unfired cartridges that shall be noted, if applicable, include:
 - 5.1.2.2.1 Design characteristics of unfired cartridges or shotshells:**
 - Manufacturer
 - Caliber/Gauge
 - Headstamp
 - Ignition system (centerfire or rimfire)
 - Composition of the case, primer, and/or hull
 - Hull markings (load information)
 - Cannelure type and location
 - Primer sealant color
 - Shape, description, and/or weight of the bullet loaded in the cartridge

5.1.2.2.2 Class characteristics of the firearm that cycled the cartridge or shotshell:

- Presence of a firing pin strike
- Extractor mark(s) and position
- Ejector mark(s) and position
- Chambering detail type
- Magazine lip marks
- Shell latch marks
- Ejection port markings
- Resizing marks or any other indications of reloading

5.2 Comparison Microscope Protocol

5.2.1 The following is an illustration of an approved method of performing a comparison microscope examination of test and/or evidence unfired cartridges or shotshells. Forensic Scientists may develop their own routine for this type of examination; however, they shall incorporate the general underlined points mentioned below.

5.2.1.1 Select the correct objective (magnification) setting and ensure that the objectives are locked in place. Low magnification (10X - 15X) is typically used to examine the cartridge or shotshell looking for areas with the most obvious individual characteristics. Higher magnification (20X or greater) is typically used to verify the correspondence of finer striations.

5.2.1.2 The illumination (lights) used shall be properly adjusted. Oblique lighting is usually preferred.

5.2.1.3 If a firearm was submitted for comparison to evidence cartridges/shotshells, first compare the test cartridges/shotshells cycled through this firearm to each other to determine which microscopic characteristics are reproducing.

5.2.1.3.1 Cycling detail

5.2.1.3.1.1 The Forensic Scientist may examine extractor, ejector, chambering, feed marks and any other marks that may be present on the test cartridges/shotshells.

5.2.1.3.1.2 Position the test cartridges/shotshells on the stages in the position that most clearly highlights the area(s) of concern.

5.2.1.3.2 If the test cartridges/shotshells cannot be matched to each other (there is not sufficient agreement), more tests cartridges/shotshells may be cycled and inter-compared. If the test cartridges/shotshells still cannot be matched, the Forensic Scientist may reach the conclusion that the firearm in question does not reproduce its individual characteristics very well or that the firearm does not produce sufficient individual marks to reach a positive conclusion.

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- 5.2.1.4** Compare unknown unfired cartridge(s)/shotshell(s) to either another unknown unfired cartridge/shotshell or a test cartridge/shotshell.
- 5.2.1.4.1** The Forensic Scientist may ascertain at this point if the class characteristics agree by noting whether or not the type, shape, and location of extractor marks, ejector marks, etc. are the same.
- 5.2.1.4.1.1** If the class characteristics are markedly different and this difference is not attributed to deformity or damage to the firearm after the cycling of the evidence cartridge/shotshell, the Forensic Scientist may conclude that the evidence cartridge/shotshell was not cycled through the evidence firearm or that the evidence cartridges/shotshells were not cycled through the same firearm.
- 5.2.1.4.2** In the case of comparison to a test cartridge/shotshell, attempt to locate the area on the evidence cartridge/shotshell that corresponds to the previously examined area of the test cartridge/shotshell.
- 5.2.1.4.3** When comparing evidence cartridges/shotshells to each other, an area with obvious individual characteristics may be noted on one cartridge/shotshell. The other cartridge/shotshell may then be examined in an attempt to locate the corresponding area.
- 5.2.1.5** These examinations shall be made with the cartridges/shotshells in phase. This means that cartridges/shotshells that are being examined shall be oriented similarly using a common point of reference such as drag marks, extractor marks, ejector marks, etc.
- 5.2.1.6** The entire unknown shall be considered. The Forensic Scientist shall examine and compare all detail of a similar type present on the unfired cartridge/shotshell. For example, when comparing chambering detail, the Forensic Scientist shall examine the entire case wall for all chambering detail present.
- 5.2.1.7** The Forensic Scientist may halt the examination if he/she finds sufficient agreement to match in one area of detail. For example, if the Forensic Scientist finds sufficient agreement to match based on extractor mark detail, the Forensic Scientist need not examine and compare chambering detail. If, however, the Forensic Scientist does not find sufficient agreement in a particular area, the Forensic Scientist shall continue looking at other areas until he/she determines that there is sufficient agreement to match or until there are no more areas of detail to examine.
- 5.2.1.8** If the cartridges/shotshells may be matched to each other, the cartridges/shotshells shall be indexed with an indelible marker to indicate the position in which the agreement is most clearly viewed.
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5.2.1.8.1 The Forensic Scientist may refer to previously indexed areas when describing the orientation, such as an extractor index mark.

5.2.1.8.2 Specific areas of chambering detail agreement shall be indexed on the case walls immediately adjacent to the agreement.

5.2.1.9 If an identification is not initially made, the Forensic Scientist may consider the following possible reasons for the lack of sufficient agreement:

5.2.1.9.1 The evidence cartridge/shotshell and test cartridges/ shotshells were cycled through different firearms.

5.2.1.9.2 The firearm was damaged between cycling the evidence cartridge/shotshell and the test cartridge/shotshell.

5.2.1.9.3 The test ammunition available is significantly different from the evidence causing a difference in the way the cartridge/shotshell was marked.

5.2.1.9.4 Extreme fouling is/was present in the firearm, either prior to cycling the evidence cartridge/shotshell or occurring since the evidence cartridge/shotshell was cycled.

5.2.1.9.5 Damage occurred to the evidence cartridge/shotshell causing distortion, deformation or the elimination of microscopic detail.

5.2.1.9.6 The evidence cartridge/shotshell was cycled through a firearm of an incorrect caliber.

5.2.1.9.7 Other reasons may exist and may be considered and tested if appropriate at the discretion of the Forensic Scientist based on his/her training and experience.

5.3 Range of Conclusions

5.3.1 The suggested report wording listed below may be modified at the Forensic Scientist's discretion to reflect more accurately his/her conclusions. Any such modifications to report wording shall be reviewed and approved with the technical review.

5.3.2 Identification

5.3.2.1 There is agreement of all discernible class characteristics and sufficient agreement of individual characteristics to constitute a match.

- "The K-1 cartridge was cycled through the K-2 firearm."
- "The K-1 and K-2 shotshells were cycled through the same firearm."

5.3.3 Inconclusive

5.3.3.1 There is agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification.

- “There is agreement of all discernible class characteristics and some agreement of individual characteristics between cycling marks found on the K-1 shotshell and test shotshells cycled through the K-2 firearm. However, the agreement is insufficient to identify K-1 as having been cycled through the K-2 firearm.”
- “There is agreement of all discernible class characteristics and some agreement of individual characteristics between cycling marks found on the K-1 and K-2 cartridges. However, the agreement is insufficient to identify K-1 and K-2 as having been cycled through the same firearm.”

5.3.3.2 There is agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.

- “There is agreement of all discernible class characteristics without agreement or disagreement of individual characteristics between cycling marks found on the K-1 cartridge and test cartridges cycled through the K-2 firearm due to an absence, insufficiency, or lack of reproducibility. Therefore, it cannot be determined whether or not K-1 was cycled through the K-2 firearm.”
- “There is agreement of all discernible class characteristics without agreement or disagreement of individual characteristics between cycling marks found on the K-1 and K-2 shotshells due to an absence, insufficiency, or lack of reproducibility. Therefore, it cannot be determined whether or not K-1 and K-2 were cycled through the same firearm.”

5.3.3.3 There is agreement of all discernible class characteristics and some disagreement of individual characteristics, but insufficient for elimination.

- “There is agreement of all discernible class characteristics and some disagreement of individual characteristics between cycling marks found on the K-1 shotshell and test shotshells cycled through the K-2 firearm. However, the disagreement is insufficient to eliminate K-1 as having been cycled through the K-2 firearm.”
- “There is agreement of all discernible class characteristics and some disagreement of individual characteristics between cycling marks found on the K-1 and K-2 cartridges. However, the disagreement is insufficient to eliminate K-1 and K-2 as having been cycled through the same firearm.”

5.3.4 Elimination

5.3.4.1 There is significant disagreement of discernible class characteristics and/or individual characteristics.

- “The K-1 cartridge was not cycled through the K-2 firearm.”
- “The K-1 and K-2 shotshells were not cycled through the same firearm.”

5.3.5 Unsuitable

5.3.5.1 The unfired evidence in question is not suitable for comparison purposes.

- “The K-1 shotshell contains no marks of comparison value for forensic firearms identification.”

5.3.6 Forensic Scientists shall include in their notes all conclusions reached from the microscopic comparison of evidence cartridges, shotshells and/or test ammunition components. Forensic Scientists shall also explain their reasons for reaching these conclusions. The reasons shall be clear and succinct and shall be able to be understood by any other competent forensic firearms scientist. The Forensic Scientist shall include the position and type of index marks used and which of the test cartridges or shotshells (if an evidence firearm was submitted) was used or if more than one test was used to reach the conclusions.

5.4 Standards and Controls – N/A

5.5 Calibration – For caliper calibration information, see the Firearm and Tool Mark Section Technical Procedure for Instrument Calibration and Maintenance.

5.6 Maintenance – For comparison microscope, stereomicroscope, and caliper maintenance information, see the Firearm and Tool Mark Section Technical Procedure for Instrument Calibration and Maintenance.

5.7 Sampling – N/A

5.8 Calculations – N/A

5.9 Uncertainty of Measurement – N/A

6.0 Limitations – N/A

7.0 Safety – Examinations performed in the Firearm and Tool Mark Section are inherently dangerous. These procedures involve hazardous chemicals, firearms, and potential biohazards. All hazardous procedures shall be performed in compliance with the State Crime Laboratory Safety Manual. If the examination involves a biohazard, the Forensic Scientist shall use proper personal protective equipment, such as eye protection, a lab coat, and/or gloves.

8.0 References

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9.0 Records

- FA Worksheets: Main, Cartridge Case, Shotshell, and Disposition/Result

10.0 Attachments – N/A

Revision History		
Effective Date	Version Number	Reason
09/17/2012	1	Original Document
12/07/2012	2	Added magnet to Equipment list; 5.1.2.2.1 – removed cup from composition line and removed shape of cartridge case
02/15/2013	3	Removed Raleigh from the header; 4.0 – added balance and bullet puller; added 5.1.1.6.3; 5.3.5.1 – changed Q to K
09/06/2013	4	5.3.3.3 - added “some” to the paragraph and to the two examples of report wording
11/15/2013	5	Added issuing authority to header