
Technical Procedure for Fired Cartridge Case/Shotshell Examination

- 1.0 Purpose** – To outline the procedures for examination and comparison of fired cartridge case and shotshell evidence.
- 2.0 Scope** – This procedure applies to cases submitted to the Firearms Unit that contain fired cartridge cases or shotshells.
- 3.0 Definitions**
- **Anvil marks** – Microscopic marks impressed on the forward face of the rim of a rimfire cartridge case as it is forced against the breech end of the chamber by the firing pin. These marks are characteristic of the breech under the firing pin and may be used to identify a cartridge case with a specific firearm.
 - **Breechface impression** – Negative impression of the breech face of the firearm found on the head of the cartridge case and/or primer after firing.
 - **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 case** – The container for all the other components which comprise a cartridge.
 - **Centerfire** – Any cartridge that has its primer central to the axis in the head of the case.
 - **Chamber detail** – Individual microscopic marks placed upon a cartridge case by the chamber wall as a result of expansion during firing.
 - **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.
 - **Firing pin aperture** – The hole in the breech face of a firing pin through which the firing pin protrudes.
 - **Firing pin aperture shear** – Striations created by the edge of the firing pin aperture as the cartridge case head moves against the breech face of a firearm.
 - **Firing pin drag** – The tool marks produced when a projecting firing pin comes into contact with a cartridge case or shotshell during the extraction, ejection cycle.
 - **Firing pin impression** – The indentation of the primer of a centerfire cartridge case or in the rim of a rimfire cartridge case caused when it is struck by the firing pin.
 - **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
- Micrometer
- Ammunition Reference Collection
- Cartridge case identification software (CartWinPro)
- FBI General Rifling Characteristics File
- Engraver
- 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 Cartridge cases and shotshells that are removed from the chamber, action, or magazine of a firearm shall not be microscopically compared to the firearm, unless specifically requested by the appropriate District Attorney's Office.

5.2 Fired Cartridge Case/Shotshell Examination

5.2.1 Item Preparation

5.2.1.1 Prior to analysis, ensure that any additional examinations (e.g., Forensic Biology, Trace, Latent, etc.) that must be completed before analysis by the Firearms Unit have been completed.

5.2.1.2 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.

5.2.1.2.1 If the trace material is not to be retained, indicate as such in the case notes.

5.2.1.3 Fired cartridge cases or shotshells contaminated with potentially bio-hazardous material may be cleaned with a soft bristle brush and a disinfectant such as Terg-A-Zyme, Hibiclens, and/or ethanol.

5.2.1.4 Fired cartridge cases or shotshells may generally be cleaned with a cotton-tipped swab saturated with ethanol, acetone, and/or cartridge case cleaner.

5.2.1.5 Mark all evidence cartridge cases and shotshells for identification.

5.2.1.5.1 Do not mark on the head or rim or mark on possible extractor or chamber marks. Find an area on the case devoid of markings.

5.2.1.5.2 Mark with the item designation number (Q number), the Laboratory case number, and the Forensic Scientist's initials.

5.2.1.5.3 If necessary, markings may be made inside a case mouth.

5.2.2 Physical Characteristics Examination

5.2.2.1 A Cartridge Case Worksheet shall be filled out in FA for fired cartridge cases that are to be compared microscopically. Cartridge cases of similar class characteristics may be grouped together in the same entry. Similar information as applicable for fired shotshells that are to be compared microscopically shall be recorded on a Shotshell Worksheet.

5.2.2.2 Fired cartridge cases/shotshells that will not be compared microscopically shall be recorded on a Firearm Worksheet or on the Disposition page as follows:

5.2.2.2.1 If the fired cartridge cases/shotshells were submitted with a firearm and are a caliber that can be fired in the firearm, either intentionally or otherwise, they shall be included on the Firearm worksheet for the firearm with which they were submitted or listed in the Comments block of the Disposition Page.

5.2.2.2.2 If fired cartridge cases/shotshells are submitted independently from a firearm or were submitted with a firearm, but are a caliber that cannot be fired in the firearm either intentionally or otherwise, they shall be listed in the Comments block of the Disposition Page.

5.2.2.3 Features of fired cartridge cases that shall be noted, if applicable, include:

5.2.2.3.1 Design characteristics of the fired cartridge case or shotshell:

- 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

5.2.2.3.2 Class characteristics of the firearm that fired the cartridge case or shotshell:

- Firing pin impression shape; Forensic Scientist may also note firing pin drag or flow and firing pin aperture shear
- Breechface impression detail type
- Extractor mark(s) and position
- Ejector mark(s) and position
- Chamber detail type
- Magazine lip marks
- Shell latch marks
- Ejection port markings
- Anvil marks
- Resizing marks or any other indications of reloading

5.3 General Rifling Characteristics (GRC) File Protocol

5.3.1 GRC File searches shall not be performed unless accompanied by a written request on letterhead from the appropriate District Attorney, US Attorney, Judicial Official, or Federal/State Official and approved by the Forensic Scientist Manager/Supervisor of the Physical Evidence Section or Crime Laboratory Assistant Director or Director.

5.3.2 If an evidence cartridge case is not identified to a particular firearm, a list of manufacturers of firearms of similar caliber and/or class characteristics may be compiled using the computerized General Rifling Characteristics (GRC) File provided by the FBI at the Forensic Scientist's discretion based on the discernible class characteristics present and the Forensic Scientist's training and experience.

5.3.3 A combination list generated using class characteristics of both fired bullets and cartridge cases shall not be produced.

5.3.4 Fill in the applicable fields at the bottom of the GRC Search page with the pertinent case information and the information obtained during the examination of the cartridge case, and run the computerized search of the database files.

5.3.4.1 The search parameters may include caliber, breechface impression type, firing pin impression shape, extractor position and/or ejector position.

- 5.3.4.1.1** Because of variation in the original data entry into the GRC File, the Forensic Scientist shall include similar class characteristics when applicable. An example is selecting both circular and hemispherical firing pin impression shapes for a cartridge case with a hemispherical firing pin impression.
- 5.3.4.2** Based on the Forensic Scientist's training and experience, the list may be filtered based on characteristics of the cartridge case that may indicate or exclude a particular type of firearm.
- 5.3.4.3** If multiple evidence cartridge cases have the same class characteristics or have been identified to each other, one list of possible firearm manufacturers may be compiled.
- 5.3.5** Record this information in the case notes and import the search results generated by the General Rifling Characteristic File into the case file.
- 5.3.6** Report the list of possible manufacturers in the main body of the report.
 - 5.3.6.1** Always include a disclaimer line notifying the submitting agency that the list may not be all inclusive and should not be used to eliminate any suspect firearm.
- 5.3.7** If the list consists of more than twenty (20) possible firearm manufacturers, the complete list shall be imported into the Case Record Object Repository and the report shall contain a statement that the list of firearms that may have fired the evidence cartridge case(s) was too numerous to be of investigative value.

5.4 Comparison Microscope Protocol

- 5.4.1** The following is an illustration of an approved method of performing a comparison microscope examination of test and/or evidence fired cartridge cases or shotshells. Forensic Scientists may develop an individual routine for this type of examination; however, they shall incorporate the general underlined points mentioned below.
 - 5.4.1.1** 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 fired cartridge case 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.
 - 5.4.1.2** The illumination (lights) used shall be properly adjusted. Oblique lighting is usually preferred. The angle of case head surface and/or lighting angle may be manipulated to achieve the best view of the surface contour.
 - 5.4.1.3** If a firearm was submitted for comparison to evidence cartridge cases/shotshells, first compare the test cartridge cases/shotshells fired from this firearm to each other to determine which microscopic characteristics are reproducing.

5.4.1.3.1 Breechface impression

5.4.1.3.1.1 Rotate one test cartridge case/shotshell to find the position that best highlights the individual characteristics on the primer and/or the base. When such an area is located, rotate the second test item to the same position.

5.4.1.3.2 Firing pin impression

5.4.1.3.2.1 The Forensic Scientist may also examine and compare the firing pin impressions of the test cartridge cases/shotshells. The cartridge cases/shotshells may be tilted toward the light source to illuminate the firing pin impression.

5.4.1.3.2.2 Rotate one test cartridge case/shotshell to find the position that best highlights the individual characteristics in the firing pin impression. When such an area is located, rotate the second test item to the same position.

5.4.1.3.3 Chamber detail

5.4.1.3.3.1 If the breechface or firing pin impressions lack sufficient agreement to be matched, the test cartridge cases/shotshells shall be examined for chamber detail.

5.4.1.3.3.2 Position one test cartridge case/shotshell so that it is oriented horizontally on the stage and rotate it to find the position that best highlights the individual characteristics. When such an area is located, rotate the second test item to the same position.

5.4.1.3.3.3 Matching chamber detail may indicate that the cartridge case/shotshell was fired in the suspect firearm. However, to prove that conclusion, the Forensic Scientist shall:

5.4.1.3.3.3.1 Work live rounds through the action of the firearm. Examine the live rounds for the chamber detail used to match the fired cartridge cases. If the matching chamber detail does not appear on the live rounds, the conclusion may be made that the detail is fired-in, or;

5.4.1.3.3.3.2 In the absence of the firearm, document that the chamber marks on three (3) or more fired cartridges/ shotshells are all in the same spatial relationship to the position/location of individual detail in the firing pin impression, breechface

impression, and/or other known fired-in marks.

5.4.1.3.4 Cycling detail

5.4.1.3.4.1 The Forensic Scientist may also examine any extractor, ejector, chambering, and feed marks and any other marks that may be present on the test cartridge cases/shotshells.

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

5.4.1.3.5 If the test cartridge cases/shotshells cannot be matched to each other, (the agreement is not sufficient) then more test cartridge cases/shotshells may be fired and inter-compared. If the test fired cartridge cases/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.

5.4.1.4 Compare unknown fired cartridge case(s)/shotshell(s) to either another unknown fired cartridge case/shotshell or a test fired cartridge case/shotshell.

5.4.1.4.1 The Forensic Scientist may ascertain at this point if the class characteristics agree.

5.4.1.4.1.1 If the class characteristics are different and this difference is not attributed to deformity or damage to the firearm after the firing of the evidence cartridge case/shotshell, the Forensic Scientist may conclude that the evidence cartridge case/shotshell was not fired from the evidence firearm or that the evidence cartridge cases/shotshells were not fired from the same firearm.

5.4.1.4.2 In the case of comparison to a test fired cartridge case/shotshell, attempt to locate the area on the evidence cartridge case/shotshell that corresponds to the previously examined area of the test cartridge case/shotshell.

5.4.1.4.3 When comparing evidence cartridge cases/shotshells to each other, an area with obvious individual characteristics may be noted on one cartridge case/shotshell. The other cartridge case/shotshell may then be examined in an attempt to locate the corresponding area.

5.4.1.5 These examinations shall be made with the cartridge cases or shotshells in phase. This means that cartridge cases/shotshells that are being examined shall be oriented

similarly using a common point of reference such as drag marks, extractor marks, ejector marks, etc.

- 5.4.1.6** The entire unknown shall be considered. The Forensic Scientist shall examine and compare all detail of a similar type present on the fired cartridge case/shotshell. For example, when comparing chamber detail, the Forensic Scientist shall examine the entire case wall for all chamber detail present.
- 5.4.1.7** 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 breechface detail, the Forensic Scientist need not examine and compare chamber 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. If all fired-in detail is examined and is unable to be matched, the Forensic Scientist shall examine cycling detail.
- 5.4.1.8** If the cartridge cases/shotshells are matched to each other, the items shall be indexed with an indelible marker to indicate the position in which the agreement is most clearly viewed.
- 5.4.1.8.1** The Forensic Scientist may refer to previously indexed areas when describing the orientation, such as an extractor index mark.
- 5.4.1.8.2** Specific areas of chamber detail agreement shall be indexed on the case walls immediately adjacent to the agreement.
- 5.4.1.9** If an identification is not initially made, the Forensic Scientist may consider the following possible reasons for the lack of sufficient agreement:
- 5.4.1.9.1** The evidence cartridge case/shotshell and test cartridge cases/shotshells were fired in different firearms.
- 5.4.1.9.2** The firearm was damaged between firing the evidence cartridge case/shotshell and the test cartridge case/shotshell.
- 5.4.1.9.3** The test ammunition available is significantly different from the evidence causing a difference in the way the cartridge case/shotshell was marked.
- 5.4.1.9.4** Extreme fouling is/was present in the firearm, either prior to firing the evidence cartridge case/shotshell or occurring since the evidence cartridge case/shotshell was fired.
- 5.4.1.9.5** Damage occurred to the evidence cartridge case/shotshell causing distortion, deformation or the elimination of microscopic detail.
- 5.4.1.9.6** The evidence cartridge case/shotshell was fired in a firearm of an incorrect caliber.

5.4.1.9.7 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.

5.5 Range of Conclusions

5.5.1 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 by the technical reviewer.

5.5.2 Fired-in Detail

5.5.2.1 Identification

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

- “The Q-1 cartridge case was fired in the K-1 firearm.”
- “The Q-1 and Q-2 shotshells were fired in the same firearm.”

5.5.2.2 Inconclusive

5.5.2.2.1 There is agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification; or

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

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 between the Q-1 fired shotshell and test shotshells fired in the K-1 shotgun; however, the comparison of individual characteristics was inconclusive. Therefore, the Q-1 shotshell could not be identified or eliminated as having been fired in the K-1 shotgun.”
- “There is agreement of all discernible class characteristics between the Q-1 and Q-2 fired cartridge cases; however, the comparison of individual characteristics was inconclusive. Therefore, the Q-1 and Q-2 cartridge cases could not be identified or eliminated as having been fired in the same firearm.”

5.5.2.3 Elimination

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

- “The Q-1 cartridge case was not fired in the K-1 firearm.”
- “The Q-1 and Q-2 shotshells were not fired in the same firearm.”

5.5.3 Cycling Detail

5.5.3.1 Identification

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

- “The Q-1 shotshell was cycled through the K-1 firearm.”
- “The Q-1 and Q-2 cartridge cases were cycled through the same firearm.”

5.5.3.2 Inconclusive

5.5.3.2.1 There is agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification; or

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

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 between the Q-1 fired shotshell and test shotshells cycled through the K-1 shotgun; however, the comparison of individual characteristics was inconclusive. Therefore, the Q-1 fired shotshell could not be identified or eliminated as having been cycled through the K-1 shotgun.”
- “There is agreement of all discernible class characteristics between cycling marks found on the Q-1 and Q-2 fired cartridge cases; however, the comparison of individual characteristics was inconclusive. Therefore, the Q-1 and Q-2 fired cartridge cases could not be identified or eliminated as having been cycled through the same firearm.”

5.5.3.3 Elimination

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

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

5.5.3.4 Unsuitable

5.5.3.4.1 The fired evidence in question is not suitable for comparison purposes.

- “The Q-1 cartridge case contains no marks of comparison value for forensic firearms identification.”

5.5.4 Not microscopically compared

5.5.4.1 Cartridge cases and shotshells were removed from the chamber, action, or magazine of a firearm.

- “The Q-1 cartridge case was not microscopically compared.”

5.5.5 Forensic Scientists shall include in their notes all conclusions reached from the microscopic comparison of evidence cartridge cases, shotshells and/or test fired 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 fires (if an evidence firearm was fired) was used or if more than one test fire was used to reach the conclusions. Also, the notes shall indicate if any live rounds were worked through the action and the results of the microscopic examination and/or comparison of these live rounds.

5.6 **Standards and Controls** – N/A

5.7 **Calibration** – For caliper and micrometer calibration information, see the Firearms Unit Technical Procedure for Instrument Calibration and Maintenance.

5.8 **Maintenance** – For comparison microscope, stereomicroscope, caliper, and micrometer maintenance information, see the Firearms Unit Technical Procedure for Instrument Calibration and Maintenance.

5.9 **Sampling** – N/A

5.10 **Calculations** – N/A

5.11 **Uncertainty of Measurement** – N/A

6.0 **Limitations** – N/A

7.0 Safety – Examinations performed in the Firearms Unit are inherently dangerous. These procedures involve hazardous chemicals, firearms, ammunition, 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

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; added new 5.3.1 and 5.3.1.1 ; correct outline numbering after 5.3.2.3.2.1
02/15/2013	3	Removed Raleigh from the header; 4.0 – added micrometer and cartridge case identification software; 5.6 – added micrometer; 5.7 – added micrometer
09/06/2013	4	5.4.2.2.3 – added “some” to the paragraph and to the two examples of report wording; 5.4.3.2.3 – added “some” to the paragraph and to the two examples of report wording
11/15/2013	5	Added issuing authority to header
09/05/2014	6	Header and various subsections – corrected to reflect organizational change; added “FBI General Rifling Characteristics File” to equipment list; added new 5.2.1 ; 5.3.1 – changed SBI-5
02/27/2015	7	5.3.2.3.3.3 – removed “either”; 5.3.2.3.3.3.2 – added “In the absence of the firearm,”; added new 5.4.4
12/11/2015	8	Moved old 5.3.1 to new 5.1 and removed 2 nd statement Deleted old 5.3.1.1 5.2.1.1 – reworded 1 st sentence, remove 2 nd Removed old 5.1.1.1.1, 5.1.1.1.2, 5.1.1.1.3, 5.1.1.2 5.2.1.3 – shall to may 5.2.2.1 – added to be microscopically compared, replaced same worksheet with same entry, removed 3 rd statement 5.2.2.2, 5.2.2.2.1, 5.2.2.2.2 – added 5.3.1 – added Supervisor, changed and to or before Crime Lab Director and added Assistant Director 5.3.4 – removed list of information 5.3.4.2 – reworded; 5.3.4.3 – added same class characteristics Removed old 5.2.4.4 5.3.5 – changed specific worksheet to case notes/file 5.4.1.8 – changed may be to are 5.5.1 – changed with to by Removed quotation marks from all conclusions 9.0 – removed specific FA worksheets
07/01/2016	9	Combined old 5.5.2.2.2 and 5.5.2.2.3 into 5.5.2.2.1 and added new bullets; combined old 5.5.3.2.2 and 5.5.3.2.3 into 5.5.3.2.1 and added new bullets; corrected revision history entry for 12/11/2015

		(entry for 5.1 changed to 5.3.1) and reordered.
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