Introduction

The National Institute of Standards and Technology (NIST) facilitated the development of this Firearms Process Map through a collaboration between the NIST Forensic Science Research Program and the NIST administered Organization of Scientific Area Committees (OSAC) for Forensic Sciences (specifically OSAC’s Firearms and Toolmarks Subcommittee) in partnership with the Association of Firearm and Tool Mark Examiners (AFTE).

This Firearms Process Map (Current Practices) captures details about the various procedures, methods and decision points most frequently encountered in the discipline of firearm examination from a national and international perspective and is intended to reflect current practices. The discipline of firearm examination requires examiners to make many decisions that can impact the quality and accuracy of results. The Firearms Process Map can benefit the firearm examination discipline by providing a behind-the-scenes perspective into the various components and decision points in the firearms analysis process.

Process mapping is the visual representation of critical steps and decision points of a process. Components of the process are deconstructed, placed into specific shapes within a flowchart and connected by one-way arrows to indicate directionality regarding decisions as well as progression throughout the overall process. The shape of each box assists the reader by representing a specific type of activity.

This process map captures the diverse practices of multiple laboratories, with the goal of allowing a firearm examiner to find their process represented in the map. To ensure this, the mapping team avoided creating a map of what should be done (e.g., best practices) and instead attempted to represent all reasonable variations of casework currently performed by firearm examiners. For this reason, it is important to state that neither the OSAC Firearms and Toolmarks Subcommittee nor AFTE necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.

This map is not intended to be a step-by-step instruction manual outlining minutia, nor is it intended to be so broad that it lacks utility. Rather, judgements were made by the process mapping group as to which steps should be combined and which steps should be divided further. Certain processes represented in the map have a required sequence while other components may vary by examiner or agency. Processes and decisions may also be dictated by agency policy or law.

Process Map Applications:

The Firearms Process Map is intended to be used to help improve efficiencies while reducing errors, highlight gaps where further research or standardization would be beneficial, and assist with training new examiners. It may also be used to develop specific laboratory policies and identify best practices.

Scope of the Firearms Process Map:

The scope of this Firearms Process map is limited to core processes within the discipline of firearm and toolmark examination such as the examination of firearms and the microscopic comparison of fired ammunition components. Several topics are omitted from this map to include individual characteristic databases, toolmark examination, fracture matching and distance determination. These topics may subsequently be addressed by the process mapping team, an individual laboratory or a standardization committee.
2000 - Examiner Evidence Intake

FROM 3200/3201
Input: Evidence Item(s) forwarded to assigned examiner
- Firearms/Firearms Parts
- Projectile (bullets and shells)
- Shell/Shell Components
- Cartridge Case/Shellshell
- Live/Loaded Ammunition
- Other Items

2120
To access additional information, such as: autopsy reports, police reports, or crime scene reports, necessary for evaluating the case?

YES
2125
No evidence or request for the necessary information

NO
2120
Examine or make request for the necessary information

2130
Inventory of Evidence (mark package and describe evidence). Per Agency Policy

2140
Additional items reviewed?

YES
2150
Communicate with customer:
- Request Additional Evidence
- Clarification on Service requested

NO
2160
Additional evidence requested?

YES
2170
Process with existing evidence items.

NO
2180
Discontinue evidence receiving and proceed PAP

2190
Review and Document Pre-Certification Information
Additional examination prior to LAAM examination and/or circumstances

2200 - Case Assessment

2205
Input: Categorized evidences items

2220
Based on Case Information/PAE, examine what samples to test and in which order (Testing Plan)

2230
Output: Evidence Testing Plan (i.e. priority list)

GO TO 3100
Item Determination

Factors When Determining Testing Plan

(e.g. which items and how many will be processed and in which order?)
- Administratively chosen
- Customer desires
- Investigative driven
- Judicial order
- Perceived probative value based on examiner's opinion
- Sequential order
- Processed based on grouping
- Crime type

Use the following questions to determine next steps:
- Review unknowns before firearms?
- Were only unknowns submitted for examination?
- Analyze all unknowns?
- Will sampling plan be applied (such as COI)?

GO TO OVERVIEW

This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSAC and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.
Descriptive Documentation Through Direct Observation - Live/Unfired Ammunition

- Photograph Documentation (Agency Dependent)
- Visual Examination for Trace Evidence (Collected? Decontaminated?)
- Determine Cartridge Caliber
- Reference Material
-anthropometry
- Measurement
- Determine cartridges/shot shell Manufacturer / Marketer
- Determine projectile type (HP, FMJ)
- Determine composition of Primer, Case, Bullet, Battery
- Document Headstamp on Cartridge
- Document Cartridges
- Document Shell
- Document Hull Marks (Shot Shells)
- Ignition System (Electric/Chemical)
- Shelled length

Detailed Toolmark Documentation (Comparable Features) - Live/Unfired Ammunition

- Reloading Marks
- Manufacturing Marks
- Light Streaks - primer
- Burnt Marks
- Feed Rams Marks
- Magazine Marks
- Chamber Marks
- Ejector Port Marks
- Extractor Marks
- Ejector Marks
- Shell Stop Marks

Enhancement Techniques

- Magnesium smoking
- Coating
- Sharpe
3800 Feature Assessment: Projectiles/Bullets

Descriptive Documentation Through Direct Observation—Projectiles/Bullets/Shotshell Components

- Photograph Documentation (Agency Dependent)
- Visual Exam for Trace Evidence (Collect? Documented?)
- Composition
- Design (Type, Round nose, hollow point, etc.)
- Canvasses (number and type)
- Characteristics of Base
- Condition (Is it mutilated? Does it require manipulation?)
- Wash/strip any internal portions of shotshell present (paper wrap, shot bullet, etc.)
- Subj Manipulation (if needed)
- Manufacturer or Marking
- Nominal Caliber/Gauge/Bore
- Weight
- Diameter
- Rifling Characteristics
- Visual Examination (reference material, experienced analysis)

Detailed Toolmark Documentation—Projectiles/Bullets/Shotshell Components

- Cycling Marks
- Manufacturing Marks/Features
- Case Match Marks
- Number of Partridges
- Mould Marks
- Shot Depressions
- Other Toolmarks
- Other Measurements
5100 Subclass Determination

From 4347 (Functionality)/4677 (Text Fire)/7305 (P to PI)/7405 (P to T)/7605 (C to C)/7805 (C to F)

510. Evaluate tool for features

5140 Document. Per Agency Policy [PAP]

5180 Can the most likely methods of manufacture be determined based on the tool design and toolmarks?

5185 Is further evaluation of subclass needed based on manufacturing techniques?

5190 Examination Evaluation for Subclass (e.g., visual and/or casting, which may include disassembly)

5190 Document, Subclass Evaluation PAP

5210 Output: Tool evaluated and subclass features documented

GO TO 4500 (Text Fire)/GO BACK TO 4720/7410/7810

From 3450/3720/3950 (Feature Assessments)

5210 Evaluate features

5220 Is the nature of the marks suggestive of substrate?

5230 Visual Examination Evaluation for Subclass

5250 Output: Toolmarks evaluated and subclass features documented

GO BACK TO 3465/3780/3955/7210/7410/7860/7930

Considerations for Subclass Determination: Tools

• Course/Hide Details
• Continuous markings (e.g. long continuous toolmarks)
• Gross uniform spacing
• Multi marks
• Similarity of pattern in other areas
• Symmetry
• How the tool moves against substrate/substrate

Considerations for Subclass Determination: Tools

• Most likely manufacturing method based on tool design
• Location of tool surface
• Directionality of marks
• Characteristics of marks
• Manufacturer literature or reference materials
• How the tool moves against substrate/substrate
7300 Comparison: Projectile to Firearm (P to F) 1 of 2

**Considerations for Comparison**

- Selecting which unknown or known to compare first/next
- Select the applicable criteria:
  - Quality/complexity of landmarks
  - Administrative chosen
  - Customer driven: investigative question
  - Random order
  - Perceived probative value based on examiner discretion

**Technology Assist**

- Computer aided comparison (3D Modeling)
- Computer-aided documentation
- Computer-aided selection of the known/unknown to compare (NBIS)
- Comparison Microscope
- Imaging Systems

This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSAC and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.
7500 Comparison: Cartridge Case to Cartridge Case (C to C) 1 of 2

FROM
1505/3515/3750
3795/4310
Input: Cartridge Case geometry for comparison

750
Are the unknowns described as test fire (TF) at time of submission?

7107
Treat as unknown?

7555
Set up Evidence Items for Comparison (e.g. comparison mark, 3D imaging software, images etc). See Considerations for Compare Comparison: Optimize lighting, magnification, and focus

7530
Are the unknowns identical/agreed?

7551
Is there disagreement among individual detail present?

7555
Are one of the unknowns described as TF at time of submission?

7560
Determine which of the two items to hold in fixed position

7553
Position fixed item using area of interest features

7540
Maneuver other item to find corresponding area of interest

7541
Is there a corresponding area of interest (C to F phase)?

7545
Determines which toolmark/area of interest to compare

- Firing Pin impression
- Bevel Ear Marks
- Firing Pin Aperture
- Screw (screw)
- Extractor Marks
- Extraction Marks
- Extraction post marks
- Chamber Marks
- Magazine marks

7549
Request Firearm PAP

7548
Is there an additional area of interest?

7547
Is there a corresponding area of interest?

7546
Can extraction be made without Firearm?

7558
Request the Firearm

7547
Can extraction be made without Firearm?

2500 Evidence Testing Plan

- Is there more evidence to examine per testing plan?
- Enter information into GRC
- Launch Search
- Document/Report GRC results
- Return to 3100 Item Determination

3000 GRC Database Search: GRC search may be appropriate when the evidence item(s) are not identified to a firearm

Conclusions
- Identification
- Exclusion
- Identification & Exclusion
- Identification & Exclusion
- Exclusion

Considerations for Comparison

Selecting which unknown or known to compare first/next:
- Select the applicable others
- Quality/symmetry of toolmarks
- Administrative chosen
- Custom chosen; investigative question
- Random order
- Perceived probability based on examiner discretion

Technology Aid:
- Computer aided comparison (2D/3D Imaging)
- Computer aided documentation
- Computer aided selection of the known/unknown to compare (NBPN)
- Comparison microscope
- Imaging Systems

This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSAC and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.
This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSA and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.
FROM 4223

9605
Input: Firearms Rendered Safe

9610
Line a tool with calculated measurement uncertainty

YES
9660
Measure and document using tool with calculated measurement uncertainty

9660 Report/Document uncertainty Per Agency Policy (PAP)

NO
9650
Report uncertainty?

YES
9670
Is examination completed?

NO
9530
Measure and Document

Technology Assist
- Calibrated Measurement Device
- Measurement Device

RETURN TO 4260 Functionality

9680
Report Barrel Length

STOP/ Document PAP or go to 2560 Evidence Testing Plan

2560 Evidence Testing Plan

Is there more evidence to calibrate per testing plan?

Return to 2500 Item Determination

GO TO REPORTING

This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSAC and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.
### Glossary of Terms and Definitions

*A brief summary of selected terminology. For the purposes of this document, the AFTE definitions are used for any terms otherwise not listed here.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assess Action Type</strong> (adopted from AFTE Terminology):</td>
<td>Assessment of the working mechanism of a firearm. The combination of the receiver or frame, the breech bolt, and the other parts of the mechanism by which a firearm is loaded, fired, and unloaded. May be broken down into action such as automatic, semiautomatic, bolt action, single action etc.</td>
</tr>
<tr>
<td><strong>Blind Verification:</strong></td>
<td>The confirmation of an examiner’s conclusion by another competent examiner who has no expectation or knowledge of the prior conclusion. In some instances, this may lead to an entire re-examination of the case.</td>
</tr>
<tr>
<td><strong>Capacity Test:</strong></td>
<td>A test to determine the maximum number of cartridges of ammunition a magazine or a magazine and firearm are capable of holding.</td>
</tr>
<tr>
<td><strong>Detailed Strip:</strong></td>
<td>To disassemble a firearm beyond Field Strip.</td>
</tr>
<tr>
<td><strong>Evidence Testing Plan (2500 series):</strong></td>
<td>Series of steps placed on the appropriate pages where the user opts to either test additional evidence items in a case or, in the event the examinations are complete, to move on to reporting steps.</td>
</tr>
<tr>
<td><strong>Exclusion / Elimination (AFTE Terminology):</strong></td>
<td>Significant disagreement of discernible class characteristics and/or individual characteristics.</td>
</tr>
<tr>
<td><strong>Ferrous v Non-Ferrous (adopted from AFTE Terminology):</strong></td>
<td>Ferrous materials are alloys containing a significant amount of iron. Ferrous metals are magnetic, versus non-ferrous materials where the main component is not iron and is not magnetic.</td>
</tr>
<tr>
<td><strong>Field Strip:</strong></td>
<td>To disassemble a firearm for cleaning, repair, or transportation.</td>
</tr>
<tr>
<td><strong>General Class Characteristics (AFTE Terminology):</strong></td>
<td>Measurable features of a specimen which indicate a restricted group source. They result from design factors, and are therefore determined prior to manufacture.</td>
</tr>
<tr>
<td><strong>GRC Database:</strong></td>
<td>General Rifling Characteristics Database. A database of firearms detailing their general rifling characteristics including, but not limited to, caliber, rifling type, land and groove dimensions, and direction of twist.</td>
</tr>
<tr>
<td><strong>GRC Database Search (10000 series):</strong></td>
<td>General Rifling Characteristics Database path. Series of steps where the user opts to perform GRC database search during the course of the examination as appropriate, while allowing them to then return and do additional examinations.</td>
</tr>
<tr>
<td><strong>Identification (AFTE Terminology):</strong></td>
<td>Agreement of all discernible class characteristics and sufficient agreement of a combination of individual characteristics where the extent of agreement exceeds that which can occur in the comparison of touchmarks made by different tools and is consistent with the agreement demonstrated by touchmarks known to have been produced by the same tool.</td>
</tr>
<tr>
<td><strong>Impact Test:</strong></td>
<td>Testing of a firearm in a controlled setting to determine if discharge may occur as a result of being struck or striking a surface.</td>
</tr>
</tbody>
</table>

**Inconclusive:** Agreement of all discernible class characteristics. Insufficient agreement and/or disagreement of individual characteristics. Cannot identify or exclude.

**Inconclusive – A (AFTE Terminology):** Agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification.

**Inconclusive – B (AFTE Terminology):** Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.

**Inconclusive – C (AFTE Terminology):** Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

**Measurement:** In some cases measurements may be taken by linear measurement device for length (e.g. Barrel Length), or may be assessed using a tool to measure weight (e.g. Trigger Pull).

**Measurement Uncertainty:** Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand. |

**Safety Mechanisms (AFTE Terminology):** A device on a firearm intended to help provide protection against accidental discharge under normal usage when properly engaged.

**Subclass Characteristics (AFTE Terminology):** 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.

**Suitability for Comparison (Suitability Determination):** Assessment of whether an item exhibits class and/or individual detail.

**Test Standards (TS):** Known standards produced by/from a tool/firearm/firearm parts. Can include test fired ammunition components, casts, forced/pushed bullets.

**Trigger Pull Measurement (AFTE Terminology):** Measurement of the amount of force which must be applied to the trigger of a firearm to cause rear release. It is measured by hanging weights or an instrument touching the trigger at a point where the trigger finger would normally rest. The force applied during measurement is approximately parallel to the bore axis.

**Trigger Puller:** An instrument used to accurately measure the trigger pull of a firearm. Examples include standard weights, spring gauges, and mechanical/digital devices. Also known as a trigger tester.

**Abbreviations:**

- PAP: Per Agency Policy
- ICD: Individual Characteristic Database

---

2. **AFTE Glossary:** [https://afte.org/resources/afte-glossary](https://afte.org/resources/afte-glossary)