

Fired Cartridge Case Error Rate Study

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Disclaimer

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- AFTE provided the largest group of participants (Jay Stuart).
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- SWGGUN Chair Andy Smith provided valuable guidance in designing the study and aided in identifying the proper selection of ammunition.
- Firearms & Toolmarks Unit at the FBI Laboratory provided input on design
- Ames Laboratory Shipping and Receiving Department for coordinating and handling shipment of all of the materials for the study, and in particular Vicki Sieve.

Goals of the Study

- Measure false positive and false negative error rates by practicing firearms examiners for comparisons of fired cartridge cases
- Determine uncertainties in the measured rates

Important Design Criteria

- Sets must incorporate multiple independent comparisons (no comparisons between sets)
- Multiple groups of examiners must be examining independent sets of samples (to obtain a measure of uncertainty)
- Measure examiner rates, not agency rates (no review)
- Use accepted standard range of conclusions
- Incorporate a measure of sample quality
- Simulate realistic sample presentation
- AFTE range of conclusions

Experimental Design

- Sets of 3 Knowns + 1 Questioned
 - Mimics a questioned case and a handgun in evidence with multiple test firings
- 15 Sets provided to each participant
 - No overlap or repeats between sets (avoid biasing effects of repeats)
 - No comparisons between sets (15 independent comparisons)
- Asked each participant to look at knowns first and identify how many were suitable for comparison
 - Internal measure of rate of good pattern production
- “Spoiler”: each kit contained 5 same-source and 10 different-source sets (not announced)
- With 25 guns we randomly assigned each examiner to 1 of 5 groups
- Groups A through E (see Table)

Sample Set Design

A	B	C	D	E
A1-A1	B1-B1	C1-C1	D1-D1	E1-E1
A2-A2	B2-B2	C2-C2	D2-D2	E2-E2
A3-A3	B3-B3	C3-C3	D3-D3	E3-E3
A4-A4	B4-B4	C4-C4	D4-D4	E4-E4
A5-A5	B5-B5	C5-C5	D5-D5	E5-E5
B v D: 1v2, 2v3, 3v4, 4v5, 5v1 and other skip permutations	C v E	D v A	E v B	A v C
C v E	D v A	E v B	A v C	B v D

Materials Used

- 25 new Ruger SR-9 semiautomatic 9-mm handguns
 - Moderate price, new model replacing P95
- 20,000 fired rounds of Remington L9MM3 FMJ
 - 2 lots
 - 3 days on the range
- Materials obtained and samples collected at WVU
- Each weapon fired 200 times before collection
- 800 rounds collected from each
- Order known to within 100 rounds (collected 100 from catcher at a time)

Ruger SR-9



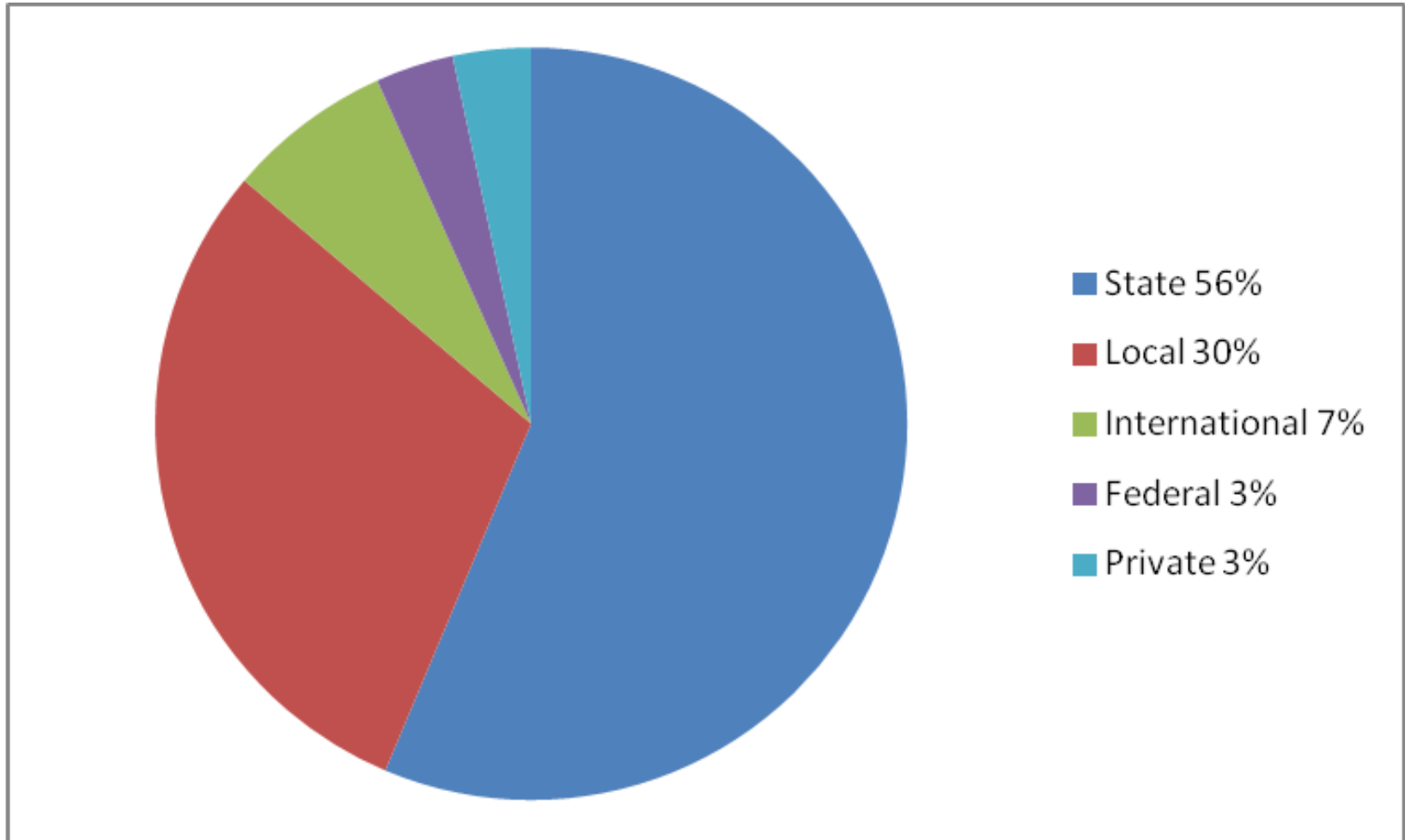
Brass Catcher



Participants

- Use of Human Subjects in federally funded project required review of design by Institutional Review Boards at Iowa State University and DoD
- Mitigate risk to participants by making responses anonymous
- Informed Consent from Voluntary participants
- Solicited from AFTE membership and ASCLD participating agencies
- Active examiners only (low rates mean little confidence in rates for small numbers in any subgroups)
- Attempt to recruit 200 to 300
- 284 enrolled, 218 responses

Makeup of Participants



Labelling

- “Kmfrcxxxyyy” or “Qmfrcxxxyyy”
- Random alpha numeric coding
- Knowns and Questioned



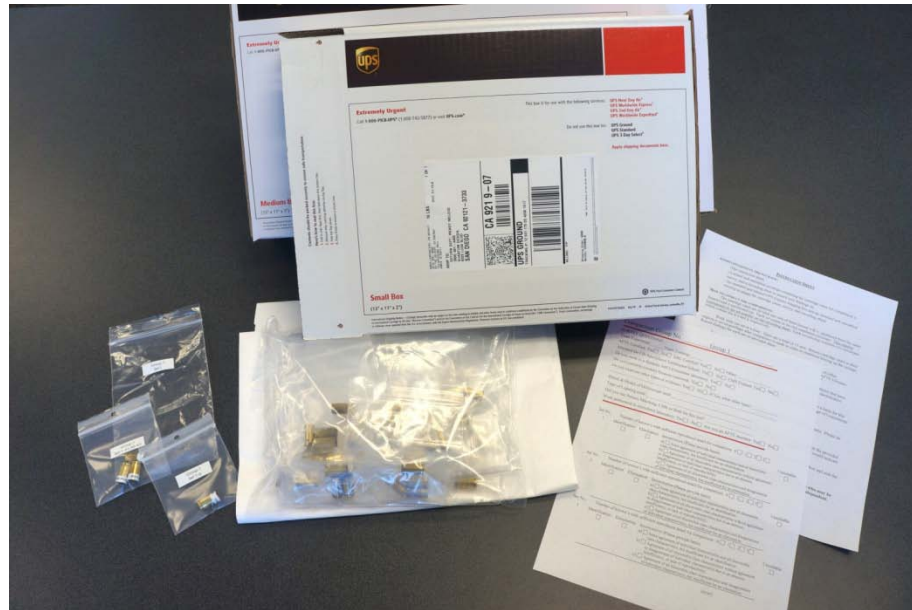
International Participants

- U.S. arms control regulations required damaging cases to prevent reloading
- Cut with a handheld rotary tool with a cutoff wheel



Packaging

- Packaged in 15 sets of 3 k + 1 q.
- Instructions
- Answer sheet
- Blank return envelope
- Prepaid return shipping package



Survey and Answers

Comparison Group No. _____

SURVEY QUESTIONS:

Years Experience: _____ Years Training: _____

AFTE Certified: Yes No ABC Certified: Yes No Other: _____

Attended the FBI Specialized Techniques School: Yes No CMS Trained: Yes No

Do you work in a firearms ASCLD-member laboratory: Yes No

Do you currently conduct firearms casework: Yes No

Do you examine other types of evidence: Yes No If Yes, what other types _____

Brand & Model of Microscope used: _____

Type of Lighting used: _____

Did you use Pattern Matching, CMS or Both for this test? _____

Work performed in accredited laboratory: Yes No Are you an AFTE member: Yes No

Set No. Number of known's with sufficient reproduced detail for comparison: 0 1 2 3

1	Identification	Elimination	Inconclusive (Please provide basis)	Unsuitable
	<input type="checkbox"/>	<input type="checkbox"/>	a) <input type="checkbox"/> Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification. b) <input type="checkbox"/> Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility. c) <input type="checkbox"/> Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.	<input type="checkbox"/>

By the Numbers

- Not everyone answered every question or supplied a response for every comparison
 - Non responsive answers not included in totals
- 5 (known same-source) x 218 (examiners) = 1090
- 10 (known different source) x 218 (examiners) = 2180 (but only 2178 responses)
- Suitability of knowns: 3 (knowns) x 15 (sets) x 218 (examiners) = 9,810 (but only 9702 responses)

Results for Known Same-Source Comparisons

- False negatives: $4/1090 = 0.3670\%$
 - 95% CI (Clopper-Pearson): 0.1001% to 0.9369%
- Include 11 Inconclusives (not errors): $15/1090 = 1.376\%$
 - 95% CI: 0.7722%, 2.260%
- Rate of unsuitable mark production: $225/9702 = 2.319\%$
 - 95% CI: 2.174% to 2.827%
- Conclusion: the rate of poor mark production may be entirely producing or obscuring the rate of examiner error (false-neg.)

Results for Known Different Source Comparisons

- Identifications from known different-source cases: $22/2178 = 1.010\%$
- However, 20 of 22 errors by 5 participants
- Indicates a highly heterogeneous distribution of error rates
- Statistical analysis based on this type of distribution of rates in a beta-binomial model
- Maximum Likelihood Estimator 0.939%
 - 95% CI: 0.360% to 2.261%
- Conclusion: error rates vary widely between different examiners

Use of Inconclusive

- 96 examiners (44%) did not use Inconclusive (used Elimination for samples without sufficient corresponding detail for an identification)
- 45 (21%) used only Inconclusive to denote insufficient corresponding detail
- 77 (35%) used a mixture of inconclusive and elimination
- Given same model of ammunition and firearms throughout, what does inconclusive mean to this third group?

Proposed Future Work

- Given the relative size of false negative and poor mark reproduction rates: Study the variation in poor reproduction rates
 - Firearm model, between multiple guns of same model, with different make and material of cartridges, between and within lots, with age of firearm, etc.
 - Are there true false negatives and should QA systems be designed to catch them?
- Study effectiveness of QA systems in catching the types and rate of false positives seen
 - Include evaluation of possible confirmation bias in study

Thank You

- For your attention
- For your participation and support