Report of Findings

Rhode Island State Crime Laboratory

Firearm and Toolmark Examination Unit

Prepared for:

Rhode Island State Crime Laboratory Commission

Prepared by:

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Report of Findings

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Request

Nichols Forensic Science Consulting, Inc. was contracted by the Rhode Island State Crime Laboratory (hereafter the Laboratory), at the direction of the Rhode Island State Crime Laboratory Commission, to review the operations of the firearm and toolmark examination unit of the Laboratory. This was to include the re-examination of cases involving firearm related evidence, reviewing processes and procedures in place for the unit along with the quality assurance processes and procedures related to the unit, and other potential duties as desired and agreed upon.

Validity of Forensic Firearm and Toolmark Examination and Identification

Firearm and toolmark examination and identification is a discipline of forensic science, the primary objective of which is to determine whether two or more toolmarks were created by the same tool or different tools. For this to be possible, two premises must have demonstrable validity. The first premise is that different tool surfaces will create different toolmarks. The second premise is that trained examiners can reliably discern differences and similarities that are being observed in toolmarks and render accurate common source determinations. The support for each will be discussed in turn.

The premise that different tools create different toolmarks was recognized early in the 20th century by researchers such as Dr. Victor Balthard from Sorbonne University in France and Calvin Goddard. Each of them recognized that the manufacturing process of different tools such as barrels, breechfaces, and firing pins resulted in microscopic features that would distinguish like items from one another. Since that time, there have been many studies that have examined the validity of this premise. These studies have included empirical studies and machine-based studies.

As early as Goddard, researchers have examined toolmarks (such as those created on fired cartridge cases or bullets) created by consecutively manufactured tools. The reason is that if any two tools should produce similar toolmarks (and therefore falsify the first premise) it should be those tools (barrels, breechfaces, firing pins) that are manufactured one after the other or in close sequence. Repeated empirical studies of this type since the 1920's

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have demonstrated that toolmarks generated by such tools have sufficient differences that they can be distinguished using comparison microscopy. This has included studies that have also quantified the similarities in toolmark pairs generated from the same source as well as in toolmarks pairs generated from different sources.[1] What was demonstrated throughout those studies is that toolmarks generated from different sources do not have patterns of correspondence while those from same sources will have patterns of correspondence.

With the advent of technology capable of capturing the three-dimensional topography of toolmarks and algorithms capable of analyzing them, there has been a wealth of objective data that has been added to the support for the first premise. To date, there are over 30 studies that have analyzed over 2 million independent data points (different source comparisons and same source comparisons), demonstrating that there is a statistically significant difference between toolmarks created by different sources and toolmarks created by the same source.[2] The difference is the lack of patterns of similarity in toolmarks created by different sources and the presence of one or more patterns of similarity in toolmarks created by the same source.

Considering the first premise has been demonstrably supported throughout the research, the question now turns to the examiner and whether a trained examiner can reliably discern the differences and similarities present in toolmarks and render accurate common source determinations. This has been demonstrated to be the case through different validation and error rate studies that have been performed involving trained firearm and toolmark examiners in the United States and abroad. The design of the error rate studies has varied from closed to open set studies, each having value because they represent different case circumstances to include unknowns to test fires and unknowns to unknowns.

For those studies that have been published in peer reviewed literature, the error rates for participants have ranged from 0 to 1-2% false positives, meaning that those participants incorrectly identified a toolmark to a tool that did not create it or a toolmark made by a different tool.[3] It is critical to understand that these error rates do not apply to the discipline as a discipline-wide error rate. What they represent is a failure of the identification criterion of the individuals who made the errors. The identification criterion is based on the AFTE Theory of Identification in which the correspondence being observed

[1] Quantification was done using the concept of consecutive matching striations (CMS) for striated toolmarks first discussed by Biasotti in 1959 (Biasotti A, 1959. A statistical study of the individual characteristics of fired bullets. Journal of Forensic Sciences 4(1):34-50).
[2] Nichols R, 2018. Firearm and Toolmark Identification: The Scientific Reliability of the Forensic Science Discipline. Academic Press, London.
[3] Ibid.

exceeds the best correspondence observed in known non-matching (different source) comparisons and is consistent with that observed in known matching (same source) comparisons.[4] Overall, these low error rates do indicate the validity of the second premise, that trained examiners can reliably discern differences and similarities and render accurate common source determinations. At the same time, as these studies have demonstrated, errors are possible and are the reason why it is essential that laboratories have standardized processes and procedures in place to help ensure the reliability of the results being generated by the laboratory.

Executive Summary

Fifteen cases were re-examined, one of which was CASE 1 in which each of the three firearm examiners employed by the Laboratory made misidentifications, either in the examination portion, the verification portion, or both in the case of EXAMINER 3. Based on my review of the cartridge cases involved in the misidentification, it should not have been made and instead, an elimination should have been reported. The misidentification in this case which was shared among all three examiners indicates a lack of diligence in the comparison of the cartridge cases with primary focus being given to a mark that had data that was over-interpreted while not critically assessing other marks that should have led to a conclusion of elimination. This was likely compounded by a significant confirmation bias, especially given that the original verifier was tasked with doing the re-examination.

In two of the cases, there were reported inconclusive results that, in my opinion, could have been concluded as identifications. These were verified as inconclusive by other examiners as well considering that all conclusions are verified except eliminations by class characteristics.

Interviews of EXAMINER 1, EXAMINER 2, and EXAMINER 3 were performed while on-site. The interviews focused on 1) background questions regarding on-boarding and training, 2) agency related questions to assess training support and potential concerns with quality programs that could impact proficiency test responses, and 3) questions related to casework processes and specifically CASE 1. I also provided for each to share anything else that they believed would be important or relevant that had not been asked. These interviews helped to establish a likely root cause for the error in CASE 1 as well as identify recommendations outlined in this report.

There is a concern that there is insufficient regard given to subclass characteristics in casework. This was identified in several of the re-examined cases in which there should have been some documented discussion in the case notes with respect to subclass

[4] AFTE Criteria for Identification Committee, 1992. Theory of identification, range of striae comparison reports and modified glossary definitions. AFTE Journal 24(3):336-340.

characteristics, but it was missing. In addition, there is both uncertainty and inconsistency with respect to what is being compared and, more specifically, the marks that are being relied upon for identification of cartridge cases. As a result, it does not allow for an adequate review of the work being performed. Furthermore, it led to the impression that what was documented was done *pro forma* without a critical regard for the need that inclusion of that information represented in the documentation and report.

When reviewing the policies and procedures in place for the firearms unit, there are areas in which they could be improved. Specific recommendations were made to bolster and strengthen the policies and procedures along with the training for examiners. It is also important that the Laboratory pursue every avenue possible for continuing education for its firearm examiners. This can be done through requiring mandatory attendance at the annual AFTE Training seminars sponsored by the Association of Firearm and Toolmark Examiners for all examiners including participation in relevant workshops.

It is also important, especially for the hiring of experienced examiners, that their experience and expertise be appropriately assessed to ensure the qualifications of the new hires. A single proficiency or competency test does not necessarily handle this well. It is recommended the Laboratory develop supplemental application questions specifically focused on critical aspects of the scientific foundations of the discipline and subclass characteristics to help screen new, experienced applicants.

It is important to stress that the policies and procedures that are in place at the Laboratory are standard for forensic laboratories as they relate to the forensic science discipline of firearm and toolmark identification. These have been reviewed as part of the accreditation process and their accreditation supports the suitability of the processes and procedures. The laboratory exceeds minimum requirements for proficiency testing and while they have "borrowed" various procedures including training, this is a common practice, especially for training. Overall, the interviewed examiners indicated a high regard for the management of the laboratory, especially with respect to quality control. This is often seen as a hinderance to examiners in many laboratories but does not seem to the case here. Based on a review of the processes and procedures and management system, neither factored into the misidentification of the cartridge cases in CASE 1.

It appears that more than anything, the Laboratory lacked a strong technical lead for the unit that was sufficiently proficient in the discipline to recognize gaps in practice, application, and training. Each has importance and at the same time, it is incumbent to stress the importance of the latter. It is understood that the newly hired examiner will be attending the National Firearms Examiner Academy (NFEA) sponsored by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). It is important to remember that the NFEA is not so comprehensive that graduates do not need further training and mentoring

upon graduation. They do. They need strong mentoring, and the laboratory currently lacks an examiner that could be considered a strong technical lead that can mentor others and provide the laboratory management with a strong liaison upon whom they can rely.

Re-examination of Cases

A total of 15 cases were contracted for re-examination. The process of selecting the cases to be reviewed was left to the discretion of the Rhode Island State Crime Laboratory with the requirement from the Task Group[5] that they not be any of the cases that were to be re-examined based on upcoming court dates. They were selected from what would be considered closed cases. They included identification, inconclusive, and elimination results for each examiner. The total number of cases selected was based on the time I would have at the laboratory for the assessment. I also determined the breakdown of the number of cases with more cases for EXAMINER 2 than EXAMINERS 1 and 3 because EXAMINER 2 had issues in two other previous instances apart from CASE 1.

Seven were selected for EXAMINER 2, five were selected for EXAMINER 3, and four were selected for EXAMINER 1. This included CASE 1 which was originally completed by EXAMINER 2 and then re-analyzed by EXAMINER 3. The selected cases, including CASE 1 are listed in the table below. Some of them will be discussed in greater detail. In addition, there will be general thoughts offered.

EXAMINER 2	EXAMINER 3	EXAMINER 1
CASE 1	CASE 1	CASE 9
CASE 2	CASE 5	CASE 11
CASE 3	CASE 7	CASE 13
CASE 4	CASE 12	CASE 14
CASE 6	CASE 15	
CASE 8		
CASE 10		

CASE 1 (EXAMINER 2, EXAMINER 3)

This is the case, at least in part, that instigated the review of operations at the Laboratory. EXAMINERS 1, 2, and 3 each had a role in this case and made misidentifications of thirteen (13) fired cartridge cases to a submitted Glock firearm that did not fire them. The original comparison was conducted by EXAMINER 2 in 2021 and verified by EXAMINER 3. Due to EXAMINER 2 not being able to testify, this case was re-examined by EXAMINER 3 in 2024 and verified by EXAMINER 1. The misidentification came to light when the cartridge cases

[5] The Task Group consisted of Adi Goldstein, Stephen Dambruch, Ed Troiano, Kenneth DeMarco, Kerry LaPlante, Amy Duhaime and Dennis Hilliard.

were properly identified to a Glock pistol recovered by another agency in the New England area.

These cartridge cases have an aperture shear mark typical of cartridge cases fired in Glock pistols. Generally, the aperture shear mark is the first mark that examiners compare because it is rich in individual characteristics and is generally straightforward to compare. Good practice would dictate that after the aperture shear is compared that other marks, specifically the breechface marks and firing pin impressions, would also be compared. During interviews each of the three examiners indicated that is the process they would follow, whether it would be the original examination or the verification.

Based on the case notes, it appears that the thirteen cartridge cases were intercompared first and a correct identification was made among those cartridge cases. It was then that one of those cartridge cases was selected to compare with the test fires from the submitted Glock pistol. If a critical examination of the shear and at least one of the two other marks (firing pin impression or breechface marks) was performed when comparing the evidence cartridge cases to test fires from the submitted Glock, then the false identification should have never occurred.

When I conducted a comparison of Item 1 with Item 6.5 (test fire from the submitted Glock), there was only incidental correspondence of the aperture shear. What that means is that there were some striations that did correspond but there was no pattern of correspondence required for an identification. This is typical of marks in which there is high striation density (e.g., there is a large number of striations within the mark) such as shear marks. Therefore, in my opinion, there was not a critical inspection of this mark by any of the three examiners.

When comparing the breechface marks, they are so different they can be considered a difference in class characteristics, which would be immediately sufficient for an elimination. In addition, the aperture opening also has a different shape. Both are highlighted in the photo below[6].

[6] The image on the left is Item 6.5, a test fired cartridge cases generated from the pistol submitted with the evidence cartridge cases under CASE 1. This image has the straight, finer, elongated marks on the breechface and significant smooth areas. It also has the squared off aperture corners at the top. The image on the right is test fire 2 from the Glock pistol from the other agency submitted under CASE 16. The thirteen cartridge cases in question have breechface markings like those on test fire 2. Therefore, these photos do represent the differences also observed between the Item 1 cartridge cases with elliptical firing pin impressions submitted under CASE 1 and the thirteen evidence cartridge cases with elliptical firing pin impressions submitted under CASE 1. These are features that were reproducible and repeatable within each of the two sets of cartridge cases, e.g., the evidence cartridge cases and the test from the submitted Glock pistol.

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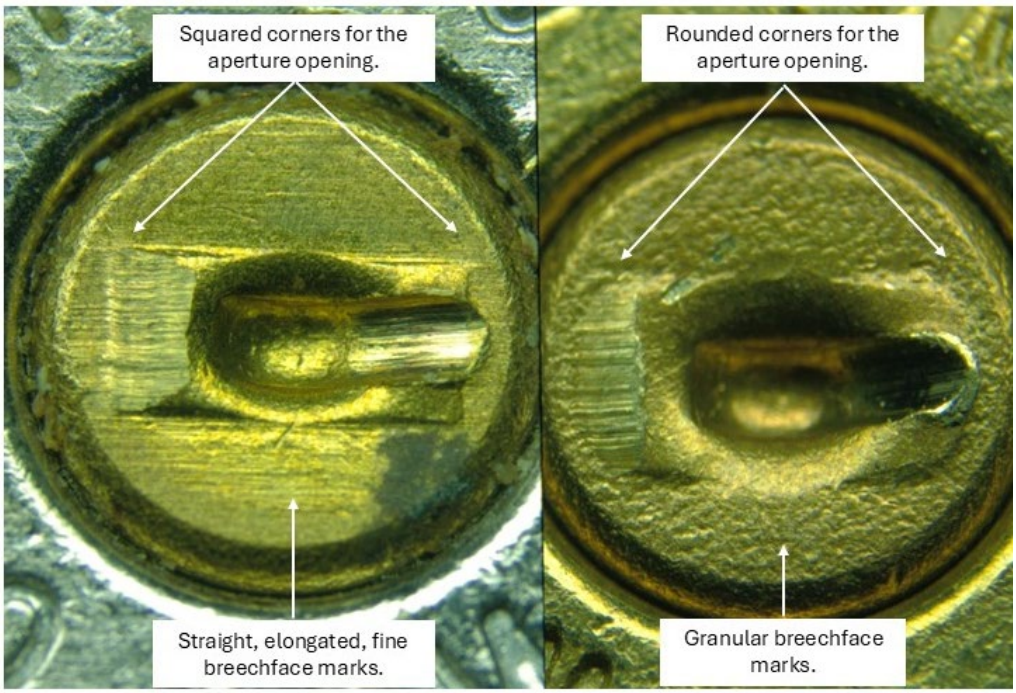

In addition, though they were not photographed, the firing pin impressions were also clearly different. Each of the two comparisons, the breechface marks and the firing pin impressions, required that the lighting be appropriately adjusted by putting the cartridge cases on a tilt. However, this is not an unusual technique and would be considered standard for a critical comparison of the marks.

In my opinion, if the examinations and verifications were as critically performed as each examiner indicated in their interviews, this error should have not occurred. The clear differences in the breechface marks and firing pin impressions should have caused a re-evaluation of the aperture shear marks which were in of themselves over-interpreted and insufficient for identification. Therefore, they were not as critically evaluated as supposed or there was confirmation bias taking place in the original verification that carried over into the re-examination of the evidence or a combination of both.

I was informed by Quality Programs that blind verifications of all opinions (except for eliminations based on class characteristics) was in place at the time of this case. At the time of this case, a worksheet was used ("Firearms Comparison and Verification Worksheet") that appears to capture both the comparison results and verification results which would impact the true blindness of this verification. Given this and the true difficulty in having a truly blind verification with a limited staff, it is reasonable to assume that some level of confirmation bias was in play in the verifications.

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It is even more reasonable to assume that confirmation bias was in play for the re-examination of this case, especially when EXAMINER 3 was the verifier for the original work performed by EXAMINER 2.[7] It is highly unlikely that having verified an identification in the first iteration of this case, EXAMINER 3 would contradict that in the re-examination of the case. Following that was the misidentification in the verification process by EXAMINER 1 who indicated in his interview that the verification was not truly blind as EXAMINER 2 had innocently shared during a conversation that this case was an identification. In addition, any potential frustration of EXAMINER 3 and EXAMINER 1 with having to re-examine cases due to the failure of a recent CTS proficiency test by EXAMINER 2 could also have a potential subconscious biasing impact on the re-examination.[8]

Finally, there were multiple fragments that were compared and for which inconclusive opinions were offered. I concur with those opinions except for one. In my opinion, fragments 2D and 2K demonstrated similarity of class characteristics and sufficient correspondence of individual markings to conclude that they were fired from the same firearm. Therefore, this opinion is different than that offered by the examiners and verifiers.

A question was asked with respect to the potential NIBIN links that existed for the cartridge cases with an elliptical firing pin impression (the cartridge cases for which a false identification was made to the submitted Glock in which they were not fired) and whether these NIBIN links should have alerted EXAMINER 3 to the potential of a mistake in the original examination, of which he was the verifier.

The cartridge cases in question were identified to each other and the submitted Glock in question in 2021. On April 15, 2022, the NIBIN National Correlation and Training Center (NNCTC) published a lead linking these same cartridge cases to a different Glock firearm, one that had been recovered by an outside agency in the New England area. It is critical to understand that the NNCTC provides correlation services to law enforcement agencies nationwide that are participating in NIBIN. The goal is to provide agencies with rapid crime gun intelligence with respect to the potential links between shootings and shootings or shootings and recovered firearms. Leads issued by the NNCTC are considered as non-confirmed, potential links between items of evidence that will need to be confirmed by a trained examiner using comparative microscopy to verify the accuracy of the lead.

The leads are then issued to the investigators in the cases involved in the leads. In many jurisdictions it is the responsibility of the investigators to bring any potential lead they

[7] It Is not necessarily unusual for a re-examination of a case to be performed by the individual who performed the verification in the first iteration of the case, especially when staffing size is limited.
[8] EXAMINER 1 conceded some frustration and animosity with respect to EXAMINER 2's on-going status with the Laboratory. Whether it was in play at the time of this case is unknown but at least in one of the two examiners, the frustration was present.

desire to have investigated further to the attention of the laboratory. Based on a review of reports published by the Laboratory, this appears to be the case for the Laboratory and its clients. Since this lead had been developed after the conclusions had been reached by EXAMINER 2 and verified by EXAMINER 3 in 2021 and having the knowledge that the Laboratory had already confirmed the submitted Glock as the responsible Glock, it would be understandable that the investigator would not pursue the lead.

Further, given the very nature of a lead, the lead with the firearm recovered by the outside agency would not necessarily have raised any flags for EXAMINER 3 in his re-examination for two reasons. The first is that not all leads issued by the NNCTC are confirmed as such by an examiner, e.g., there are false leads. The second is that the question of the source of the cartridge cases in CASE 1 had, in the mind of the examiners at the Laboratory, been already established. Therefore, there would be no logical reason to consider that possibility. Simply put, in the mind of the examiners, it must have been a false lead.

CASE 12 (EXAMINER 3)

This case involved two badly damaged 22 L/LR caliber cartridge cases. The results were inconclusive based on similar class characteristics and insufficient correspondence of individual marks in the firing pin impression, which appeared to be the only mark that was compared. There are other marks that can be compared on 22 caliber cartridge cases that would indicate that they were fired in the same firearm including the anvil mark found on the underside of the rim where the firing pin impression is located and chamber marks that can be found on the obturated portions[9] of the cartridge case sides.

When I compared the cartridge cases, there were some individual characteristics in the firing pin impression and anvil marks that were significant yet insufficient for identification. However, there were chamber marks on obturated areas of the sides of the cartridge cases that had, in my opinion, significant and sufficient correspondence to conclude that the two cartridge cases were fired in the same firearm. Therefore, this opinion is different than that of the examiner.

In addition, EXAMINER 4 was listed as the verifier. It is unknown whether EXAMINER 4 meets the requirements to perform technical reviews of comparisons of fired ammunition components. The marks discussed (anvil marks and chamber marks) are not routinely assessed or acquired in NIBIN[10] operations.

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[9] Obturation occurs when a cartridge is fired. The cartridge case swells to seal the chamber area to maximize the ballistic efficiency of the cartridge. For 22 caliber cartridge cases the case generally remains swelled and as it is extracted, the chamber can mark the sides of the cartridge case.

[10] NIBIN is the National Integrated Ballistics Information Network. It is a program managed by the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) for the purpose of rapidly providing potential links between

CASE 2 (EXAMINER 2)

I concur with the results that were provided in this case. At the same time, when reviewing the case notes I developed a concern that what I was being told in interviews may not have been what was practiced in the examination of bullets and cartridge cases. This has to do with the issue of subclass characteristics.

Subclass characteristics are defined by the AFTE Glossary as, "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."[11] Subclass characteristics are directly related to machine processes by which firearm parts such as barrels, breechfaces, and firing pins are manufactured. If not properly assessed for, these can be misinterpreted as individual characteristics and result in a misidentification of a toolmark to a tool other than the one that made it. There are guidelines in place that an examiner can follow to assess firearms, bullets, and cartridge cases for subclass characteristics that were compiled and published in 2018.[12]

During the interviews, each of the three examiners stated that they routinely assess firearms, bullets, and cartridge cases for the presence of subclass characteristics. However, they all stated that it is not documented unless they observe them. EXAMINER 3 did indicate that he had considered making it part of the standard operating procedures and including it on worksheets, but he never followed up with that.[13]

The 380 AUTO cartridge cases in CASE 2 (Items 8 through 11) had concentric circular marks on the head of the cartridge case that during the initial assessment raised a concern for me that they could have potential for subclass characteristics. While this was dismissed, it was not without a thorough inspection of the marks to rule out the possibility, an inspection that should be captured in the case notes. In this case, there was no mention of the marks at all, let alone a discussion of subclass potential.

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cartridge cases recovered at shootings scenes with other such shootings or test fired cartridge cases from recovered firearms.

[11] AFTE Standardization and Training Committee, 2013. AFTE Glossary, 6th ed., Version 6.030317.

[12] Nichols R, 2018. Subclass characteristics: from origin to evaluation. AFTE Journal 50(2): 68-88.

[13] When discussing the issue with EXAMINER 2 in his interview, I am not convinced that EXAMINER 2 truly understands the concern with subclass characteristics. He continued to refer to marks that are pre-existing on unfired ammunition components as subclass characteristics. These are more commonly referred to as manufacturer marks and while a type of subclass characteristic it is only one type. When asked whether subclass characteristics could be imparted onto ammunition components when fired, he indicated no. This is not true. There have been many published studies in which this is the case and is the primary subclass concern for examiners.

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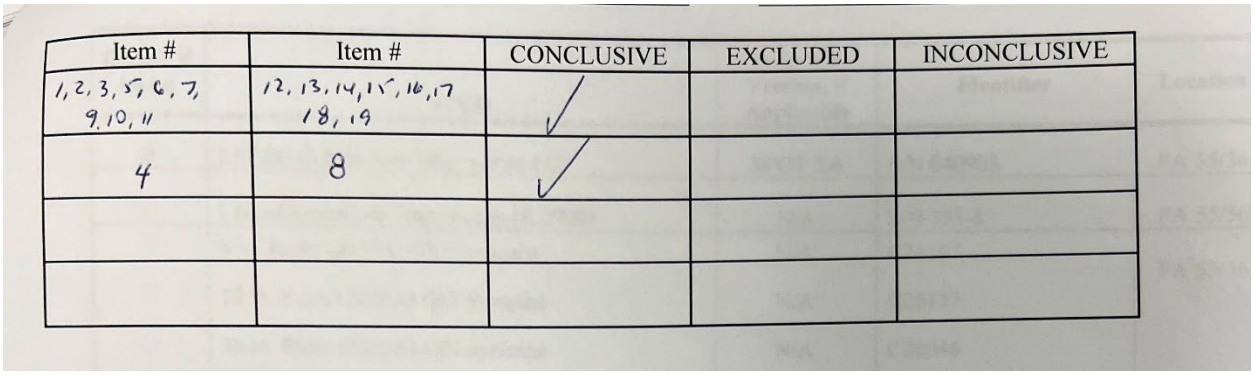
There were other cases[14] in which there were breechface marks or marks in the firing pin impressions of examined cartridge cases that during the initial assessment raised a concern for me that they could have potential for subclass characteristics. Again, while these concerns were dismissed, it was not without a thorough inspection of the marks to rule out the possibility, an inspection that should be captured in the case notes. While there was not a negative impact in that there were no misidentifications, the lack of discussion of the potential for subclass characteristics is something that needs correction.

CASE 6 (EXAMINER 2)

I concur with the results that were provided in this case except for EXAMINER 2's assessment of two of the projectile fragments, Items 2 and 4. For each of these fragments, EXAMINER 2 provided measurements of land impressions which would imply conventional rifling. These fragments do not display conventional rifling but polygonal rifling with rails, created by a Glock marking barrel. The results were still inconclusive which is correct as the markings on the fragments were limited. However, it is important that projectiles and fragments be more thoroughly inspected and examined.

CASE 7 (EXAMINER 3)

I concur with the results that were provided in this case. There are two other things that I discovered when reviewing the case jacket. The first refers to the image below which is found on the older Firearms Comparison and Verification Worksheet and the more current iteration of that worksheet in two different worksheets. The numbers in the first two cells on the first line of the table represent all the cartridge cases that were identified as a group. The challenge is that the reviewer would not know which items were specifically compared to which items, either for the examination or the verification. In all reviewed cases in which there were many cartridge cases within a group, it was handled this way. This should be much clearer.



Item #	Item #	CONCLUSIVE	EXCLUDED	INCONCLUSIVE
1, 2, 3, 5, 6, 7, 9, 10, 11	12, 13, 14, 15, 16, 17 18, 19	✓		
4	8	✓		

[14] CASE 7 (EXAMINER 3), CASE 8 (EXAMINER 2), CASE 13 (EXAMINER 1), and CASE 14 (EXAMINER 1).

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The other issue is the documentation of the verification that was performed, by EXAMINER 5. The following are quotes from the Worksheet (below the above table):

> "Items 1-7, 9-17 were conclusive to each other based on agreement of class (caliber firing pin shape) and sufficient agreement of individual (breechface/firing pin impressions) characteristics. Items 1-7, 9-17 were discharged from the same gun."
>
> "Items 4,8 were conclusive to each other based on agreement of class (caliber, firing pin shape) and sufficient agreement of individual (breech face impressions) characteristics. Items 4 & 8 were discharged from a second gun.

The first paragraph is incorrect because it includes Item 4 when Item 4 was not identified to that group, it was part of the second group. This was missed in the technical and administrative reviews.

CASE 11 (EXAMINER 1)

I concur with the results regarding the cartridge cases that were provided in this case. The bullets were not re-examined. The primary concern is a documentation issue on page 45. The caption reads, "[CASE 11]-37 33 35x 37b". This makes no sense given the format of the other captions which included the case number followed by the item number on the left side of the photograph which in turn was followed by the magnification which in turn was followed by the item number on the right side of the photograph and a letter designation if there was more than one photograph. In the cited caption there are two exhibit numbers to the left of the magnification documentation.

Overview

Apart from the misidentification of the cartridge cases in CASE 1, there were two instances in which I did not concur with the reported comparative examination results. In each of the instances the Laboratory examiner opined inconclusive while, in my opinion, there was sufficient correspondence to identify the samples that were compared.

In instances in which there were many cartridge cases having similar class characteristics that were being compared, the report and notes were consistently unclear with respect to which cartridge cases were compared with each other. A typical approach is to select the best marked cartridge from the group and compare the rest against that selected one, sometimes making a change if the ammunition type is different or for some other similar reason.[15] The way the Firearms Comparison and Verification Worksheet is completed does

[15] For example, in CASE 11, there was a total of 18, 45 AUTO caliber cartridge cases that had similar class characteristics. Among the 18 cartridge cases, there were two different headstamps. So, I chose one from

not shed any light on this issue. Adding to this is that in one case, CASE 11, in which there were many photographs, the captions for those photographs indicate quite a bit of cartridge case swapping when it was not necessary.[16] While there is nothing wrong with this approach, it can lead to inefficiency and potential mixing of samples because there is so much switching going on.

There were instances in which the marks that were compared were different than those reported. For example, in CASE 14, under Analysis Performed and Results section of the report, it indicates, "individual characteristics include breech face marks, firing pin marks, firing pin shear marks." On the "Lined Notes" page there is a space to check for which individual marks were used for the comparison and identification, only the box for breech face marks was checked, not the other two.

Generally, there was simply a lack of clarity with respect to what was being compared when there were multiple samples and, for cartridge cases, what marks were being compared and relied upon for identification conclusions that were reached. The lack of clarity and inconsistency gave the appearance that such notations were being made *pro forma* rather than having specific meaning and intent. The purpose of notes is to be able to reconstruct what was done and the accompanying thought process. The notes in the reviewed cases do not permit a full understanding of what specifically was done nor the accompanying thought process. In addition, there was a lack of documentation regarding the potential for subclass characteristics in cases in which there should have been some discussion given what was shared in the interviews.

It appears that examiners rely on notes generated by EXAMINER 4 with respect to the triage of cartridge cases for NIBIN related purposes. There is nothing inherently wrong with that because it is an efficient way to do casework. At the same time, evaluating cartridge cases for NIBN purposes is different than evaluating cartridge cases for microscopic comparison cases. For example, subclass characteristics aren't as critical for NIBIN as they are for an examiner who is going to perform an identification. So, the definition of "parallel" with respect to cartridge cases for comparison has a much stronger implication for potential subclass characteristics than it would have for NIBIN related purposes.

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one group (of 3) and compared that with the other two. I chose one from the other group (of 15) and compared that with the rest. Then I selected one from each group and compared those to link the two groups.

[16] For example, for the 9mm Luger cartridge cases in CASE 11, the following comparisons were documented with photographs of the firing pin impression: Item 13 was compared with Items 25, 26, 27, 28, and 29; Item 26 was compared with Item 35; Item 27 was compared with Item 28; Item 30 was compared with Items 31, and 32; Item 32 was compared with Item 45; Item 33 was compared with Item 37; Item 34 was compared with Item 36; Item 37 was compared with Items 38, 39, and 40; and Item 40 was compared with Item 42.

It is also possible that the triaging performed by EXAMINER 4 could have a biasing effect on the examiner. For example, this could have impacted EXAMINER 2 in the initial examination of CASE 1 based on the notation that was observed on page 1 of the notes. Immediately after evidence listing, the firearm was test fired with the following notes "No NIBIN on the test fired cartridge cases since there were related cartridge cases already in NIBIN." It is unknown if this was decided after the comparison was performed or before[17] but if it was before, then it could have biased his comparison. It is important to remember that triaging is not expected to be perfect while examiners should generally be much more discriminating in their assessment of class and individual characteristics even when using the stereo microscope.

While there is a good use of worksheets, it was generally difficult to reconstruct what was done and when it was done throughout the cases based on the notes, specifically with respect to the chronology of events. This is not necessarily a problem when examinations are conducted within a single day but when the examination is conducted over several days, some sort of chronology is important. This can be easily accomplished using the "Lined Notes" worksheet much more effectively. For example, after a brief description of the evidence, there can be a heading – Examination of Cartridge Cases (Items 1 – 18): see Cartridge Case Examination Worksheets by EXAMINER 4. It can then be followed by another heading – Comparison of Cartridge Cases (Items 1 – 18): see Firearms Comparison Worksheets. This helps to guide the reviewer as to the order of examinations and when they were performed.

One final note deals with the marking of evidence. In the earlier cases, it was observed that cartridge cases were marked with the laboratory number, item number and initials of the examiner using indelible ink. In the latter cases, it was observed that cartridge cases were being scribed with the same information. While scribing is preferred as ink can be worn off, indiscriminate scribing of the sides of cartridge cases can ruin potentially valuable chamber marks on the side of cartridge cases. This was noted by EXAMINER 1 in case 14 who, according to the notes, brought it to the attention of EXAMINER 2. If scribing is going to continue to be the practice, the Laboratory should consider requiring the scribing to be done inside the case mouth when possible. In this way there would be no danger of ruining firearm produced marks such as chamber marks.

Review of Processes and Procedures

Documents were provided electronically through Google Drive. Documents in the following folders were reviewed for areas of potential risk and/or improvement:

[17] The initial note pages appeared to serve as a summary of examinations when reviewing EXAMINER 2's casework. Therefore, there was no real chronology of events that could be reconstructed.

- Firearms procedures
- Firearms QAQC procedures
- Forms and worksheets
- NIBIN procedures
- Training Manual
- Job description and salary range

Prior to identifying areas of potential risk and/or improvement, I do wish to comment on Document Number 1690, General Procedures for Processing Evidence. There are several points that are especially important and strong including: 1) all evidence to be compared before exemplars; 2) all conclusions except for eliminations based on class characteristics shall be verified and those verifications conducted blind whenever possible; and 3) all casework being subjected to technical and administrative review.

The examination and comparison of evidence prior to exemplars is preferred from a bias perspective because it helps to prevent the "reading in" of information gained from the exemplars into the evidence. While verification is employed as a best practice for forensic science laboratories, due to caseloads, not all laboratories have verification procedures in place for all conclusions as the Laboratory does. The comprehensive verification policy is an excellent one to have in place as is the desire for them to be conducted blind whenever possible. Finally, subjecting all casework to technical and administrative review is also the best policy to have in place to ensure as best as possible that all casework has met the standards for casework that the laboratory has set in place.

Based on my review of the documents, there was nothing intrinsic in the policies and procedures that was the cause for the misidentification in CASE 1. Indeed, based on conversations with the laboratory management, it was those policies and procedures that have been responsible for catching a previous critical misidentification in the past. Even so, as in all things, there is room for improvement. The following are findings for which recommendations are offered. Some of these are more critical than others. These will be addressed first, followed by those items that should be considered less critical but good practice.

Critical Items

1) Subclass characteristics are defined as, "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." Such characteristics can be confused with individual characteristics and can result in misidentification if they are not appropriately assessed.

In interviews with the three examiners, they indicated that they routinely assess submitted firearms, bullets, and cartridge cases for subclass characteristics. They further indicated that if any are found, then that will be documented. This is not consistent with what was observed in my assessment of case jackets in which some of the evidence, when I examined it, should have created a discussion of subclass potential in the case notes.

For firearms, this assessment generally would take place during the examination of the firearm prior to test firing or prior to the comparisons of bullets and cartridge cases. For bullets and cartridge cases, this assessment would begin with an evaluation of the cartridge cases using the stereo microscope and continuing with the evaluation of them using the comparison microscope. During an interview with EXAMINER 3, he indicated that he was going to introduce it into the processes and worksheets but had not yet done that. This should be considered critical and addressed appropriately.

Recommendation: Include the following language in Document 1347, Projectile and Cartridge Case Identification: "Bullets and cartridge cases shall be assessed for the possible presence of subclass characteristics. Documentation of such assessment shall be documented in the case notes which can include worksheets. Such documentation shall include a description of the toolmarks observed and why (or why not) subclass characteristics can be ruled out. When test fired bullets and cartridge cases are being compared with submitted evidence bullets and cartridge cases, the barrel, breechface, and firing pin (as necessary) will be evaluated for subclass characteristics and documented in the case notes which can include worksheets. Documentation should include a description of the toolmarks observed and why (or why not) subclass characteristics can be ruled out."

2) There may be instances in which an individual assigned to verify conclusions of another examiner may disagree with that examiner. In Document Number 1648 (QA Case Review), when a disagreement in conclusions that is not resolved, it is reported as inconclusive. It is important to recognize that that is not necessarily an appropriate response. In firearm and toolmark identification, an inconclusive conclusion is supported when there is insufficient support for a more conclusive elimination or identification.[18] When either of those conclusions has been reached, it means the examiner is of the opinion that sufficient support does exist for that

[18] AFTE Criteria for Identification Committee, 1992. Theory of identification, range of striae comparison reports and modified glossary definitions. AFTE Journal 24(3):336-340.

conclusion. Therefore, inconclusive would not be an appropriate compromise between such disparate conclusions such as identification and elimination.

Recommendation: There are different ways in which this can be approached but defaulting to an inconclusive opinion when a disagreement in conclusions is not resolved should be avoided and the language should be removed. Alternatives include having a third examiner perform an independent examination and reporting the majority opinion while keeping the disparate opinion in the notes (and potentially the report) or outsourcing the case to an independent consultant.

3) The AFTE Range of Conclusions identifies three different examples of inconclusive opinions. These are as follows. A) Significant agreement of individual characteristics and all discernible class characteristics. but insufficient for an identification. B) Significant agreement of all discernible class characteristics without significant agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility. C) Agreement of all discernible class characteristics but significant disagreement of individual characteristics insufficient for an elimination.[19] The language in Document Number 1649 (Range of Conclusions) includes only the first two examples. In addition, only the first two examples are cited in the reports of firearm-related examinations.

   Recommendation: Include the third example in the document and reports so its absence is not seen as a pro-prosecution bias and specifically allows for the possibility that another tool could have been responsible for the examined and compared toolmarks.

4) A common source determination of bullets or cartridge cases requires congruence of class characteristics between the two items as well as sufficient correspondence of individual characteristics. Document 1269 (Microscopy Notes) has two listed options A and D, each of which seem to imply that an opinion of common source can be based on observed agreement of discernible class characteristics alone. This is not true and is confusing.

   Recommendation: Either clarify options A and D or remove them all together. Specify, "Discharged [or Fired] from one firearm based on observed discernible agreement of class characteristics (caliber, shape of firing pin, presence and shape of aperture shear) [or (number of land and grooves, twist, width of impressions)] and individual characteristics of the breechface marks, firing pin marks, aperture shear,

[19] Ibid.

and chamber marks [or striations within the land/groove impressions] necessary for identification."

5) Quality Manual Section 7.7.5.d discusses established criteria for determining successful completion of proficiency tests. Section 7.7.5.g discusses expected results. During the interviews with the three examiners, each of them stated that they had the confidence that should they have the need to conclude inconclusive on a proficiency test that it would be acceptable to the Quality Programs of the Laboratory. At the same time, it is important that laboratory documents recognize that inconclusive in a firearm and toolmark proficiency test will sometimes be appropriate even when the test has true identifications and true eliminations.[20]

   Recommendation: Include language like, "It is recognized that despite being a true identification or true elimination in a proficiency test, some firearm and toolmark samples may not have sufficient data to support an identification or elimination. In instances where there is insufficient data to reach a more conclusive opinion, an inconclusive response is encouraged provided there is sufficient documentation that explains the reason for the inconclusive opinion. Given the difficulty in rendering elimination conclusions when there is only one sample representing one of the potential tools in a comparison, an inconclusive response when the item is a true elimination will be considered by the Laboratory as an acceptable response when the class characteristics of those items is similar. This is because there is no way to assess the reproducibility and repeatability of marks when there is only one sample that is potentially representing that tool."

Less Critical Items

1) Measurements of the land and groove engraved areas of submitted bullets are required as part of the examination process. These measurements can be input into a General Rifling Characteristics (GRC) database to generate a list of potential firearms from which the submitted bullet(s) could have been fired. Typical practice is for a +/- range added to the measurements to account for possible error when performing the search of the GRC database. This practice is not specified in the two documents, Numbers 1321 and 1334 (Determine Type Weapon and General Rifling Characteristics Utilization, respectively), in which it appears to be a good fit.

[20] Identification and elimination conclusions are not mutually exclusive in firearm and toolmark identification. While identifications can be based on data gathered from the evidence alone, this is not the case with eliminations. There are many instances in the literature in which true identifications have shown so little correspondence that they appeared as eliminations. Therefore, some of the information that may be needed to render a conclusion of elimination is extant to the evidence being examined and oft unavailable to the examiner.

Furthermore, in a review of case jackets in which such a search was performed, there was not such an error range implemented. This should be considered less critical but good practice.

Recommendation: Include the following statement in the documents Numbers 1321 and 1334: When performing a search of the General Rifling Characteristics Database, use an error range of +/- 0.003" of the measured land and groove impressions on the submitted bullet(s).

2) There are several different firearm produced markings that indicate firing of a firearm. These include the firing pin impression, the breechface marks, chamber marks due to obturation, along with the aperture shear and firing pin drag mark, (when available). There are two documents in which three of the five are mentioned, but not the other two. These are Document Numbers 1284 and 1286, Evidence Verification Worksheet and Lined Notes, respectively.

   Recommendation: Include chamber marks and firing pin drag marks as options with the firing pin impression, the breechface marks, and aperture shear. This should generally be assumed to be the case for trained examiners but for sake of completeness, their inclusion should be considered.

3) The Quality Manual (Document Number 2421-2) includes the following language under 3.34 – "an example of provision of 'objective evidence' is 'confirmation of a test result/opinion'". Opinions of identification, inconclusive, and elimination are subjective. Verification of a subjective opinion does not make that opinion more objective; it is still a subjective opinion. It is unknown if I am interpreting the language differently than intended but that implication is how it reads to me.

   Recommendation: Rework the language to remove the implication that a verification of a subjective conclusion, a verification that is as subjective as the original conclusion, makes it more objective.

4) The Quality Manual (Document Number 2421-2), 6.2.2 has no specifics with respect to previous experience and 6.2.4 designates one competency test for experienced examiners prior to beginning casework. 6.2.2 is likely too broad and should have some specific topics that should be included. Provided the competency test is sufficiently challenging, then one can be sufficient, but it would be best to ensure a comprehensive test to include cartridge cases and bullets, preferably in individual sample sets much like PCAST recommends for error rate study design.[21]

[21] President's Council of Advisors on Science and Technology (PCAST), 2016. Forensic Science in Criminal Courts: Ensuring the Scientific Validity of Feature-Comparison Methods.

Recommendation: For 6.2.2, the following should be included at a minimum: "…comparison training that included known match and known non-match comparisons; machining fundamentals and subclass characteristics, comparative pattern analysis theory, mock testimonies, and previous competency testing".

For 6.2.4, recommend establishing a standardized competency test including at least 5 sample sets of bullets and five sample sets of cartridge cases. Each sample set should consist of two knowns and one unknown which may be either a true identification or a true elimination. True eliminations should have similar class characteristics as the known samples.

5) Quality Manual 6.2.6 and 7.7.1.d discuss potentially different time periods for a testimony review. Section 6.2.6 specifies once per accreditation cycle while 7.7.1.d specifies once every five years. These could be in conflict if an accreditation cycle is 3 or 4 years.

   Recommendation: Make the language consistent.

6) Document Number 1690, General Procedures for Processing Evidence mention blind verification when possible.

   Recommendation: Given the limited staff size and the value that collaboration could have when performing casework, blind verification may not be fully possible. Given this, I would recommend working out an arrangement with another nearby laboratory to perform blind verifications of a limited number of cases that are randomly selected. This would have benefits for both laboratories.

7) The job description could be modified to include a separate designation for a Technical Lead for the section that would highlight specific qualifications sought for that role within the Unit. The salary and benefits appear appropriate, understanding that a Technical Lead would likely require the higher end of the salary scale.

8) The Laboratory Training Manual leverages the AFTE Training Manual as much as possible. This is the approach most laboratories take as the AFTE Training Manual has been the accepted standard for many years. There are four areas in which the training could be more rigorous. 1) While machining operations and subclass characteristics are discussed in the AFTE Training Manual, the training is not as directed as it could be. 2) The AFTE Theory of Identification specifies an identification criterion that must exceed the best correspondence observed in known non-matching conditions and be consistent with correspondence expected in known matching conditions. It is critical that the trainee is provided or generates

samples for being more deliberate in the comparison of known matching conditions and known non-matching conditions. 3) The scientific foundations of the discipline are not presented as directly as they could be. In an era of evidentiary hearings becoming more commonplace, it is essential that examiners be prepared to handle these issues much better. 4) There is a statement that none of the reading is required but only recommended. There are many articles that should be considered required reading to provide trainees with a minimum foundation of knowledge with respect to the discipline and the underlying scientific foundations.

Recommendation: Bolster the training and make it more rigorous by including specialized training in tool manufacture, manufacturing theory, subclass characteristics, and the scientific foundations of the discipline (e.g., comparative pattern analysis theory). In addition, ensure the comparison training includes directed training in which the trainee is comparing known non-matching samples and matching samples to better develop their criterion for identification. Finally, review the reading in the AFTE Training Manual and identify the literature that will be required.

Other Duties as Agreed

Interviews

Much of what was garnered in the interviews was addressed in the areas that have been discussed elsewhere in this report. The primary concern yet to be addressed that was learned from the interviews is the on-boarding procedures of the Laboratory. It appears this has possibly resulted in the Laboratory over-valuing the stated experience of examiners and not knowing how to critically assess the training and expertise of potential candidates. This is not uncommon. However, this does need to be corrected.

There are questions that can be asked on applications for positions that can help elicit the needed information to help ensure as much as possible that the skill set matches the impression of a fully trained examiner. There are tests that can be administered, both written and practical that can serve to assess knowledge and skill sets, especially when seeking already qualified candidates. Given the status of examiners at the laboratory, it may be necessary to hire a consultant to provide additional guidance with respect to this.

Review of Report of Findings – OUTSIDE CONSULTANT 1 re: EXAMINER 2 Assessment

OUTSIDE CONSULTANT 1 published a report dated June 19, 2024. This assessment is not designed to comment upon the report as much as it is a discussion of the Firearms Competency Test that was administered to EXAMINER 2. It was designed to be a very challenging test in that the bullets and cartridge cases that were to be compared by

EXAMINER 2 were fired using ten consecutively hammer forged barrels and ten consecutively manufactured breechfaces. Based on manufacturing processes, it is expected that if any two tools should be alike, it should be those manufactured in consecutive sequence with one another.

EXAMINER 2 completed this test successfully, making every identification that was available to be made with no false identifications. The documentation included photographs in which EXAMINER 2 found sufficient correspondence to make the common source identifications. These photographs did demonstrate significant correspondence of appropriate individual markings from either the barrel or the breechface.

While it is acknowledged that the samples are sufficiently challenging, the design of the test and instructions could have the impact of biasing the test taker, in this case, EXAMINER 2. The test taker was provided with information that each lettered unknown would be associated with one of the submitted known sample sets. This is a potentially biasing statement because the test taker can utilize a “best-fit” criteria to the comparisons of unknowns with knowns. Essentially, given that statement, a test taker could conclude identification based on significant correspondence between an unknown and a known because that is the best correspondence observed, even if insufficient for an identification.

For EXAMINER 2, this is especially relevant given a couple of statements made in his interview. One was when he was asked about CASE 1 in which a false identification was made to the submitted firearm when in fact it was a different firearm that was responsible for firing some of the cartridge cases. He indicated that if the other gun had been submitted alongside the one that had been submitted, he was confident he would have made the correct identification. This is a “best-fit” statement. He also indicated that he has not used the inconclusive opinion in a proficiency test and the reason for the false identification in the firearms proficiency test in which he was unsuccessful was because he was convinced there had to be at least one identification. Had it been an actual case, he is confident he would have concluded inconclusive.

Based on these statements, it appears EXAMINER 2 can be biased when taking proficiency and competency tests. Therefore, his performance and results on the competency test provided by OUTSIDE CONTRACTOR 1 may not be as reliable as they could have been without the potentially biasing statements. If EXAMINER 2 is going to be reinstated to the bench to perform comparative casework, an additional competency test should be provided, one that includes at least ten sample sets of bullets and ten sample sets of cartridge cases. Each sample set should consist of two knowns and one unknown which may be either a true identification or a true elimination. True eliminations should have similar class characteristics as the known samples. EXAMINER 2 would be given no

information with respect to the samples apart from the instructions to perform comparisons of each sample set as an independent entity.

In addition, given his responses with respect to subclass characteristics there appears to be a significant gap in knowledge that would be critical to remedy. This would not be sufficiently remedied by simple lectures or reading at this point but would require directed training with practical exercises designed to test EXAMINER 2's skill set with respect to the appropriate assessment of subclass characteristics on bullets, cartridge cases, and tool surfaces.

Conclusions

No further misidentifications were made in the re-examined cases apart from the one already known to exist in CASE 1. There were two instances in which an identification could have been made between samples and was not. This included CASE 1 which was missed by EXAMINERS 1, 2, and 3 along with a second case, examined by EXAMINER 3 and verified by EXAMINER 4. Given the limited number of re-examinations that could be reviewed in the allotted time frame, further re-examinations are highly recommended. Particular attention should be given to cases in which firearms were recovered, test fired, compared, and identified or when evidence from two different shootings was compared and identified.

The policies and procedures in place at the Laboratory are sufficient and would not have inherently led to the misidentification in CASE 1. There are areas in which they could be clearer and more direct. These should be considered finer tuning of already adequate policies and procedures. Recommendations were given for those as well as for the current training procedures for new examiners.

The implementation of the policies by the examiners was not as diligent as it could have been. It was the lack of diligence combined with likely confirmation bias that was the cause of the misidentification and not a lack in the policies and procedures. Furthermore, there were instances in which the case notes and report were not as congruent as they should have been and others in which the stated procedures by the examiners were not supported by what was documented in the note packages. This also points to a lack of diligence as they knew the correct thing to do, it just appears they were not as diligent in following through as well as it may have been thought.

Given the time needed to train new firearm and toolmark examiners, it is always desirous for laboratories to hire those that have already been trained. The laboratory should be implementing processes to better verify the stated qualifications of trained applicants for positions to ensure that they are sufficiently trained. Recommendations for this were also provided.

Nichols Forensic Science Consulting, Inc.
Antioch, CA 94509
October 9, 2024

Two of the three examiners responsible for the misidentification in CASE 1 have left the Laboratory. Due to concerns with respect to previous false identifications in casework and proficiency testing, the seeming influence of subconscious confirmation bias inherent in this individual, and the lack of understanding with respect to critical issues such as subclass characteristics, it is recommended that EXAMINER 2 be removed from comparative analysis casework. This is notwithstanding his successful performance in the challenging comparison test administered and passed as it appears to have a flaw in design that would not sufficiently offset EXAMINER 2's subconscious biases.

Administratively, the Laboratory appears to be managed appropriately as can be demonstrated by its current accreditation. A critical error was made that appears due to an error of over-interpretation of too little correspondence and a lack of recognition of significant differences that should have resulted in an elimination of the submitted firearm as a source of the fired cartridge cases. This over-interpretation was likely compounded by confirmation bias. The Laboratory is exercising due diligence into investigating the potential cause of the error in the case at hand and the potential for error in other cases. This is the appropriate action to take.

Report submitted by Ronald G. Nichols, President
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