TEXAS FORENSIC SCIENCE COMMISSION

Justice Through Science

FINAL REPORT FOR COMPLAINT FILED BY ATTORNEY FRANK BLAZEK REGARDING FIREARM/TOOL MARK ANALYSIS PERFORMED AT THE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCE (SWIFS)

Finalized at Quarterly Meeting on April 12, 2016

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I. SUMMARY OF THE COMMISSION'S STATUTORY AUTHORITY

A. Legislative Background and Jurisdiction

The Texas Legislature created the Texas Forensic Science Commission ("Commission") during the 79th Legislative Session by passing House Bill 1068 (the "Act"). The Act amended the Texas Code of Criminal Procedure to add Article 38.01, which describes the composition and authority of the Commission. *See* Act of May 30, 2005, 79th Leg., R.S., ch. 1224, § 1, 2005.

During the 83rd and 84th Sessions, the Legislature further amended the Code of Criminal Procedure to clarify and expand the Commission's jurisdictional authority. *See* Acts 2013, 83rd Leg., ch. 782 (S.B.1238), §§ 1 to 4, eff. June 14, 2013; Acts 2015, 84th Leg., ch. 1276 (S.B.1287), §§ 1 to 7, eff. September 1, 2015, (except TEX. CODE CRIM. PROC. art. 38.01 § 4-a(b) which takes effect January 1, 2019).

The Commission has nine members appointed by the Governor of Texas. *Id.* at art. 38.01 § 3. Seven of the nine commissioners are scientists and two are attorneys (one prosecutor nominated by the Texas District and County Attorney's Association, and one criminal defense attorney nominated by the Texas Criminal Defense Lawyer's Association). *Id.* The Commission's Presiding Officer is Dr. Vincent J.M. Di Maio, as designated by the Governor. *Id.* at § 3(c).

1. Investigative Jurisdiction

Texas law requires the Commission to "investigate, in a timely manner, any allegation of professional negligence or professional misconduct that would substantially affect the integrity of the results of a forensic analysis conducted by an accredited laboratory, facility or entity." TEX. CODE CRIM. PROC. art. 38.01 § 4(a)(3). The Act also requires the Commission to: (1) implement a reporting system through which accredited laboratories, facilities or entities may report professional negligence or professional misconduct; *and* (2) require all laboratories, facilities or entities that conduct forensic analyses to report professional negligence or misconduct to the Commission. *Id* at §§ 4(a)(1) and 4(a)(2).

This complaint involves firearm/tool mark comparison and analyses. Firearm and tool mark analysis is an *accredited* discipline under Texas law. 37 Tex. Admin. Code § 651.5. Therefore, the analyses that are the subject of this complaint are subject to a professional negligence and/or misconduct review by the Commission. TEX. CODE CRIM. PROC. art. 38.01 § 4(a)(3).

2. Accreditation Jurisdiction

The Commission is charged with accrediting crime laboratories and other entities that conduct forensic analyses of physical evidence for use in criminal proceedings. TEX. CODE CRIM. PROC. art. 38.01 § 4-d(b). Texas law exempts certain forensic disciplines from the accreditation requirement—either by statute, by administrative rule, or by determination by the Commission. *See* TEX. CODE CRIM. PROC. art. 38.35 § (a)(4); 37 Tex. Admin. Code §§ 651.5 - 651.7; and TEX. CODE CRIM. PROC. art. 38.01 § 4-d(c). Unless a forensic analysis and related testimony is accredited or falls under an exemption, the evidence is not admissible in a criminal action in Texas courts. TEX. CODE CRIM. PROC. art. 38.35 § (d)(1).

3. Licensing Jurisdiction

As a result of legislation passed during the 84th Legislative Session, the Commission is required to establish a forensic examiner licensing program by January 2019. TEX. CODE CRIM. PROC. art. 38.01 § 4-a. While accreditation is granted to the *entities* that perform forensic analysis, licensing (sometimes also referred to as certification) is a credential attained by the *individuals* who practice the forensic analysis.

Currently, the licensing requirement applies to examiners who perform "forensic analysis" on behalf of accredited laboratories only. The Commission may establish voluntary licensing programs for disciplines falling outside the accreditation requirement but has not yet done so. TEX. CODE CRIM. PROC. art 38.01 § 4-a(c). The Commission's licensing program is still under development as of the writing of this report. Updates will be published on the Commission's website at www.fsc.texas.gov.

II. INVESTIGATIVE PROCESS

A. Complaint Screening

When the Commission receives a complaint, the Complaint and Disclosure Screening Committee conducts an initial review of the document at a publicly noticed meeting. (*See* Policies and Procedures at 3.0). After discussing the complaint, the Committee votes to recommend to the full Commission whether the complaint merits any further review. *Id.*

In this case, the Committee discussed the complaint at a publicly noticed meeting of the Complaint and Disclosure Screening Committee in Fort Worth, Texas on July 31, 2014. The Commission discussed the complaint again the following day, on August 1, 2014, at its quarterly meeting, also in Fort Worth, Texas. After deliberation, the Commission voted to create a 3-member investigative panel to review the complaint pursuant to Section 3.0(b)(2) of the Policies and Procedures. Members voted to elect Dr. Vincent Di Maio, Dr. Sarah Kerrigan and Mr. Richard Alpert as members of the panel, with Dr. Di Maio serving as Chairman. In September 2014, Dr. Sarah Kerrigan's appointment to the Commission expired, and Dr. Sheree Hughes-Stamm was appointed to fill her seat on the Commission and the investigative panel.

Once a panel is created, the Commission's investigations include: (1) relevant document review; (2) interviews with stakeholders as necessary to assess the facts and issues raised; (3) collaboration with affected agencies (*e.g.,* accrediting bodies, District Attorney's Office, etc.);

(4) requests for follow-up information where necessary; (5) hiring of subject matter experts where necessary; and (6) any other steps needed to meet the Commission's statutory obligations.

After deliberation and discussion at its October 7, 2014 meeting, Commission members voted to retain firearm and tool mark expert John Murdock from John E. Murdock & Associates ("Murdock")[1] to review the case and issue an expert opinion ("Murdock Report"). *See* **Exhibit A**.

B. Other Important Limitations on the Commission's Authority

The Commission's authority contains other important statutory limitations. ***For example, no finding contained herein constitutes a comment upon the guilt or innocence of any individual.*** TEX. CODE CRIM. PROC. 38.01 at § 4(g). Additionally, the Commission's written reports ***are not admissible*** in a civil or criminal action. *Id.* at § 11.

The Commission also does not have the authority to issue fines or other administrative penalties against any individual, laboratory or entity. The information the Commission receives during the course of any investigation is dependent upon the willingness of stakeholders to submit relevant documents and respond to questions posed. The information gathered has ***not*** been subjected to the standards for admission of evidence in a courtroom. For example, no individual testified under oath, was limited by either the Texas or Federal Rules of Evidence (*e.g.,* against the admission of hearsay) or was subjected to formal cross-examination under the supervision of a judge.

Despite the limitations described above, the Commission's reports are important tools in improving the criminal justice system. Judges take their gatekeeping responsibility seriously and do their utmost to make sound decisions regarding admissibility of forensic evidence. However,

[1] After Murdock released his report in the case, SWIFS requested a second evaluation by the Association of Firearm and Tool Mark Examiners (AFTE). The Commission's General Counsel contacted AFTE but they declined to perform an additional review.

most judges have neither the time nor the resources to review foundational research extensively or assess the latest standards in forensic science, especially considering the vast and diverse array of forensic disciplines that come before them. For this reason, the observations and recommendations made in Section VII of this report are intended to provide general guidance in all cases for which firearms and tool marks analysis and identification is offered into evidence.

III. SUMMARY OF THE COMPLAINT AND CRIMINAL CASE

Defense attorney Frank Blazek ("Blazek") filed this complaint on behalf of his client Joshua Ragston. *See* **Exhibit B**. Ragston was charged with capital murder in Grimes County, Texas. The murder victim was known to carry a .410/.45 caliber revolver, the same type of weapon with which the victim was shot several times. Investigators found no weapon at the crime scene. The State's theory was that the perpetrators took the victim's pistol, shot him with it and then left with the weapon.

A few months after the crime, a .410 Taurus revolver similar to that owned by the deceased was recovered on a roadside in a nearby county. Law enforcement submitted the weapon to a firearm/tool mark examiner ("Examiner") at the Southwestern Institute of Forensic Science ("SWIFS") for analysis. Based on a microscopic comparison of barrel rifling marks on three plastic shotshell wads recovered from autopsy to test-fired lead slugs, the Examiner identified the Taurus weapon as having fired the bullets recovered from the deceased. The Examiner's analysis and conclusions were verified by the laboratory supervisor who also technically reviewed and approved the report and supporting examination records.

Further police investigation determined the recovered Taurus weapon did not in fact belong to the deceased, but rather to a party unrelated to the investigation. In September 2012, the District Attorney resubmitted the same weapon and bullets to SWIFS along with 3 exemplar weapons of the same make and model. The Examiner reanalyzed and compared additional test fires using shotshells with plastic wads. The Examiner concluded she could no longer confirm the weapon she originally identified was the murder weapon. The Examiner indicated the first report was "scientifically valid," but she did not know if the weapon actually fired the fatal rounds.

The Complainant requested that the Commission investigate whether the misidentification was attributable to professional negligence or misconduct. The Complainant also requested Commission consideration of reporting language in firearm and tool mark cases. The original report in this case used unequivocal language: "Items [. . .] were all identified as having been fired by the item 69 Taurus revolver." Understanding that firearm and tool mark examination requires the *subjective evaluation* of objective data, the Complainant asked the Commission to consider safeguards against reporting and testimony that implies a greater degree of certainty than is scientifically possible and could therefore be misleading to the trier of fact. (*See* **Exhibit B**.)

IV. OBSERVATIONS AND FINDINGS REGARDING ROOT CAUSE

Murdock conducted an extensive review of various SWIFS case documents as well as the case evidence itself. His report with attachments is provided as **Exhibit A**, and his primary findings may be summarized as follows:

1. The root cause of the misidentification was that the Examiner attributed too much significance to a small amount of matching striae.

2. The misidentification was an error that may have been prevented if the Examiner had selected more appropriate ammunition for test firing.

3. The misidentification may also have been prevented if the verifier/technical reviewer had been more thorough in his review of the basis for the match.

The laboratory's initial review of the case file and documentation related to this incident identified no definitive cause for the apparent misidentification. *See* **Exhibits C and D**. Laboratory procedures were followed in the analysis, and the identification of the autopsy wads to the submitted firearm based upon comparison of the wads to test fired slugs was confirmed by a verifying Examiner. The verifier/technical reviewer observed the similarities in striations between evidence wads and test fires and agreed with the primary Examiner that those similarities were sufficient to indicate identification.

However, after receiving the Murdock Report, SWIFS performed a supplemental root cause analysis that considered—and to a large extent agreed with—the observations and recommendations made by Murdock. *See* **Exhibit D**. The laboratory's root cause analysis did not identify any lack of competency by the Examiner who had successfully completed ATF's National Firearm Examiner Academy in 2003 and one proficiency test every year after she was qualified as an independent Examiner in 2003.

The laboratory's supplemental analysis identified root causes similar to those identified by Murdock. For example, the Examiner chose ammunition for test firing that was inappropriate, because the ammunition was not sufficiently similar to the ammunition used to fire the evidence shotshell wads/cups. (The technical reviewer/verifier also did not identify that the ammunition chosen for test fire was inappropriate). Both the Examiner and the verifier attributed too much significance to a small area of microscopic similarity between the autopsy plastic shotshell wads/cups and the test fired lead slug. Additionally, SWIFS concluded that confirmation bias likely contributed to the misidentification, including:

1. Microscopic comparison of rifling impressions on plastic shotshell wads/cups had never been performed by the laboratory. The Examiner and verifier were overly confident in their ability to examine the material and did not conduct baseline studies to establish that the plastic material could be reliably examined using the laboratory's microscopic comparison methods;

2. Expectancy bias likely contributed to the failure of the technical reviewer to identify there was insufficient microscopic agreement to support the identification finding. Verifications of microscopic tool mark comparisons were not performed by the laboratory in a "blind" fashion; therefore, prior to performing the verification, the verifier knew the Examiner had reached a finding of identification.

Additionally, the Examiner provided insufficient photographic documentation in the case record to support the identification finding. Case file documentation requirements in 2010 required photographs to be taken in order to illustrate representative regions of microscopic similarity. Photographs were not taken at that time for the purpose of providing a full and convincing justification for the identification.

Finally, the laboratory utilized the "pattern matching" approach in reaching the identification finding. The lab did not utilize the Quantitative Consecutive Matching Striae (QCMS) approach described by Murdock in his report. SWIFS believes if the QCMS approach had been applied in this case, the small region of similarity observed between the autopsy shotshell wads/cups and the test fired lead slug would not have met the criteria for identification.

V. COMMISSION FINDINGS AND OBSERVATIONS RE: NEGLIGENCE

Article 38.01 of the Texas Code of Criminal Procedure requires the Commission to describe whether professional negligence or misconduct occurred in this case. Neither "professional negligence" nor "professional misconduct" is defined in the statute. The

Commission has defined both terms in its policies and procedures. (Policies and Procedures at 1.2.)

The Commission did not identify any evidence of "professional misconduct" in this case. However, the Commission did find evidence of "professional negligence" as described below. The term "professional negligence" is defined in Section 1.2 of the Commission's Policies and Procedures as follows:

> "Professional Negligence" means the actor, through a material act or omission, negligently failed to follow the standard of practice generally accepted at the time of the forensic analysis that an ordinary forensic professional or entity would have exercised, and the negligent act or omission would substantially affect the integrity of the results of a forensic analysis. An act or omission was negligent if the actor should have been but was not aware of an accepted standard of practice required for a forensic analysis. (Policies and Procedures at 1.2)

In his initial report, Murdock opined that the Examiner in this case committed professional negligence by attributing too much significance to a small amount of matching striae and by failing to use the appropriate test firing material. However, upon reflection, both Murdock and the Commission believe a more thorough analysis indicates the true root cause is attributable to a number of factors as described above, including the technical reviewer/verifier's failure to identify the lack of sufficient matching striae or the need to use plastic test firing material instead of lead. The Commission does not believe either fundamental fairness or an accurate reading of the facts in this case would lead a responsible oversight body to lay the blame for the misidentification solely at the feet of the Examiner. Examiners work within a system of quality controls. In this case, that system did not work as well as it should have. The Commission and Murdock agree the findings in this case are due to a series of quality breakdowns for which the Examiner is only partially responsible, and the appropriate remedial measure is additional training as described in SWIFS' corrective action plan, and *not* dismissal or other disciplinary action absent additional material facts. (*See* **Exhibit D.**)

The Commission encourages SWIFS to work with the Dallas County District Attorney's (DA) office to ensure attorneys understand the corrective actions and remedial measures taken. If the DA's office requests a retroactive review of the Examiner's casework, SWIFS should work collaboratively with the DA's office to develop a plan to implement the request in a resource-efficient manner.

VI. CORRECTIVE ACTION TAKEN BY SWIFS

In response to the Murdock Report, the Commission's initial finding and the laboratory's root cause analyses, the laboratory has taken the following corrective action:

1. Removed the Examiner from active casework involving microscopic comparisons pending finalization of the Commission's investigation. (The laboratory developed a technical remediation program that required the Examiner to perform and document examinations of known non-matching fired bullets);

2. Revised its procedures to specify the use of ammunition for test fires that are physically similar to the questioned evidence ammunition, including the addition of guidelines for selection of "similar" ammunition and a technical review requirement to assess the appropriateness of the test fired ammunition;

3. Revised its procedures to require sufficient photographic documentation to fully support microscopic identifications and added a technical review requirement related to the sufficiency of photographic documentation of identifications;

4. Implemented a procedure for blind verification of microscopic comparisons that reduces the opportunity for expectancy bias on the part of the verifier/technical reviewer;

5. Implemented a policy addressing the need for validation–type studies as a precondition for analysis when unusual test materials are received for analysis; and

6. Investigated the implementation of QCMS analysis for striated tool mark comparison. (The laboratory noted that it understands the QCMS approach is

> not universally accepted in the firearm and tool mark community; however, the laboratory believes the QCMS approach may enhance the objectivity and reproducibility of some aspects of the process of microscopic comparison of marks so the laboratory has taken steps to identify QCMS training opportunities and in-house validation studies.)

The Commission commends SWIFS for developing and implementing a thorough corrective action and retraining program and encourages laboratory management to consider publishing the Supplemental Training Program Design as a model for criteria for the identification of striated tool mark identification training. (*See* **Exhibit E.**) As Murdock observed, the program offers a "very effective way to help ensure that an examiner does not assign too much significance to a small region of striated tool mark similarity." Publication would be a worthy project both for the examiners in the firearm/tool mark section at SWIFS and the larger community of firearm and tool mark examiners nationwide. The Commission encourages the laboratory to work with John Murdock and others to expedite publication of the program.

VII. RECOMMENDATIONS

The laboratory has already taken significant corrective action to address the issues identified in the complaint. Following are recommendations of the Commission that may be extended to other laboratories with firearm/tool mark sections in Texas:

1. Examiners should select ammunition for test firing that is as close to the physical properties of the questioned items as possible.

2. Forensic laboratories in Texas should explore resource-efficient methods for implementing blind verification in pattern matching disciplines and implement those methods as soon as practicable.

3. All firearm/tool mark examiners should clearly document their criteria for identification in their case notes.

4. Examiners should number the pages of their case notes and illustrate the basis for identifications with photographs.

5. Laboratories should not issue reports or provide testimony in court that could lead the end-user to believe an association is being made with absolute certainty. Various national organizations are currently addressing the issue of reporting language including: the National Commission on Forensic Science, The Organization of Scientific Area Committees and ASTM International. Commission staff will work with the Texas Association of Firearm and Mark Examiners to develop a subsequent recommendation regarding specific reporting language.

6. Laboratories should consider incorporating QCMS for striated tool mark comparison *as a tool* for use in addition to traditional pattern matching methodologies. To be clear, the Commission is not requiring its use but rather suggesting that laboratories consider exploring it as a resource to enhance the objectivity and reproducibility of some aspects of the process of microscopic comparison of tool marks. Laboratories interested in support for training in this area are encouraged to contact the Commission's General Counsel.

EXHIBIT A

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REPORT OF EXAMINATION*

Laboratory No:	PCF 14-2	**Agency:**	Texas Commission on Forensic Science
Report Date:	July 28, 2015	**Agency Case No:**	14-08
Service:	Review documents, examine evidence, and respond to questions	**Requested by:**	Lynn Robitaille Garcia, General Counsel
Request Date:	November 2014	**Case Type:**	Misidentification of a firearm
Subject of Investigation:	SWIFS Laboratory #09P1160		

In November 2014, I was retained by the Texas Commission on Forensic Science (the Commission) to respond to a series of questions (attachment 1) formulated by the Commission in response to a complaint received from Attorney Frank Blazek concerning the misidentification of a revolver by an examiner from the Dallas County Southwest Institute of Forensic Science (SWIFS). This report consists of six parts: 1) General review of various SWIFS documents, including an evaluation of a portion of the undated draft (received 6-25-15) of the SWIFS Corrective Action Plan (CAR Plan, attachment 2); 2) Report of laboratory examinations conducted by John Murdock; 3) General observations regarding criteria for the identification of striated and impressed toolmarks; 4) General observations regarding taking photographs of firearm and toolmark identifications; 5) General observations regarding the numbering of note pages in forensic case work; and 6) Responses to questions posed by the Commission.

Part 1 – General Review of various SWIFS documents, including an evaluation of a portion of the undated draft (received 6-25-15) of the SWIFS Corrective Action Plan

It was reported to me (attachment 1) that on October 19, 2010, a SWIFS firearms examiner released a report (attachment 3) concluding that fired plastic combination shotshell wads and lead pellets submitted from autopsy were fired by a certain Taurus "Judge" revolver which the State believed to be the murder weapon at that time. Subsequent factual developments in the case revealed that the State's initial theory was incorrect. The parties in the case (both the State and defense counsel) eventually learned the murder weapon was a different Taurus "Judge" revolver than the one initially identified in the October 2010 report.

Examined By:

John E. Murdock, Criminalist
July 28, 2015

*Attachments: 27 documents totaling 199 pages

After re-testing, the same SWIFS examiner changed her report conclusion. On September 5, 2012, her revised report (attachment 4) contained the following conclusion: "Based on new analyses using previously submitted items of evidence and microscopic comparisons with newly produced test standards, the original reported conclusion identifying the wads recovered from autopsy…as having been fired by the item 003-001 revolver ***cannot be confirmed***. Additionally, there were no subclass carryover toolmarks observed among the newly purchased firearms." [emphasis added]

A review of the three pages of case notes, each dated May 10, 2010, (attachment 5) associated with SWIFS Laboratory #09P1160 report, dated October 19, 2010, (attachment 3) revealed that each of the plastic combination shotshell wads from autopsy, Items 3-1, 4-1, and 6-1, were compared and positively identified with test-firing 69TF3. Reference to the Firearm Worksheet, dated May 7, 2010, (attachment 6) for this case describes the test-fired standard for comparison and identification, #69TF3, as a "slug". This "slug" is further described at the top of page 2 of 4 of the revised 2012 laboratory report (attachment 4) #09P1160-11 as being from a "Federal brand 410 shotshell containing a rifled slug and plastic wad".

The revised 2012 report also states (on page 1) that the Item 69 Taurus revolver was test fired in 2010 "…using ammunition chosen from laboratory stock based on projectile type and availability" and that (on page 2) the "…Federal brand 410 shotshell containing a rifled slug and plastic wad was determined to be the best representation of the barrel". There are no case notes, however, that describe how the rifled slug and accompanying plastic wad were determined to be the best representation of the barrel.

In fact, subsequent testing by SWIFS in 2011, reported on in their 2012 revised report, showed that a rifled slug was not the best representation of the barrel. A review of the page labeled "Microscopic Comparison Matrix -3- (attachment 7) from the 2011 case notes accompanying the 2012 revised report reveals that the test-fired rifled slug, #69TF3, was again compared with all three plastic wads from autopsy with inconclusive results this time. A footnote describing all three of these comparisons reads as follows "Striae in the red phase (as before) still looks good, but not great, and it's not enough to make a definitive conclusion…especially considering all the tests of ***appropriate material*** (plastic wad to plastic wad) that have now been examined and compared microscopically." [emphasis added]

This footnote is clearly an acknowledgment that it was not appropriate to test fire a rifled slug (#69TF3) for comparison to the fired plastic shotshell wads from autopsy that had clearly contained lead shot. This inappropriateness is further illustrated by the results of the microscopic comparisons listed on the case note page labeled "Microscopic Comparison Matrix -2-, dated 8/22/2011 to 03/13/2012 (attachment 8). In these eight comparisons (high-lighted), the #69TF3 test-fired rifled slug was compared to eight different plastic shotshell wads (originally containing lead shot) test-fired in the misidentified Taurus revolver. The result of each of these comparisons was inconclusive. Had testing of this sort been conducted with another Taurus revolver prior to test-firing the Taurus revolver submitted in 2010, it would have clearly demonstrated that it was not a good idea to test fire a shotshell loaded with a rifled slug for comparison with fired plastic shotshell wads that had contained lead shot. It is, therefore, my opinion that the selection of inappropriate ammunition for the 2010 test-firing is a major contributing factor to the misidentification of the Taurus revolver, Item 69, and that Item 10 on the "Peer/Technical Review" form, dated 10/19/10, "Do the tests performed conform to accepted techniques" should have been checked "no" (attachment 9).

In their draft on of a "Corrective Action Plan" for case 09P01160, (attachment 2) SWIFS states that "…the cause of the apparent misidentification in the 2010 analysis is not obvious" and that they have "…identified no definitive cause for the apparent misidentification…." It is my opinion that the root cause of the misidentification in SWIFS case 09P01160 is that both the primary and verifying examiners ascribed too much significance to a small amount of microscopic agreement they found during the comparison of the striated toolmarks. Their criteria for identification, although not specifically described anywhere in the case notes, was likely based on the non-quantitative method of toolmark comparison and identification called "pattern-matching". Examiners using pattern-matching for the comparison and identification of striated toolmarks must compare the quality and quantity of agreement between questioned and known striated toolmarks with what they can remember was the best agreement they can recall between known-non-matching (KNM) striated toolmarks. The reason why they must require this much agreement is because striated toolmarks can only be identified as having been made by a particular tool working surface (in this case the rifled bore of a Taurus revolver) when the agreement between the questioned toolmarks (in this case the striae on the fired plastic shotshell wads from autopsy) and the known toolmarks (on appropriate test-fired wads) exceeds the best KNM agreement that has ever been seen personally or reported in the literature as the result of sound research. This is what is required by the Association of Firearm and Toolmark Examiners (AFTE) Theory of Identification adopted by AFTE in 1993 and slightly revised in May 2011 (attachment 10). Most forensic laboratories in the US have adopted this theory, either explicitly or implicitly.

Based on an evaluation of the striated agreement illustrated in the small photograph labeled "Ex.4 (1) to Ex 69TF3 (red phase)" on the "Case Summary Worksheet" dated October 19, 2010 and initialed "HRT", (attachment 11), presumably page three of the October 19, 2010 report (attachment 3), and in the 7 by 10 inch enlargement of the same photograph (attachment 12), it is my opinion that there is clearly an insufficient amount of agreement for identification. It could not be determined by this reviewer whether there were other areas of agreement since there are no other photographs and no mention of any specific areas of agreement in the case notes.

Part 2 - Report of Laboratory Examinations Conducted by John Murdock (see attachment 13 for 62 pages of case notes, including photographs referenced in this report)

Description of Evidence (received by John Murdock on January 13, 2015)

3-1, 4-1, and 6-1 – Three plastic shotshell wads shot reported to have been recovered during autopsy

69 – Taurus five-shot revolver, model The Judge-Ultra-Lite, 45 Colt/410 Gauge caliber, serial number BX715042

69-1 – A Forensic-Sil bore cast of Item 69 prepared by J. Murdock

69TF3 – A rifled shotgun slug reported to have been test-fired in the Item 69 Taurus revolver in 2010 by SWIFS. This is one test-firing from among SWIFS's 2010 test-firings 69TF1 through 69TF6. No shotshell wads used to contain lead shot were test-fired in this 2010 series.

69TF-1, 2, (#3 was reported to have been lost), 4, 5, 6, 7, 8, 9, 10, and 11 are all shotshell wads used to contain lead shot that were reported to have been test-fired in the Item 69 Taurus revolver in 2011 by SWIFS. These are described as Items 3-1TF1, 2, and 4 through 11 by SWIFS in the bottom paragraph of page 2 in their laboratory report dated September 5, 2012.

5-1 – Taurus five-shot revolver, model The Judge, 45 Colt/ 410 Gauge caliber, serial number DU275155, and a manila envelope reported to contain test-firings from this revolver

5-1A – A Forensic-Sil bore cast of Item 5-1 prepared by J. Murdock

6-1 – A manila envelope reported to contain test-firings from a Taurus Judge revolver, serial number DU275141

7-1 – Taurus five-shot revolver, model The Judge, 45 Colt/410 Gauge caliber, serial number DU275138, and a manila envelope reported to contain test-firings from this revolver

7-1A – A Forensic –Sil bore cast of Item 7-1 prepared by J. Murdock

Summary

The plastic wads collected during autopsy can be identified with one another and the plastic wads test-fired from the Taurus revolver, Item 69, can be identified with one another. However, an inter-comparison of one group of wads with the other group of wads revealed no significant agreement. This clearly demonstrates that the three autopsy wads were not fired in the Taurus revolver, Item 69.

Examination Results and Conclusions

A comparison was made between the plastic shotshell wad, Item 4-1, and the rifled shotshell slug, Item 69TF3, because this was the comparison that apparently formed at least part of the basis for the determination by SWIFS that the autopsy wads, Items 3-1, 4-1, and 6-1, were fired from the Taurus revolver, Item 69. When making this comparison, Items 4-1 (plastic wad) and 69TF3 (test-fired rifled slug) were set up on the comparison microscope (see photographs 11, 12, 13, and 14 in attachment 13) in the position illustrated in the small SWIFS photograph appearing on their "Case Summary Worksheet", dated October 19, 2010 (attachments 11 and 12) because it is labeled as being a "Photo of Representative Identification Made". It is my opinion that there is not enough striated toolmark agreement illustrated in this SWIFS photograph to support a conclusion of identification, either by Pattern Matching or Quantitative Consecutive Matching Striae.

Fired plastic shotshell wads are difficult to illuminate with oblique light for microscopic comparison because they are partially translucent. Therefore, the firearm-produced striae, do not show up well when viewed with the traditional comparison microscope using reflected light. Alternatively, the best way to compare fired plastic shotshell wads is by making a Forensic-Sil (preferably brown color) cast of the entire bore-bearing circumference (360 degrees), cutting the cast in a pre-selected area, and stapling the cast onto a small piece of 3 by 5 inch card stock so that the cast is laid out flat with the firearm- produced striae facing up.

An inter-comparison of casts of autopsy wads 3-1, 4-1, and 6-1 revealed sufficient agreement of individual firearm-produced toolmarks to establish that they were fired in the same unknown firearm (see photographs 1, 2, 3, 4, and 5 in attachment 13). The determination that these marks are individual in nature assumes that they were fired in a Taurus Judge revolver devoid of subclass influence.

A microscopic comparison of a cast of autopsy wad 4-1 with a cast of the test-fired rifled slug, Item 69TF3, revealed no significant agreement.

The plastic shotshell wads used to contain lead shot that were test-fired in the Taurus revolver, Item 69, in 2011 by SWIFS, Items 3-1TF1, 2, and 4 through 11, were evaluated for the quality and quantity of identifiable firearm-produced markings. Among these plastic wads, Item 3-1TF2, 5, 7, 8, 9, and 11 had the best markings. Forensic-Sil casts were prepared of these markings in the manner described above. An inter-comparison of the casts of wads 3-1TF5, 3-1TF8, and 3-1TF9 revealed sufficient agreement of individual firearm-produced markings to establish that these three wads were fired in the same firearm (see photographs 15, 16, 17, 18, and 19 in attachment 13). This agreement demonstrates the reproducibility of identifiable markings produced by the Taurus revolver, Item 69.

The reproducibility of the firearm that was used to fire the three plastic wads from autopsy, Items 3-1, 4-1, and 6-1, was established by being able to identify each of them with one another.

The cast of test-fired plastic wad #3-1TF5 (2011) was compared with the cast of autopsy wad 6-1. No significant agreement was found (see photographs 20 and 21 in attachment 13).

The examinations described above clearly show that the plastic wads collected during autopsy can be identified with one another and that the plastic wads test-fired by SWIFS in 2011 can be identified with one another.

However, a comparison of one group's reproducible firearm-produced markings with the other group's reproducible firearm-produced markings reveals no significant agreement. This clearly demonstrates that the autopsy wads were fired in the same unknown firearm, but a different firearm than the Taurus revolver, Item 69.

Disposition of Evidence

All submitted evidence will be returned to the Grimes County District Attorney's Office, 1022 SH 90, Anderson, TX 77830. The three bore casts, and all casts of test-fired shotshell wads, prepared by John Murdock will be retained by John Murdock.

Part 3 – General Observations regarding Criteria for the Identification of Striated and Impressed Toolmarks

Although this case deals only with the identification of striated toolmarks, for the sake of thoroughness, I have elected to discuss impressed toolmarks as well.

There are two main types of toolmarks considered by the firearm and toolmark examiner; impressed and striated. Impressed toolmarks are, as the name implies, created when a harder tool working surface strikes, or comes into contact with, a softer surface with sufficient force to create an impression. Despite ongoing research efforts, there are currently no quantitative criteria for the identification of impressed toolmarks. All examiners currently use non-quantitative pattern matching, as discussed above, to identify impressed toolmarks.

Striated toolmarks are created by a sliding motion where a harder tool working surface, like the rifled bore of a firearm, makes contact with a softer material, like a fired bullet or plastic shotshell wad. Parallel lines, called striae, of varying width, are formed. Three-dimensional striae have depth, or contour, when viewed through the conventional comparison light microscope. Striae having no perceptible depth (contour) when viewed through the conventional comparison light microscope are described as being two-dimensional.

Striae have proven easier to quantitate than toolmark detail in impressed toolmarks. Because of this, after extensive empirical comparison of known-non-matching (KNM) toolmarks, a conservative quantitative criteria for the identification of both three and two-dimensional striated toolmarks was proposed by Biasotti and Murdock in 1997 (attachment 14, pages 708-709). This criteria is: *(1) In three-dimensional toolmarks when at least two different groups of at least three consecutive matching striae appear in the same relative* *position, or one group of six consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark; and (2) In two-dimensional toolmarks when at least two groups of at least five consecutive matching striae appear in the same relative position, or one group of eight consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark. For these criteria to apply, however, the possibility of subclass characteristics must be ruled out.*

This conservative identification criteria, known as quantitative consecutive matching striae (QCMS), has remained unchanged, and has not been proven wrong. It has been taught extensively both in the US and abroad (attachment 15 pages 1, 18 and 21 from John Murdock's CV describing classes given). Examiners that use QCMS in their case work first locate areas worthy of tabulation by using their pattern matching ability, and then tabulate runs of matching consecutive matching striae. When the amount tabulated exceeds the 1997 QCMS criteria, an identification is made, to the practical exclusion of other tools. Using QCMS, an examiner does not have to rely on what they can remember about the best KNM. The best KNM values for both three and two-dimensional toolmarks are known.

The 1997 QCMS criteria for the identification of striated toolmarks has been adopted by some forensic laboratories and incorporated into their policies and procedures (attachment 16, Contra Costa County Forensic Laboratory Policy #CE.04). Other laboratories include QCMS as one identification criteria option, in addition to the traditional pattern matching. Attachment 16 also illustrates how a laboratory can adopt the AFTE Range of Conclusions, the AFTE Theory of Identification, as well as comparing and contrasting Pattern-Matching and QCMS for the identification of toolmarks.

If an examiner applies the 1997 QCMS ID criteria, for three-dimensional striated toolmarks (because these toolmarks are clearly three-dimensional) to the striated toolmark agreement illustrated in the single photographic image included with the October 19, 2010 SWIFS "Case Summary Worksheet" (attachments 11 and 12), the extent of agreement clearly **does not meet** the three-dimensional QCMS identification criteria and therefore does not constitute an identification.

However, the toolmarks illustrated on the "Case Summary Worksheet" comparison between LIMS Item 2-1 and LIMS Item 2-4, dated 03/13/2012, are clearly three-dimensional and the amount of agreement **does meet** the three-dimensional QCMS identification criteria (attachment 17).

Using the 1997 QCMS identification criteria for striated toolmark identification removes some, but certainly not all, of the subjectivity from the evaluation/decision making process. While I am not suggesting that its use be made mandatory, I am suggesting that it be approved for use as an option, along with pattern matching.

<u>Part 4 – General Observations regarding Taking Photographs of Toolmark Comparisons</u>

It is very apparent that SWIFS firearms examiners take very few photographs of firearm related toolmark comparisons. An examination of SWIFS case note pages entitled "Microscopic Comparison Matrix: -1-, -2-, -3-, and -4-", covering the period 8/22/2011 to 3/13/2012, associated with the re-examination, shows that while there were 97 comparison results recorded, only one photograph was taken (attachment 18). This photograph is the one that appears on the "Case Summary Worksheet" dated 3-13-2012 (attachment 16). In addition, reference to these four pages of "microscopic comparison matrix" shows that there are no "microscope Magnification" entries for 96 of the comparisons. There is an entry (22X) for the one photograph taken. It is my opinion that the magnification should be recorded for every comparison in case any of them need to be redone during the verification or technical review processes, or by outside experts.

The identification of toolmarks produced both by firearm and other tools are made through visual observation. It is well-established that although visual data may be interpreted verbally (i.e. - sufficient individual firearm-produced agreement is present to establish an identification), when the arrangement of the data (i.e. - the extent to which striated toolmarks line up, or match) forms the basis of the interpretation, it should be recorded photographically (attachment 19, page 173). Sufficient photographs should be taken to record the visual basis for a toolmark identification. However, each identification, in a series of identifications of similar matching toolmarks, does not have to be photographed as long as at least one photographic series is representative of the others. It is sufficient for a representative photograph series to be used as an example of similar agreement in the other comparisons. However, when the matching agreement begins to differ, this calls for complete photographs clearly illustrating the basis for this different matching toolmark agreement.

In 2005, AFTE agreed upon standardization of comparison documentation (attachment 20). In this document, while AFTE acknowledged that photography is the preferred method of documentation, they stopped short of requiring it when they added "…narrative descriptions, sketches, diagrams, charts, worksheets, and other methods, or a combination of multiple methods may serve to satisfy the requirements of this standard".

While I agree that these non-photographic methods are very useful in forensic case work, none of them are as capable of recording the visual basis for firearm and toolmark identifications as photography. For this reason, I feel that photography should be mandatory. Today, it is a simple matter to take high-quality digital images of toolmark identifications. There is simply no good reason for not doing so. Contra Costa County Policies #CE.11 and CE.17 are examples of policies that mandate taking photographs in firearm (attachment 21) and toolmark cases (attachment 22)

If SWIFS decides to require that the basis for firearm and toolmark identifications be documented photographically, they could add "photographs" to Item 7 on their Peer/Technical Review Form (attachment 23)

<u>Part 5 – General Observations regarding the Numbering of Note Pages in Forensic Case Work</u>

I was surprised to see that while SWIFS requires the laboratory number and examiner's initials to be on each page of the case notes, they do not require that the note pages be numbered. Even though ASCLD-LAB does not require page numbering, there are compelling reasons why note pages in forensic case work should be numbered. **First**, it usually compels examiners to organize their case notes. **Second**, page numbers are very useful during: 1) pre-trial conferences; 2) review by opposing experts; 3) trial testimony; and 4) review by the Commission and their agents. **Third**, when notes are discovered by opposing counsel, note packages can be described as consisting of a certain number of pages, and council will be able to determine whether or not they have received the complete case note file. **Forth**, requiring examiners to number their case notes helps to prevent the unscrupulous addition of notes that might be added later to correct an error of some sort, or to correct deficiencies in the use of the scientific method which might have led to incorrect conclusions.

Once a set of case notes is numbered, and the total number of pages indicated on the first and last pages, it is a simple matter to legitimately add pages as necessary by editing the total number and describing what was added, when it was added, and why. If this is done after discovery, it is important to attempt to provide opposing council with the newly constituted case note file as soon as possible.

If SWIFS decides to require that case note pages be numbered, they could add "page numbers" to Item 6 on their Peer/Technical Review Form (attachment 23).

Part 6 – Responses to Questions Posed by the Committee

1. **Question**: Was the examiner's incorrect conclusion in the October 2010 report attributable to an error by the examiner? If so, was the error due to any professional negligence on the part of the examiner. *"Professional negligence" means the actor, through a material act or omission, negligently failed to follow the standard of practice generally accepted at the time of the forensic analysis that an ordinary forensic professional or entity would have exercised, and the negligent act or omission would substantially affect the integrity of the results of a forensic analysis. An act or omission was negligent if the actor should have been but was not aware of an accepted standard of practice required for a forensic analysis. See TFSC Policies and Procedures, Section 1.2.*

Response: Yes, it is my opinion that the incorrect conclusion, or misidentification, of the Taurus revolver, Item 69, as having been used to fire the three plastic wads collected at autopsy was an error that could have been prevented by selecting more appropriate ammunition for test firing.

It is common practice among firearm examiners to try to minimize variables when test firing for comparison purposes by selecting ammunition that is as close as possible to the questioned item(s) to be compared. In this case, it was clear that the wads from autopsy were the type used to contain lead shot. This was obvious from the lead shot removed from the body, and from the shot impressions in the plastic wads.

In spite of clear evidence of what should have been test-fired, no shotshells of this type were test-fired in 2010. Instead, various 45 Colt cartridges, one shotshell with double-ought buck pellets, and one shotshell containing a rifled slug were test-fired (see note page #26 in Murdock's case notes, attachment 13, for a photocopy of these test-firings).

Although it was correctly determined in 2010 that the three autopsy wads had been fired in the same firearm, thus demonstrating the reproducibility of the firearm-produced markings on the wads, no apparent determination of the reproducibility of the Taurus revolver, Item 69, was done. Instead, some similar markings on the one test-fired rifled slug were used as the basis for a positive identification with the autopsy wads.

Subsequent test-firing in 2011, using the correct plastic wads, demonstrated the reproducibility of the firearm-produced markings from the Taurus revolver, Item 69. But, although the three autopsy wads match each other, and the correct wads test-fired from the Item 69 Taurus revolver match each other, the two groups do not match each other, indicating clearly that the autopsy wads were not fired in the Item 69 Taurus revolver.

The correct test-firing and the determination of reproducibility should have both been done in 2010. To have not done so, in my opinion, constitutes professional negligence.

I also believe that an aura of negligence surrounds the "...cannot be confirmed" wording of the revised 2012 report. This leaves the impression that the Taurus revolver, Item 69, may still be the firearm used to fire the autopsy wads. I feel that there is ample evidence, from the additional case work done by SWIFS, to justify a conclusion that is stated in a more forthright way, such as: based on additional comprehensive testing, it is evident that the identification of the Taurus revolver, Item 69, with the autopsy wads, was in error.

2. **Question:** If the examiner's erroneous conclusion in the October 2010 report was not attributable to any professional negligence on the part of the examiner, please provide your opinion regarding the root cause of the error.

   Response: Although incorrect test-firing procedures, and failure to establish reproducibility, contributed to the misidentification, this was not the root cause of the misidentification. The misidentification was caused by attributing too much significance to a small amount of matching striae, as discussed above.

3. **Question:** If the root cause involves an element of subjective judgment (*i.e.*, two competent, trained examiners could have reached different conclusions), should the laboratory include standard language in its firearms reports describing subjective elements of the examination?

   Response: The root cause does indeed involve an element of subjective judgment. The primary examiner determined that there was sufficient individual, firearm-produced, agreement to establish an identification, and apparently took one photograph reported to be "representative" of the identification (attachments 11 and 12). The verifier, having been told by the primary examiner that an identification had been made, as described in the Summary of the Verification and Technical Review Process for 2010 Testing, 09P1160 (attachment 24), agreed with the primary examiner's subjective conclusion.

   The fact that the 2010 verification procedure set up the very real possibility of confirmational bias has been recognized by SWIFS, and they have now drafted a blind verification procedure as a part of their CAR. I think this is a major step in the right direction, and I give them a lot of credit for not having to be prompted to take it.

   The identification of firearms and toolmarks is one of the comparative forensic science specialties that require the subjective evaluation of objective data, in this case, striated and impressed toolmarks. Examiners achieve expertise in toolmark identification through: 1) extensive comparison of known-matching (KM) and known-non-matching (KNM) toolmarks; and 2) the study of manufacturing methods used to produce the working surfaces of tools. A firearm is simply a collection of tools. These KM and KNM comparisons are done until the examiner, as noted Criminalist John Thornton once put it, "*...begins to forge a notion of uniqueness in the smithy of his (or her) own consciousness. The process is subjective in the sense that each examiner must make up his or her own mind, but criteria for identification of bullets do exist as the projection of a gestalt of past experience*" (attachment 25, page 18).

   Because toolmark identifications are subjective determinations of objective data, it is very important for the examiner to record thorough case notes so as Lattrucci put it *"In determining which kinds and amounts of data should be included in a study, the scientist bears in mind the basic fact that scientific research demands exactness and clarity; and thus he includes in his presentation all those elements which a competent student of the subject might require in order to be able to understand and possibly criticize both the methods and the conclusions"*. (attachment 19, page 175)

Thorough case notes include a series of photographs recording the basis for toolmark identifications, not just a photograph or two of a "representative" area. However, it is permissible, in a series of similarly marked questioned items, like fired cartridge cases, to completely record the basis for a representative sample in the series, and then simply refer to this one series of photographs as being the basis for the rest of the identifications. Another element of thoroughness is the inclusion of the examiner's criteria for identification. For example, did the examiner use traditional pattern-matching or was QCMS used.

Assuming that case notes are produced in the manner described above, I do not feel that there is a need to include a statement in every report drawing attention to the subjective nature of the toolmark identification decision making process. I am, however, not opposed to including one. Such a statement could be crafted much like the preceding several paragraphs above.

I do think that a standard statement of a different sort should be included when toolmark identifications are made. I have included such a statement as part of my response to question 4.

4. **Question:** If so, what are best practices in the discipline regarding this type of "disclaimer" or "qualifying" language?

   Response: It is my opinion that the following statement should be included in every laboratory report of a firearm or toolmark identification under the heading of "Strength of Associations made in the Identification of Firearm and Non-Firearm Produced Toolmarks":
   The identification of toolmarks is made to the practical, not absolute, exclusion of all other tools. This is because it is not possible to examine all firearms or tools in the world, a prerequisite for absolute certainty. The conclusion that sufficient agreement for identification exists between two toolmarks means that the likelihood another firearm or tool could have made the questioned mark is so remote as to be considered a practical impossibility. This statement makes it very clear that firearm and toolmark identifications are not absolute.

   When asked to define practical impossibility, I believe that the following response is appropriate:
   The phrase "practical impossibility", which currently cannot be expressed in mathematical terms, describes an event that has an extremely small probability of occurring in theory, but which empirical testing and experience has shown will not occur. In the context of firearm and toolmark identification, "practical impossibility" means that based on: 1) extensive empirical research and validation studies; and 2) the cumulative results of training and casework examinations that have either been performed, peer reviewed, or published in peer-reviewed forensic journals, no firearms or tools other than those identified in any particular case will be found that produce marks exhibiting sufficient agreement for identification. AFTE thought enough of this definition to include it in their 2013 6th edition Glossary (attachment 26, page 86).

5. **Question:** Are there any other recommendations for SWIFS laboratory policies and procedures you would suggest to minimize the likelihood of this type of error in the future? Should these recommendations be extended to all laboratories in Texas?

   Response: A. Emphasize the need to select ammunition for test-firing that is as close to the physical properties of the questioned items as possible. This may require using some of the unfired evidence ammunition submitted with the case, if it is available. This should be done with the permission of the client, and only if the evidence ammunition is not needed for other purposes, such as the comparison of "action marks" and/or a muzzle-to-target distance determination.

B. Require all forensic laboratories in Texas to develop a procedure for blind verification of toolmark identifications, with some inconclusives and eliminations included as well. Dr. Itiel Dror addresses the need for blind verification in his paper "Practical Solutions to Cognitive and Human Factor Challenges in Forensic Science" (attachment 27).

C. Require all forensic laboratories in Texas to have examiners include their criteria for the identification of toolmarks in their case notes.

D. Require all forensic laboratories in Texas to number the pages of their case notes.

E. Require all forensic laboratories in Texas to illustrate the basis for firearm and toolmark identifications with photographs.

F. Require all forensic laboratories in Texas to include a "Strength of Associations" statement that clearly indicates these identifications are made to a practical, not absolute, certainty, and that they consider defining practical certainty in the manner described in the latest AFTE Glossary (attachment 26).

End of Report

PCF 14-2 - attachment #1 rec'd 11/13/14 p. 1/2

SCOPE OF WORK FOR DISCUSSION WITH JOHN MURDOCK, FIREARM/TOOLMARK EXPERT

SWIFS Complaint by Atty. Frank Blazek (Chair: Dr. Vincent Di Maio)

Summary of Key Facts:

On October 19, 2010, a SWIFS firearms examiner released a report concluding that fired plastic combination shotshell wads and lead pellets submitted from autopsy were fired by a certain Taurus "Judge" revolver which the State believed was the murder weapon at that time. Subsequent factual developments in the case revealed that the State's initial theory was incorrect. The parties in the case (both the State and defense counsel) eventually learned the murder weapon was a different Taurus "Judge" revolver than the one initially identified in the October 2010 report.

After re-testing, the same SWIFS examiner changed her report conclusion. On September 5, 2012, her revised report contained the following conclusion:

> "Based on new analyses using previously submitted items of evidence and microscopic comparisons with newly produced test standards, the original reported conclusion identifying the wads recovered from autopsy . . . as having been fired by the item 003-001 revolver ***cannot be confirmed***. Additionally, there were no subclass carryover toolmarks observed among the newly purchased firearms." [emphasis added]

Questions for Mr. Murdock:

1. Was the examiner's incorrect conclusion in the October 2010 report attributable to an error by the examiner? If so, was the error due to any professional negligence[1] on the part of the examiner?

2. If the examiner's erroneous conclusion in the October 2010 report was not attributable to any professional negligence on the part of the examiner, please provide your opinion regarding the root cause of the error.

3. If the root cause involves an element of subjective judgment (*i.e.,* two competent, trained examiners could have reached different conclusions), should the laboratory include standard language in its firearms reports describing subjective elements of the examination?

4. If so, what are best practices in the discipline regarding this type of "disclaimer" or "qualifying" language?

---

[1] "Professional Negligence" means the actor, through a material act or omission, negligently failed to follow the standard of practice generally accepted at the time of the forensic analysis that an ordinary forensic professional or entity would have exercised, and the negligent act or omission would substantially affect the integrity of the results of a forensic analysis. An act or omission was negligent if the actor should have been but was not aware of an accepted standard of practice required for a forensic analysis. *See* TFSC Policies and Procedures, Section 1.2.

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11-13-14
p. 2/2.

5. Are there any other recommendations for SWIFS laboratory policies and procedures you would suggest to minimize the likelihood of this type of error in the future? Should these recommendations be extended to all laboratories in Texas?

CAR: Misidentification in 09P01160

Description of Corrective Action Plan

Cause analysis

A review of the case file documentation for the firearms report dated 11/4/2010 identified no definitive cause for the apparent misidentification in 09P01160. Laboratory procedures were followed in the analysis. The identification of the autopsy wads to the submitted firearm based upon comparison of the wads to test fired slugs was confirmed by a verifying second examiner. The verifier observed the similarities in striations between evidence wads and test fires, and agreed with the primary examiner that those similarities were sufficient to indicate identification.

The current process used by the laboratory requires verification of identifications by a second examiner (the verifier). However, it does not require that the verifications be performed in a blind fashion. At the time that the verifier is asked to perform a verification he knows that the primary analyst has already reached a conclusion of identification. The verification is therefore performed to determine if the verifier agrees that the markings are sufficient to support the conclusion of identification. The verification is not performed to reach an independent finding of identification.

Although the cause of the apparent misidentification in the 2010 analysis is not obvious, the overall process would be strengthened by performing verifications in a blind manner. Performing verifications in a blind manner where the verifier is unaware of the findings of the primary analyst would reduce the possibility of confirmation bias on the part of the verifier. In this way, any final conclusion of identification would reflect the agreed upon conclusion of two independent evaluations of the evidence.

Corrective Action Plan

A process has been developed to perform blind verifications. In order to achieve blind verifications of identifications, the verification process would also need to include the verification of some eliminations and inconclusives. The process that has been developed utilizes a spreadsheet workbook to randomly select comparisons performed by the primary analyst for verification by the verifier. The selection of comparisons for verification is based upon a matrix of probabilities (see Table 1) in which the probability of selecting a comparison for verification depends upon the type of comparison performed (i.e., test fire-to-test fire, test fire-to-questioned, questioned-to-questioned) and the finding of the primary analyst (i.e., identification, elimination, inconclusive).

Table 1. Mock example of a probability matrix for selecting comparisons for verification. Abbreviations, TF, test fire; Q, questioned.

	Primary Analyst's Finding		
Comparison Types	Inconclusive	Identification	Elimination
TF-to-TF	0%	50%	100%
TF-to-Q	50%	100%	100%
Q-to-Q	50%	100%	100%

In this process, the primary analyst would perform analysis using the standard casework procedure, and would document in the workbook the items examined, the comparisons performed, and the results of those comparisons. Based upon the matrix of probabilities, two work lists would be generated for the verifier: 1) a work list of required verifications; and 2) a work list of optional verifications. The verification work lists would not indicate the conclusions of the primary analyst, so the verifier would not know at the time of verification whether he was verifying a finding of identification, elimination, or inconclusive. Following completion of the required verifications, the verifier would have the option of verifying any other comparisons done by the primary analyst. Mock examples of the primary analyst's comparison summary (Table 2), and the planned verifier's work lists (Table 3 and Table 4) are attached.

Following completion of required and optional verifications, any discrepancies between the findings of the primary analyst and the verifier would be resolved through additional work, with the scope of work being determined by the primary analyst and verifier.

Status of Corrective Action

Because of the pending status of the complaint by the TFSC, implementation of this planned corrective action is on-hold until the laboratory receives feedback from the complaint review process. The TFSC complaint review may identify different or additional causes for the misidentification that may require significant modification of this corrective action.

Microscopic Comparison Summary Sheet - Firearms Analysis

Case#: IFS-12-12345

Request #: 008

	Item A			Item B			Comparison	
Batch #	Batch ID	Description	Item Type	Batch ID	Description	Item Type	Comaprison Type	Result
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item 1	TF-P	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	TF-to-TF	ID
2	(1)IFS-12-12345 #1-1	Test fired bullet from Item 1	TF-P	(3)IFS-12-12345 #1-3	Test fired bullet from Item 1	TF-P	TF-to-TF	ID
3	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	Q-to-Q	ID
4	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(6)IFS-12-12345 #4	Autopsy bullet	Q-P	Q-to-Q	ID
5	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	TF-to-Q	ID
6	(7)IFS-12-12345 #5	Bullet from scene	Q-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	Q-to-Q	ELIM
7	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(7)IFS-12-12345 #5	Bullet from scene	Q-P	TF-to-Q	ELIM
8	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	TF-to-Q	ELIM

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Table 3. Mock example of required verification work list. Abbreviations: TF, test fire; Q, questioned; P, projectile.

Required Verification Worklist - Firearms Microscopic Comparisons

Case#: IFS-12-12345

Request #: 8

	Item A			Item B			Comparison					
Batch #	Batch Item ID	Description	Item Type	Batch Item ID	Description	Item Type	Type	INC	ID	ELIM	Notes	Initials
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item	TF-P	(3)IFS-12-12345 #1-3	Test fired bullet from Item	TF-P	TF-to-TF					
2	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	Q-to-Q					
3	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(6)IFS-12-12345 #4	Autopsy bullet	Q-P	Q-to-Q					
4	(2)IFS-12-12345 #1-2	Test fired bullet from Item	TF-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	TF-to-Q					
5	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	TF-to-Q					

Table 4. Mock example of optional verification worklist. Abbreviations: TF, test fire; Q, questioned; P, projectile.

Optional Microscopic Verification Worklist - Firearms

Case #: IFS-12-12345

Request #: 8

Batch #	Item A			Item B			Comparison					Initials
	Batch Item ID	Description	Item Type	Batch Item ID	Description	Item Type	Type	INC	ID	ELIM	Notes	
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item	TF-P	(2)IFS-12-12345 #1-2	Test fired bullet from Item	TF-P	TF-to-TF					
2	(7)IFS-12-12345 #5	Bullet from scene	Q-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	Q-to-Q					
3	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(7)IFS-12-12345 #5	Bullet from scene	Q-P	TF-to-Q					

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John Murdock - FW: Follow-up from Firearms Expert (John Murdock) for Taurus ID case

6.

From: Lynn Garcia <lynn.garcia@fsc.texas.gov>
To: John Murdock <jmurdock@so.cccounty.us>
Date: 6/23/2015 11:56 AM
Subject: FW: Follow-up from Firearms Expert (John Murdock) for Taurus ID case
Attachments: CAR Plan - 09P01160.pdf

Here you go.

Lynn Robitaille Garcia
General Counsel
Texas Forensic Science Commission
1700 North Congress, Suite 445
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(512) 936-0649 (direct)
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From: Timothy Sliter <Timothy.Sliter@dallascounty.org>
Date: Tuesday, June 23, 2015 at 1:51 PM
To: Lynn Robitaille Garcia <lynn.garcia@fsc.texas.gov>
Subject: RE: Follow-up from Firearms Expert (John Murdock) for Taurus ID case

Ms. Garcia,

I have attached a summary of where we stand in regard to our corrective action planning. Implementation is awaiting finalization of the TFSC review, so that we can factor in any suggestions from John Murdock and the Commission.

If you need any additional information, please let me know.

Timothy J. Sliter, Ph.D.
Section Chief - Physical Evidence
Dallas County Southwestern Institute of Forensic Sciences
Dallas, Texas
Ph. 214-920-5980
timothy.sliter@dallascounty.org

From: Lynn Garcia [mailto:lynn.garcia@fsc.texas.gov]
Sent: Friday, June 19, 2015 4:33 PM

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To: Timothy Sliter
Subject: FW: Follow-up from Firearms Expert (John Murdock) for Taurus ID case

Dr. Sliter,

John Murdock is finishing his report and asked to me to check in with you regarding the item listed at #5 in the email below. If there is any information you would like to provide for his consideration in response to #5 (such as a CAR or any amendments to SOPs, etc.) please forward to me.

Thanks,
Lynn

From: Lynn Garcia [mailto:lynn.garcia@fsc.texas.gov]
Sent: Wednesday, November 12, 2014 3:42 PM
To: Timothy Sliter
Subject: Follow-up from Firearms Expert (John Murdock)

Dr. Sliter,

The Commission is contracting with firearms/toolmarks expert John Murdock to review the SWIFS firearms case that was the subject of the complaint filed by Mr. Blazek. He has requested some information to assist with his review:

1. Complete case file including all case notes and photographs
2. Laboratory procedures describing the identification process (i.e., criteria for identification to the extent it is set forth in the laboratory's procedures)
3. Laboratory procedures/protocols for tech and admin review in the firearms discipline
4. A description of the technical review process (i.e., the scope and extent of review) used in the particular case under review
5. A description of any initiatives the section is working on to improve its processes going forward (you had mentioned this was underway at the meeting in Fort Worth)

Would you kindly let me know if you are able to provide this material to us for review?

Thank you,
Lynn Robitaille Garcia
General Counsel
Texas Forensic Science Commission
1700 North Congress, Suite 445
Austin, Texas 78701
(512) 936-0649 (direct)
(512) 936-7986 (fax)

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SOUTHWESTERN
INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

Firearm & Toolmark Unit

5230 Medical Center Drive
Dallas, Texas 75235

FILED NOV 04 2010

October 19, 2010

Investigating Agency:	Det. Travis Higginbotham Grimes County District Attorney P.O. Box 599 Anderson, Texas 77830	**Laboratory #:**	09P1160
		Agency #:	09-0717-01DA
		DCME #:	2324-09
		Complainant:	Don Stolz
		Offense:	Homicide

EVIDENCE:

Submitted by J. Barnard, M.D. on July 20, 2009:

3(1 – 12). One fired plastic combination shotshell wad and eleven lead pellets
4(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
5(1 – 11). Eleven lead pellets
6(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
7(1 – 13). Thirteen lead pellets

Submitted by T. Higginbotham via FedEx# 257685100000523 on February 9, 2010:

69. One Taurus 45 Colt caliber / 410 "gaugc" revolver, model The Judge, serial number BX715042
70 – 72. Three unfired 410 Winchester brand shotshells
73 – 74. Two unfired 45 Colt caliber Hornady brand shotshells

RESULTS:

The item 69 revolver is a mechanically functional firearm as received in the laboratory. It has conventional style rifling consisting of six lands and grooves with a right twist. The trigger pull forcc was measured to be approximately 4 to 5 pounds in single action and 10 to 11 pounds in double action. Item 69 was test fired using ammunition selected from laboratory stock. The test shots were labeled as items 69TF1 through 69TF6.

Items 3(1), 4(1), and 6(1) are three fired plastic shotshell combination wads. They were compared microscopically to each other and to item 69 test shots. Items 3(1), 4(1), and 6(1) were all identified as having been fired by the item 69 Taurus revolver.

Examiner's Initials HT

Items 3(2 – 12), 4(2 – 11), 5(1 – 11), 6(2 – 11) and 7(1 – 13) are lead pellets that are consistent with No. 6 shot. These items are not suitable for comparative examinations.

Item 70 is an unfired 2 ½ inch shotshell loaded with buck shot of undetermined size. Items 71 and 72 are unfired 2 ½ inch shotshells loaded with "bird" shot of undetermined size. Items 70 through 72 are suitable for firing in the item 69 revolver but were not used for test firing purposes.

Items 73 and 74 are unfired cartridges. These items are suitable for firing in the item 69 revolver but were not used for test firing purposes.

DISPOSITION OF EVIDENCE:

The listed item(s) of evidence and any test standards will be released to the investigating agency.

Heather Thomas

Heather R. Thomas
Firearm and Toolmark Examiner
Direct Line: 214-920-5895
E-mail: hthomas@dallascounty.org

cc: DCME# 2324-09 (JJB)

3.

CASE SUMMARY WORKSHEET

Case # 09P1160

Case Start Date: 05/07/2010

Case Completion Date: 10/19/2010

Examinations Requested:

- Analyze
- Firearm comparison

Conclusions:

- Item 69 revolver is a mechanically functional firearm; tfcc entered into NIBIN with no associations made
- Items 3(1), 4(1), and 6(1) are fired 410 shotshell wads; ID to each other and to item 69 revolver
- Items 3(2-12), 4(2-11), 5(1-11), 6(2-11), and 7(1-13) are lead pellets c/w with No. 6 shot; not suitable for microscopic comparisons
- Items 70 through 74 are all suitable for firing in the item 69 revolver, but were not used

Comparisons Verified By: RC N/A

Photos of Representative Identifications Made: N/A

Ex. 4(1) to Ex. 69TF3
(red phase)

Examiner's Initials/Date: HT October 19, 2010

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![County of Dallas seal]

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INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

2355 North Stemmons Freeway
Dallas, Texas 75207

Telephone: 214-920-5900
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Report Date:	September 05, 2012
Laboratory #:	09P01160-0011
Agency #:	09-0717-01DA - Grimes County District Attorney
Requested by:	Grimes District Attorney Grimes County District Attorney P.O. Box 599 Anderson, TX 77830-0599
Offense:	Homicide
Complainant(s):	Don Stolz

Evidence Submitted:

The following evidence was received by the laboratory from Grimes County District Attorney:

002-001: One fired plastic wad and eleven lead pellets recovered from autopsy - Legacy item 3(1-12)
002-002: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 4(1 - 11)
002-003: Eleven lead pellets consistent recovered from autopsy - Legacy item 5(1 - 11)
002-004: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 6(1 - 11)
002-005: Thirteen lead pellets consistent recovered from autposy - Legacy item 7(1 - 13)
003-001: Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite, serial number BX715042 - Legacy item 69
003-002: Test standards - Legacy items 69TF1 through 69TF6
003-003-001: One unfired Winchester brand 410 shotshell loaded with buckshot - Legacy item 70
003-003-002: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 71
003-003-003: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 72
003-004: Two unfired Hornady brand 45 Colt caliber cartridges - Legacy items 73 and 74
003-005: One disassembled reference 410 shotshell
004-001-001: Twelve unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-002: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-003: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-004: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-005: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
005-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275155
006-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275141
007-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275138

Description of Analysis:

This is a supplemental report addressing additional examinations performed using previously submitted items and newly submitted items.

PREVIOUS ANALYSIS

The item 003-001 revolver (Legacy item 69) was received by the laboratory in 2010 for mechanical evaluation testing and for comparison to items recovered during autopsy. In 2010, the item 003-001 revolver (Legacy item 69) was test fired using ammunition chosen from laboratory stock based on projectile type and availability.

A total of six test standards were fired during the 2010 examination and labeled as items 69TF1 through 69TF6,

(item 003-002). During the 2010 examination, the item 69TF3 rifled slug (originally, a Federal brand 410 shotshell containing a rifled slug and plastic wad) was determined to be the best representation of the barrel. As such, it was chosen as the test standard for comparative examinations with the fired plastic wads recovered from autopsy [Legacy items 3(1), 4(1), and 6(1)]. Based on those comparisons, the wads from autopsy were determined to have been fired by item the 003-001 revolver (Legacy item 69).

NEW ANALYSIS

A request was made by Travis Higginbotham, Grimes County District Attorney's Office, for the reanalysis of item 003-001 revolver (Legacy item 69) for comparison to the autopsy wads using ammunition provided by the District Attorney's Office. The ammunition was obtained from the owner of the item 003-001 revolver (Legacy item 69).

Additionally, Mr. Higginbotham requested analysis to determine if identification of the three autopsy wads to the item 003-001 revolver (Legacy item 69) was based on individual characteristics or subclass characteristics of this particular model of Taurus revolvers. Therefore, the District Attorney's Office submitted three newly purchased Taurus revolvers of a similar model to the item 003-001 revolver (Legacy item 69).

Results & Conclusions:

REANALYSIS OF ITEM 003-001 REVOLVER (LEGACY ITEM 69)

The item 003-001 revolver (Legacy item 69) was re-evaluated and determined to be functional as received in the laboratory. The trigger pull force was measured to be approximately 4.373 to 5.474 pounds in single action and 9.823 to 10.661 pounds in double action. These values are consistent with trigger pull values obtained during the previously reported testing period.

The item 003-001 revolver (Legacy item 69) was test fired a total of thirteen times using a combination of submitted and laboratory stock ammunition for test standards. Items 003-003-002 (Legacy item 71) and 003-003-003 (Legacy item 72) were used to create test standards 003-001 TF1 and 003-001 TF2, respectively. Item 004-001-002 includes two shotshells used to create test standards 003-001 TF3 and 003-001 TF4. The ammunition chosen from laboratory stock includes nine Winchester brand 410 shotshells used to create test standards 003-001 TF5 through 003-001 TF13. Each of the shotshells contained a plastic wad in addition to either lead shot or a rifled slug. All of the test standard wads were recovered except the wad from 003-001 TF3 which was lost in the range's backstop media. Test standard slugs from items 003-001 TF12 and 003-001 TF13 were recovered.

The recovered test standard wads and slugs were microscopically compared to each other for the purpose of determining whether the rifling toolmarks in the barrel of item 003-001 revolver (Legacy item 69) were reproducing adequately for identification purposes. The test standard wad 003-001 TF6 could not be identified or eliminated to any of the other test standards listed; however, all of the other test standards were identified to each other, thereby adequately establishing reproducibility of the rifling toolmarks within the barrel of the item 003-001 revolver (Legacy item 69).

To verify that the original test standard chosen as the best representation of the barrel in 2010 still displayed the now-established reproducibility of the rifling toolmarks within the barrel, item 003-002 (Legacy item 69TF3 rifled slug) was microscopically compared to test standard wads 003-001 TF1, 003-001 TF2, 003-001 TF4 through 003-001 TF13 and to test standard slugs 003-001 TF12 and 003-001 TF13. Item 003-002 (Legacy item 69TF3 test standard slug) could not be identified or eliminated to any of the newly produced test standards. One possible explanation for the inability to identify the previously produced test standard (item 003-002 - Legacy item 69TF3) to the newly produced test standards is that there could have been a slight change in the microscopic characteristics within the barrel due to (1) the cleaning of the barrel; (2) multiple firings of the firearm during the

initial examination; and/or (3) multiple firings of the firearm during the most recent examination.

The fired plastic wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) were microscopically compared test standard wads 003-001 TF1, 003-001 TF2, and 003-001 TF4 through 003-001 TF11. While there are areas of similarity, the correspondence of the individual characteristics between the wads recovered from autopsy and the test standards is not sufficient to identify or eliminate the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) as having been fired by the item 003-001 revolver (Legacy item 69).

The original reported conclusion identifying the wads recovered from autopsy to the item 003-001 revolver (Legacy item 69) cannot be confirmed. However, the previously reported conclusion identifying the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) to each other was confirmed with the caveat that the specific firearm from which they were fired is not known.

The wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) are consistent with having been fired by a 45 caliber/.410 bore firearm having a conventional styling rifling configuration consisting of six lands and grooves. The direction of twist and the measurements of the rifling impressions on the autopsy wads could not be determined.

As previously reported, the lead shot in items 002-001 (Legacy item 3(2 - 12)), 002-002 (Legacy item 4(2 - 11)), 002-003 (Legacy item 5(1 - 11)), 002-004 (Legacy item 6(2 - 11)), and 002-005 (Legacy item 7(1 - 13)) are consistent with No. 6 shot size.

INDIVIDUAL vs SUBCLASS CHARACTERISTICS ANALYSIS

Inasmuch as the Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite is no longer produced, three Taurus 45 Colt/.410 bore revolvers, model The Judge (item 005-001, item 006-001, and item 007-001) were submitted to the laboratory to determine if Taurus revolvers produced subclass characteristics.

Items 005-001 revolver , 006-001 revolver, and 007-001 revolver are mechanically functional firearms as received in the laboratory. They are designed to fire a 45 Colt caliber cartridge or a 2 1/2 inch 410 shotshell. The barrels of each of these firearms have a conventional style rifling configuration consisting of six lands and grooves with a right twist. The trigger pull force for item 005-001 was measured to be approximately 4.102 to 4.545 pounds in single action and 11.114 to 13.195 pounds in double action. The trigger pull force for item 006-001 was measured to be approximately 5.487 to 5.681 pounds in single action and 10.369 to 10.646 pounds in double action. The trigger pull force for item 007-001 was measured to be approximately 4.418 to 6.420 pounds in single action and 10.595 to 11.983 pounds in double action.

Silicone casts of the interior portion of the barrels of items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) were made for the purposes of identifying the presence of microscopic carryover toolmarks from one barrel to the next. The silicone casts were compared microscopically to each other but subclass carryover toolmarks were not viewed on the casts.

Items 005-001 (revolver) and 007-001 (revolver) were each test fired eight times and the item 006-001 (revolver) was test fired seven times, all using a combination of submitted and laboratory stock ammunition. Submitted ammunition in items 004-001-005, 004-001-004, and 004-001-003 were used to create test standards 005-001 TF1 through 005-001 TF3, 006-001 TF1 and 006-001 TF2, and 007-001 TF1 through 007-001 TF3, respectively. The ammunition chosen from laboratory stock included fourteen Winchester brand 410 shotshells loaded with No. 6 shot that were used to create test standards 005-001 TF4 through 005-001 TF8, 006-001 TF3 through 006-001 TF7, and 007-001 TF4 through 007-001 TF8.

Each of the shotshells used for test standards by the items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) contained a plastic wad. All of the test standard wads were recovered except the wad from 005-001 TF1, 005-001 TF2 and 007-001 TF1, which were lost in the range's back stop media. None of the shot from the test standards were recovered as the firearms were fired into the range's backstop media.

The test standards and silicone casts of the items were microscopically compared. While a few similar toolmarks were noted, these toolmarks were not considered to be characteristic of subclass toolmarks, or marks that were carried over among the barrels of the items 005-001, 006-001, and 007-001 Taurus revolvers.

Conclusions:

Based on new analyses using previously submitted and newly submitted items of evidence and microscopic comparisons with newly produced test standards, the original reported conclusion identifying the wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) as having been fired by the item 003-001 revolver cannot be confirmed. Additionally, there were no subclass carryover toolmarks observed among the newly purchased firearms.

Disposition of Evidence:

The listed items of evidence and all recovered test standards will be returned to the investigation agency.

In the event that additional analysis is required, please contact the laboratory.

Heather Thomas
Firearms Examiner
Phone: 214-920-5895
Email: Heather.Thomas@dallascounty.org

PROJECTILE WORKSHEET

Case # 09P1160
Item # 3

Container
Outer: (Sealed) Unsealed (Envelope) Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container
Inner: Sealed Unsealed Envelope Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container (N/A) Other ______

Trace Evidence: None Glass Wood Plaster Paint ______ (Biologicals) Fibers Other ______

Description: Bullet Bullet Fragment Bullet Jacket Bullet Jacket Fragment Pb Core Pb Fragment Metal Fragment Rifled Slug
(Shot) Size see below Buck Shot Size ______ (Wad) plastic Other ______ Undetermined

Condition: Whole Flattened (Deformed) (Damaged) Mushroomed Fragmented **Total Pieces:** 12 Jacket — Lead 11 Wad 1

Description of condition: See Photo Below (Caliber/Gauge): 3(1) .410 (12 to gun) N/A Undetermined **Weight:** 3(2→12) ≈ 21.1 total Grains 05/11/2010

Number of Cannelures: ___ (N/A) **Style:** Knurled Plain Crimp (N/A)

Type: 3(2→12) FMJ TMJ SJ Jacketed Steel Al Brass (Pb) → not magnetic **Plated/Coated:** Cu Brass 3(1) (Wad) —— Undetermined N/A

Style: RN FN HP SP SWC WC TRUNC 3(2→12) (SHOT) UNK N/A **Base:** Closed Open Flat Concave Convex Undetermined (N/A)

Brand: undetermined **Bent:** Y (N) **Cleaned:** 3(1→12) (Y) N

Class Characteristics: 3(1) GR Undetermined 3(2→12) (N/A) **Parts of how Many Visible:** 4 N/A **Determined by:** Count Estimation Calculation 10% bleach solution (Comparison) N/A

Measurements: (L.S) conventional not measured not suitable N/A (G.S.) not measured N/A **Possible Firearms:** See Printout (N/A)

How Marked by Examiner: case No, item No, initials **Where:** Ogive Base Lead (Other) new inner packaging (#5) *

Other ID Marks: (None) ______ **Where:** Ogive Base Lead Other: ______

Results: 3(1) (ID) Elim N/N 3(2→12) (No Value) N/A Not suitable **To Which Item(s)?:** Ex 4(1), 6(1), Ex 69 revolver **Phase Color:** red orange

Bullet ID Made Using: (L.S. G.S.) N/A **Location:** (Base Middle) Nose N/A **Item#** 69 TF3 **Used as Standard** N/A

3(1) d ≈ .424 inches
3(1) = wad → combination wad/shot cup plastic, clear
3(2→12) = pellets

one for 3(1) and one for 3(2→12)

no visible suitable toolmarks (rifling) on items 3(2→12) for comparison

Ex. 3(2→12)
Total wt. ≈ 21.1 grains
wt of one pellet ≈ 1.9 grains
d ≈ .104 inches (most spherical pellet) ⟩ Ex 3(2→12) are c/w No. 6 (see table copy)
+ comparison w/ known winchester brand No. 6 size lead shot unfired shotshell

The known eleven unfired No. 6 shot wt. ≈ 21.5 grains ∴ 1 ≈ 1.95 grains d ≈ .111 inches

Revised 7/14/2004

Examiner's Initials/Date HT May 10, 2010

PROJECTILE WORKSHEET

Case # 09P1160
Item # 4

Container
Outer: (Sealed) Unsealed (Envelope) Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container

Inner: Sealed Unsealed Envelope Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container (N/A) Other

Trace Evidence: None Glass Wood Plaster Paint (Biologicals) Fibers Other

Description: Bullet Bullet Fragment Bullet Jacket Bullet Jacket Fragment Pb Core Pb Fragment Metal Fragment Rifled Slug

(Shot) Size ___ Buck Shot Size ___ (Wad) plastic combo Other ___ Undetermined

Condition: Whole Flattened (Deformed) (Damaged) Mushroomed Fragmented **Total Pieces:** * 11 Jacket – Lead 10 Wad 1

Description of condition: See Photo Below (Caliber/Gauge): .410 4(1) (ID to gun) Undetermined **Weight:** ~~4(2→11)~~ 4(2→10) ≈ 17.3 total Grains (05/12/2010)

Number of Cannelures: – (N/A) **Style:** Knurled Plain Crimp (N/A)

Type: FMJ TMJ SJ Jacketed Steel Al Brass (Pb) 4(2→11) not magnetic **Plated/Coated:** Cu Brass (Wad) 4(1) Undetermined N/A

Style: RN FN HP SP SWC WC TRUNC (SHOT) 4(2→11) UNK N/A **Base:** Closed Open Flat Concave Convex Undetermined (N/A)

Brand: undetermined **Bent:** Y (N) **Cleaned:** (Y) 4(2→11) N

Class Characteristics: 4(1) 6R conventional Undetermined (N/A) 4(2→11) **Parts of how Many Visible:** 4 N/A **Determined by:** Count Estimation Calculation (Comparison) 10% bleach solution N/A

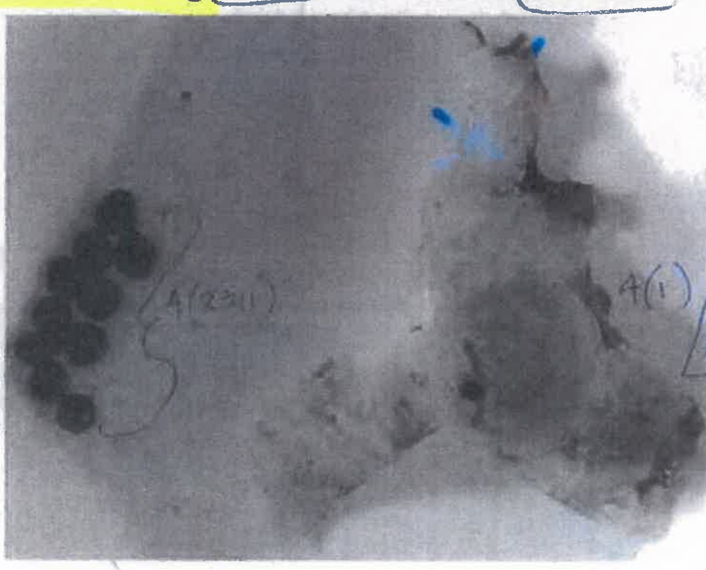
Measurements: (L.S) not measured N/A (G.S.) not measured N/A **Possible Firearms:** See Printout (N/A)

How Marked by Examiner: Case No, item No, initials **Where:** Ogive Base Lead (Other:) new inner packaging (s) *

Other ID Marks: (None) **Where:** Ogive Base Lead Other:

Results: (ID) 4(1) Elim N/N (No Value) ~~4(2→11)~~ 4(2→11) Not suitable N/A **To Which Item(s)?:** 3(1), 6(1), → Ex. 69 revolver **Phase Color:** red

Bullet ID Made Using: (L.S. G.S.) N/A **Location:** (Base Middle) Nose N/A **Item#** 69TF3 **Used as Standard** N/A



* one for 4(1) and one for 4(2→11) **

no visible suitable tool-marks (rifling) on 4(2→11) for comparison

EA(1) id ≈ .425 inches

* 4(2→11)

during cleaning, one pellet was ~~separated from~~ ... class characteristics, results, other calculation exams ... 4(2→11) will be based on 4(2→10), including wt. total, and shot size determination

EA(2→11) c/w No. 6 shot

** 4(11) found 05/11/2010. Not weighed. ~~counted in shot size determination~~

avg. wt of (1) pellet ≈ 1.73 grains d ≈ .113 in most spherical pellet (see table)

Revised 7/14/2004

Examiner's Initials/Date May 10, 2010

3,

PROJECTILE WORKSHEET

Case # 09P1160
Item # 6

Container
Outer: Sealed Unsealed Envelope Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container

Inner: Sealed Unsealed Envelope Plastic bag Paper bag Box Zip Lock Bag Glass Vial Film Container N/A Other

Trace Evidence: None Glass Wood Plaster Paint Biologicals Fibers Other

Description: Bullet Bullet Fragment Bullet Jacket Bullet Jacket Fragment Pb Core Pb Fragment Metal Fragment Rifled Slug
Shot Size Buck Shot Size Wad plastic Other Undetermined

Condition: Whole Flattened Deformed Damaged Mushroomed Fragmented **Total Pieces:** 11 Jacket — Lead 10 Wad 1

Description of condition: See Photo Below **Caliber/Gauge:** 6(1) .410 (ID to gun) Undetermined **Weight:** 6(2→11) 18.7 total Grains 05/13/2010 HGT

Number of Cannelures: — N/A **Style:** Knurled Plain Crimp N/A

Type: FMJ TMJ SJ Jacketed Steel Al Brass Pb 6(2→11) nonmagnetic **Plated/Coated:** Cu Brass 6(1) Wad Undetermined N/A

Style: RN FN HP SP SWC WC TRUNC 6(2→11) SHOT UNK N/A **Base:** Closed Open Flat Concave Convex Undetermined N/A

Brand: undetermined **Bent:** Y N **Cleaned:** 6(1→11) Y N 10% bleach solution

Class Characteristi[...]le: 4 N/A **Determined by:** Count Estimation Calculation Comparison N/A

Measurements: (L.[...] (G.S.) not measured N/A **Possible Firearms:** See Printout N/A

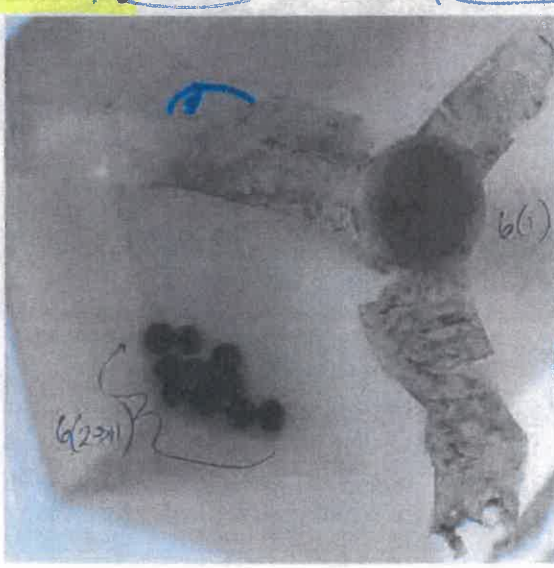
How Marked by Ex[...] **Where:** Ogive Base Lead Other: new inner packaging (x2)

Other ID Marks: [...] **Where:** Ogive Base Lead Other:

Results: 6(1) ID Elim [...]ich Item(s)?: 3(1), 4(1), → Ex. 69 revolver **Phase Color:** red

Bullet ID Made Using: L.S. G.S. N/A **Location:** Base Middle Nose N/A **Item#** 09P1F3 **Used as Standard** N/A

(Sticky note: 2. Land - striae / - groove striae)



☆ one for 6(1) and one for 6(2→11)

6(1) → plastic combination wad/shotcup d ≈ .423 inches

6(2→11) → (10) lead shot pellets c/w No. 6 shot
avg. wt of one pellet ≈ 1.9 grains
d ≈ .111 inches of most spherical pellet (see table)

no visible suitable toolmarks (rifling) on items 6(2→11) for comparison

Revised 7/14/2004

Examiner's Initials/Date HGT May 10, 2010

PCE 14.2 attachment #6 - p.1/1

FIREARM WORKSHEET

Case # 09P1160

DPD Gun Tag #: ______ (N/A) Rec'd Attached Attached by Examiner Removed

Item # 69

Container
Outer: (SCR) Unsealed Envelope Plastic Bag Paper Bag Zip Lock ~~Gun Box~~ Other: ______
Inner: SCR Unsealed Envelope Plastic Bag Paper Bag Zip Lock Gun Box (N/A) Other: ______

Type: (Revolver) Pistol Rifle Shotgun Derringer Other: ______ **Firearm Loaded:** Yes (No)

Make: Taurus **Model:** 4510TKR (The Judge)

Additional: made in Brazil N/A **Manual Safety:** On (Off) N/A **Bolt/Slide:** Forward / To the Rear (N/A)

Caliber / Gauge: 45 Colt/410 bore (2½" shotshells) Undetermined **Rifling:** 6R conventional **Residue in Barrel:** (Y) N

Serial #: [redacted] right side: frame + bbl **Firearm Marked:** CN, Item #, IN **Location:** left side bbl, frame, and on cylinder

Cylinder Flare: (Yes) No N/A **# of Flares** 4 Undetermined **Residue in Cylinder:** (Y) N N/A **Rotation:** (L) R N/A

Finish: Blued (Stainless) matte bbl + cylinder Nickel Chrome Tenifer Parkerized (Anodized) frame Paint Other: "Ultra lite stainless steel" matte → see copy of literature w/ rubber grips

Choke: Full Modified Improved Cylinder Cylinder Bore Adjustable Sawed-off Other: ______ (N/A)

Action Type: Int (Extr Hammer) (Swing Open) Auto Loading (Single Barrel)
Striker Break Open Lever Action Double Barrel
(Single Action) Pin Type Pump Action Other:
(Double Action) Bolt Action Loading Gate

Safeties: Manual: (Yes) on hammer – keyed; no key submitted* No **Blocks:** (Hammer) Sear Slide Firing Pin Trigger **Glock Safety Group**
Grip *Decocking Lever* *Disconnector* Trigger Lock Trigger
Magazine ½ Cock Auto Firing Pin Block *Firing Pin Lock* Firing Pin
Hammer Block *Rebound* (Transfer Bar) Two Piece Firing Pin Drop
Safety Intercept Notch Other: ______ *Sigarms Safety Group*

Capacity: Magazine: ______ (N/A) **Cylinder:** 5 N/A **Derringer:** ______ (N/A) **Push Off:** Yes (No) N/A

*additional ☆ **Test Fired:** # 2 **INTO:** (H₂O) - Box - Trap **From:** (Lab) - Evid 69TF1, 69TF2 **Make:** Winchester Br/Ni LRN (45 Colt) **Retained:** Yes (No)
(additional) Test Fired: # 1 **INTO:** (H₂O) - Box - Trap **From:** (Lab) - Evid 69TF3 **Make:** Federal Br/Ni 410 shotshell **Retained:** Yes (No)

Functional: (Yes) No **General Ejection Direction:** Right Left Top Forward Lateral Rearward (N/A) (slug)

BFM: (P) A C (G) S X **FPI Shape:** (H) C E R W Other: ______ **FPI Micro:** (C) G S P **FP Drag:** Y (N)

TF Std(s) for Comp: Cart. Case #: ______ (N/A) **Bul. #:** 69TF3 (410 slug) N/A **NIBIN Entry:** ~~(Yes)~~ 69TF4 on 10/01/2010 HT (No) Not Suitable / no alterations 10/04/2010 HT

Trigger Pull: (Trigger Scan / Spring Gauge) **SA:** ~~10 to 11 lb~~ 4 to 5 N/A **DA:** 10 to 11 ~~Trigger Scan~~ N/A **Auto:** (N/A)

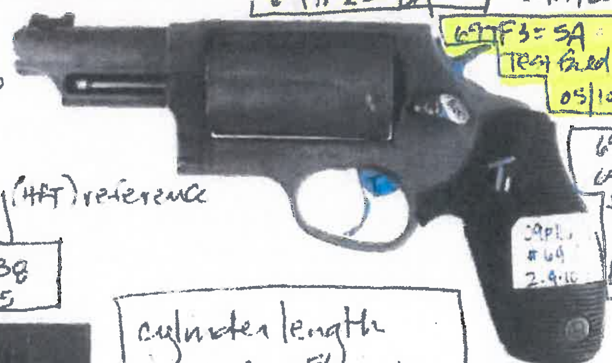
Barrel Length: ≈ 3 inches **Modified Firearm Over-all Length:** ______ (N/A)

69TF1 = SA
69TF2 = DA
→ Test fired by HT 05/07/2010

69TF3 = SA
Test fired by HT 05/10/2010

Triggerscan not used due to pause of hammer falling during single action test. Does not happen during DA test, (?) or when firing in SA.

← Rust spots in various locations



69TF4 + 69TF6 test fired by CMC 10/01/2010

*used key from my (HT) reference

L&G 5 ≈ .086/.138 inches ± .005

importer:
Taurus Int. MFG
Miami, FL USA ←

[redacted]

cylinder length ≈ 2¾ inches

[redacted]

ID to Ex 3(1), 4(1), 6 6(1) shotshell wads

additionally ☆ Test fired:
2 into (H₂O) from (Lab) Cor-Bon Br/Ni JHP → 69TF4, 69TF5 → 45 colt
1 into (H₂O) from (Lab) Remington Br/Br 410 shotshell → 69TF6 → 410 shotshell

Revised 07/13/2004 **Examiner/Date:** HT May 7, 2010

PCF 14-2 – attachment #7 – p. 1/1

MICROSCOPIC COMPARISON MATRIX - 3 - Case# 09P01160

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-1TF5	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF6	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF8	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF8	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF8	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 2-1 (Legacy 3-1)	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	ID- orange,red,pink	NO	N/A
LIMS 2-2 (Legacy 4-1)	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	ID- orange,red,pink	YES-orange, red, pink	22X
LIMS 3-2 (Legacy 69TF3)	LIMS 2-1 (Legacy 3-1)	slug to wad (autopsy)	.410	INC****	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 2-2 (Legacy 4-1)	slug to wad (autopsy)	.410	INC****	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 2-4 (Legacy 6-1)	slug to wad (autopsy)	.410	INC****	N/A	N/A
LIMS 3-1TF10	LIMS 3-1TF7	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A
LIMS 3-1TF10	LIMS 3-1TF11	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A
LIMS 3-1TF10	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF10	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A

slug

** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (red phase area)*

*** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (silver and blue phase areas)*

" **** *Striae in the red phase (as before) still look good, but not great, and it's not enough to make a definitive conclusion...especially considering all the tests of appropriate material (plastic wad to plastic wad) that have now been examined and compared microscopically.* "

LIMS 3-1TF6 wad is not a suitable test to use for comparisons as it could not be ID or ELIM to any of the other test fired wads.

This is JEM conclusion based on 4-1 wad ~~vs~~ 69TF3

Comparison Microscope(s) Used:

☐ Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186

☒ Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724

☐ Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661

☐ Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none

Revised 10/06/2011 Examiner/Date: HRT 08/22/2011 – 03/13/2012

PCF14.2 attachment #8 – p. 1/1

Correct wads.

1st slug TF.

MICROSCOPIC COMPARISON MATRIX - 2 - Case# 09P01160

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF1	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF2	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF4	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF5	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF6	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF7	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF8	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF9	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-2 (Legacy 69TF1)	slug to bullet	.410 to 45	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-2 (Legacy 69TF2)	slug to bullet	.410 to 45	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF2)	LIMS 3-2 (Legacy 69TF1)	bullet to bullet	45	ID*	NO	NO
LIMS 3-1TF1	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF1	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF1	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF5	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF5	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A

* *69TF1 and 69TF2 are 45 caliber bullets. They exhibit profound gas cutting and though they are id to each other, are not suitable for comparisons to the plastic wads.*

** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (red phase area)*

LIMS 3-1TF6 wad is not a suitable test to use for comparisons as it could not be ID or ELIM to any of the other test fired wads.

Comparison Microscope(s) Used:

☐ **Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186**

☒ **Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724**

☐ **Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661**

☐ **Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none**

Examiner/Date: HRT 08/22/2011 – 03/13/2012

Institute of Forensic Science
Peer/Technical Review

It is essential that a representative number of reports be subjected to a peer/technical review for each individual in each area in which work is performed to ensure that the conclusions reported are reasonable and within the constraints of scientific knowledge and accepted procedures.

Laboratory Case Number: 09P1160 **Date of Report:** 10/12/10

Primary Examiner/Analyst: Heather Thomas **Discipline for Review:** Firearms

	YES	NO*	N/A	
				REPORT
1.	✓			Have the requested examinations been addressed?
2.	✓			Are the results clearly communicated to the reader?
				ADMINISTRATIVE REVIEW
3.	✓			Is the report correct editorially and typographically?
4.	✓			Is the general format of the report consistent with laboratory practice?
				NOTES
5.	✓			Is the evidence adequately described?
6.	✓			Do the case number and analyst's initials appear on all pages?
				SUPPORTING DOCUMENTATION
7.	✓			Are all graphs, charts, etc. available to support the examinations conducted?
8.	✓			Is the chain of custody (including internal transfer sheets) current and adequately documented?
				CONCLUSIONS
9.			✓	Were standards and/or control samples used and adequately documented?
10.	✓			Do the tests performed conform to accepted techniques?
11.	✓			Were the conclusions drawn fully supported by the data?
12.	✓			Are the conclusions reasonable and within the range of acceptable opinions of peers within this discipline?

*Comments required.

Comments: None

Reviewer: Raymond Cooper Date Reviewed: 10/19/10

Instructions to Reviewer: If a "No" is recorded for any question, forward this form together with the report and supporting documentation package to the Section Chief (or designee) for review. If no review is needed (i.e., no "No" response), attach this form to the report package for filing in the case file.

Section Chief (or designee) Review

Action(s) Taken: ______

Supervisor Signature: ______ Date Reviewed: ______

Quality Manager: ______ Date Reviewed: ______

HT

Terminal Ballistics
Refer to **Ballistics, Terminal.**

Terminal Energy
Refer to **Energy, Terminal.**

Terminal Velocity
Refer to **Velocity, Terminal.**

Test Barrel
Refer to **Barrel – Test Barrel.**

Test Bullet
A bullet fired into a bullet recovery system in a laboratory for comparison or analysis.

Test Cartridge Case
A cartridge case obtained while test firing a firearm in a laboratory to be used for comparison or analysis.

Test Fire
To discharge a firearm in a laboratory or controlled setting in order to obtain representative bullets and cartridge cases for comparison or analysis, to determine functionality of the firearm, or to produce gunshot residue or shot patterns at known distances.

Theory of Identification as it Relates to Toolmarks *
1. The theory of identification as it pertains to the comparison of toolmarks enables opinions of common origin to be made when the unique surface contours of two toolmarks are in "sufficient agreement."
2. This "sufficient agreement" is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours. Agreement is significant when the agreement in individual characteristics exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool. The statement that "sufficient agreement" exists between two toolmarks means that the agreement of individual characteristics is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.
3. Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

Thicket Load
Refer to **Load – Scatter Load.**

Throat
Refer to **Chamber Throat.**

Through Bolt
A long bolt extending through the shoulder stock and threaded into the frame.

* This revision was approved by the AFTE BOD on May 30 2011.

J Murdock
7-11-15

2.

Letter to the Editor: Impact Damage on a Bullet and the Comparison to a Silicone Cast of Damage on a Shower Door Frame

Dear Editor,

I regrettably neglected to acknowledge the assistance of Laboratory Director Barry Miller, Solano County Crime Laboratory (former co-worker) in working the scene discussed in my paper "Impact Damage on a Bullet and the Comparison to a Silicone Cast of Damage on a Shower Door Frame" 2011 Volume 43, Number 3 (Summer), Page 261 thru 263.

Sincerely,

Mike Barnes

Theory of Identification as it Relates to Toolmarks: Revised

By: Committee for the Advancement of the Science of Firearm & Toolmark Identification

Theory of Identification as it Relates to Toolmarks*

1. The theory of identification as it pertains to the comparison of toolmarks enables opinions of common origin to be made when the unique surface contours of two toolmarks are in "sufficient agreement."

2. This "sufficient agreement" is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours. Agreement is significant when **the agreement in individual characteristics** exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool. The statement that "sufficient agreement" exists between two toolmarks means that the agreement **of individual characteristics** is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.

3. Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

**The additions that appear in bold, underlined text in the last two sentences of Section 2 were approved on February 22, 2011 by all members of the AFTE Committee for the Advancement of the Science of Firearm and Toolmark Identification. The Committee felt it was necessary to make these additions in order to account for the possible influence of sub-class characteristics when determining if sufficient agreement exists to conclude if two toolmarks share a common origin. The need for these additions was first recognized by AFTE member Gene Rivera on page 250 of his article "Subclass Characteristics in Smith & Wesson SW40VE Sigma Pistols", AFTE Journal, Vol. 39, No.3, Summer 2007, pgs. 247-253. The Committee recommends that these additions be adopted by the AFTE Board of Directors and that the AFTE Glossary be updated accordingly, to include an appropriate revision date. Footnote by John Murdock, Chairman, February 25, 2011.*

These additions were approved, by the AFTE BOD's at an AFTE Business meeting May 30, 2011 — J Murdock 7-11-15

3. p.6,

Meeting
Drake Hotel, Chicago, IL
May 30, 2011
FINAL

AFTE 2010 – 2011 Business Board members in attendance:

John Finor, President
Dan Gunnell, 1st Vice President
Ray Cooper, 2nd Vice President
Wendy Gibson, Secretary
Andy Smith, Membership Secretary
Jim Hall, Treasurer
Mark Keisler, Member-at-Large
James Krylo, Immediate Past President

The meeting was called to order at 1: 19pm on May 30th by President John Finor
Parliamentarian = John Murdock
Sergeant-at-Arms = Katharina Babcock, Jim Ryan

A quorum of 69 members is needed; members were counted with 81 present (meets quorum)

Secretary's Report (oral report provided)

As decided at the mid-year meeting, a climate controlled storage unit was rented. It currently contains about a dozen boxes of historical Association records (member applications, meeting minutes, and committee notes from ~ 1970 to early 2000). Paper records that have been digitized were shredded. Past Presidents and the current historian were contacted and informed of the storage unit; the offer was extended to transfer any records these individuals may have had.

Since December 2010, three (3) members have been upgrade to Distinguished status. A total of seven (7) members will be awarded Distinguished plaques at this training seminar.
2010 Business meeting minutes were posted for members on the Association's web site, June 22, 2010 and published in the AFTE News (Vol. 8, No. 2) November 2010.

Motion: Ken Green made a motion to accept the 2010 Business Meeting minutes as posted / published.
Second: Dan Jackson
Discussion: Nothing
Voice vote all AYE / 0 NAY - PASS

Motion: Jim Roberts made a motion to accept the Secretary's reports as discussed.
Second: Jamie Becker
Discussion: Nothing
Voice vote all AYE / 0 NAY - PASS

Treasurer's Report (oral report provided)

Since the last business meeting (5/3/2010), AFTE had income of $123,829.06, with expenses of $127,848.99 for a net income of -$4,019.93.

No members have paid for life dues ($2,000.00) during the past year. The value of the life dues payment money, which is held in the Schwab-One Account CD's, and the T. Rowe Price Capitol Appreciation Fund is $227,800.63 (which is up $18,047.77 from last year). Currently approximately 43% of the life dues money is invested in cash or fixed income vehicles and 57% is invested in a mutual fund.

As of May 26, 2011 we have roughly 106 Members, Subscribers or Technical Advisors that have not paid their 2011 dues or fees. Members or Subscribers who have not paid by July 1, 2011 will be suspended during the month of July. A notice of this action was included on all invoices distributed in January.

A current balance report and profit & loss report itemizing AFTE's finances since the last business meeting have been posted. (Appendix)

Motion: Bill George made a motion to accept the Treasurer's report as read and posted.

process of writing the conclusions to her research project and this Committee looks forward to reading her article.

Historical Committee

All of the AFTE pictures in the Historical archives have been digitally imaged and will be posted on the Association's web page, in a member's only accessible area. Members that wish to have their individual picture removed should contact the chair of the Historical Committee.

Training Seminar Planning Manual Revision Committee (Ad-hoc)

Revisions have been made to the manual which is currently under review by the Board of directors and will be posted on the web site upon completion.

2011 Host Committee (oral report provided by Chair, Pete Striupaitis)

The meeting is going well and has exceeding all expectations with 360 registrations and another 17 or so expected.

Committee for the Advancement of the Science of Firearm & Toolmark Identification (Ad-hoc) (oral report provided by John Murdock)

On 2-25-2011, the committee sent two recommended additions to the AFTE Theory of Identification to President Finor for consideration by the AFTE BOD. These additions, which specify that toolmark agreement must be between "individual characteristics", were approved on 2-22-2011 by all members of the committee. The committee felt it was necessary to recommend these additions in order to account for the possible influence of sub-class characteristics when determining if sufficient agreement exists to conclude that two toolmarks share a common origin. The need for these additions was first recognized by AFTE member Gene Rivera in his article "Subclass Characteristics in Smith & Wesson SW40VE Sigma Pistols", AFTE Journal, Vol. 39, No. 3, Summer 2007. (The recommended additions were displayed for the members). The Board discussed and approved the recommended additions; the Glossary and other pertinent documents will be updated.

On 4-25-2011, the committee was asked to help respond to a list of 25 questions asked by the Research Development Testing & Evaluation Interagency Working Group (RDT&E IWG) of The Subcommittee on Forensic Science (SoFS). This assignment, received by AFTE President John Finor on 4-18-2011, with a requested due date of 5-20-2011, specifically asks for the appropriate scientific literature references for each question. It is not certain at this time how much committee time will be required for this assignment; SWGGUN responded with 47 pages in May. AFTE requested and has received an extension until June 15th to submit their response. At this time the usage intent by the IWG is unknown; the sunset clause on SOFF expires in September of this year and the continuation of the committee is uncertain.

Motion: TL Price made a motion to accept the President's committee reports as discussed.
Second: Larry Paul
Discussion: Will the photos from the Historical Committee only going to be in the member's only area of the forum, and will the Board then assume that any usage of these photos by another individual will only be for professional purposes? (Note: There are member photos posted in the public forums under each trainings seminar heading). The Board is assuming that photos will not be used inappropriately; the new 2011 web user agreement guards against any inappropriate usage and provides an avenue to remove members from the forum if an agreement violation occurs. What will be the status of viewing photos of non-members that have been attendance of AFTE functions (eg – subscribers at training seminars)? Subscribers would not have access to the member forum; attempts have been made to name / identify members in photos prior to posting. If there is a concern, the chair of the committee should be contacted.

Will the answers to IWG from the Association

PCF 142 - attachment #11 - P. 1/1

CASE SUMMARY WORKSHEET

Case # 09P1160

Case Start Date: 05/07/2010 **Case Completion Date: 10/19/2010**

Examinations Requested:

- Analyze
- Firearm comparison

Conclusions:

- Item 69 revolver is a mechanically functional firearm; tfcc entered into NIBIN with no associations made
- Items 3(1), 4(1), and 6(1) are fired 410 shotshell wads; ID to each other and to item 69 revolver
- Items 3(2-12), 4(2-11), 5(1-11), 6(2-11), and 7(1-13) are lead pellets c/w with No. 6 shot; not suitable for microscopic comparisons
- Items 70 through 74 are all suitable for firing in the item 69 revolver, but were not used

Comparisons Verified By: RC N/A

Photos of Representative Identifications Made: N/A

Ex. 4(1) to Ex. 69TF3
(red phase)

Revised 10/05/2007

Examiner's Initials/Date: HT October 19, 2010

PCF142
#12
p.1/1

Ex. 4(1) to Ex 69TF3
(RED PHASE)

PCF142-Attachment #13 – P.1/62

PCF 142 Murdock (*)

Form 1 of 1

Page 1/62

CRIMINALISTICS REQUEST FORM

Instructions: Legibly fill out the entire form except the shaded areas (laboratory use only). More than one form may be used.

Primary Agency: Texas Commission on Forensic Science (TCFS)	Agency Case #: 14-08	Laboratory #: PCF142
Requestor: Lynn Robitaille Garcia – General Counsel	Phone/Cell #: 512-936-0649	Primary Offense Code:
Email Address:		Offense Date:

~~Indicate whether the individuals named below are victims, suspects or listed for the purpose of elimination.~~

	~~Last Name~~	~~First Name~~	Victim	Suspect	Elimination	Date of Birth
1	Subject of TCFS Case #14-08 = –		☐	☐	☐	
2	– Southwestern Institute of Forensic		☐	☐	☐	
3	Sciences at Dallas –		☐	☐	☐	
4	Case #89P1160		☐	☐	☐	
5			☐	☐	☐	

Instructions: Describe each item of evidence, include source and how packaged. Check box for service requested.
All packages must be tape sealed & initialed.

Rush Request: ☐
*Explain below**

Laboratory Item #	Agency Item #	Description	~~Collected From (i.e., victim, suspect, scene, auto, etc.)~~	Packaging	Biology DNA	Latent	Firearm	IBIS Only
		→ For a description of items submitted, and items examined, as well as a description of how these items were packaged, refer to handwritten inventory and the section of Murdock's report to the TCFS entitled: "Laboratory Examinations Conducted by John Murdock".			–	–	X	–

Packaging Key: BKIT=Buccal Kit, **CB**=Cardboard Box, **ENV**=Envelope, **FPE**=Fingerprint Envelope, **ME**=Manila Envelope, **PB**=Paper Bag, **PLB**=Plastic Bag, **SAEK**=Sexual Assault Evidence Kit and **Other**=Describe under Description.

***List case specific details:** *(Attach additional sheets if needed)* The purpose of this request is to evaluate ① SWIFS reports, case notes; ② Examine certain physical evidence associated with a 2010 mis-identification of a fadeless revolver; and ③ respond to a series of questions posed by TCFS.

Related Evidence:	Police Report Submitted: Yes ☐ No ☑ On File ☐
Delivered By Print Name:	Date Request Received: November 2014 — Received By: John Murdock
Signature:	Reviewed By & Date:

(*) This cover page constitutes page #1 of John Murdock's case notes.

Laboratory Worksheet

Inventory –

– The following items were rec'd by UPS Ground on January 12, 2015 by John Murdock at the CCSO Forensic Lab." (rec'd in Lab 1-12-15 + by J Murdock 1-13-15 10AM)

– a brown Cd bd box – 10" x 15" x 10" high (rec'd w/ all seams sealed with clear tape + box undamaged) contg:

– a large man. env (12" x 15½" – rec'd w/ clasp closed onto flap) contg:

– a padded env (7" x 8" + sealed w/ evidence tape sufficient so that envs inside would not fall out) contg: 5 man envs:

LIMS #

(2-1) → SWIF Ex #3 (1-12) – man env (3⅛" x 5½" – evidence tape sealed) contg –

– (3-1) – a fired plastic shotshell wad

– (3-2 → 12) – small ZLPB (zipped closed and evidence tape sealed) contg eleven (11) grey pellets resembling fired shotshell pellets.

(2-2) → SWIF Ex #4 (1-12 + should be 4(1-11) – man env (3⅛" x 5½" – evidence tape sealed) contg –

– (4-1) – a fired plastic shotshell wad

– (4-2 → 10) – small ZLPB (zipped closed + ev tape sealed) contg nine (9) grey pellets resem fired SS pellets

– (4-11) – small ZLPB (zipped closed + ev tape sealed) contg one grey pellet resem a fired SS pellet.

Laboratory Worksheet

Laboratory Number: PCF14-2
Analyst: JMurdock
Date(s): 3-21-15
Page: 3 of ____

Inventory continued

Lims #

(2-3) → SWIF Ex #5 (1-11) - man env (3 1/8" x 5 1/2" - evidence tape sealed) reported to contain eleven (11) fired shotshell pellets - not opened by JMurdock.

(2-4) → SWIF - Ex 6 (1→11) - man env (3 1/8" x 5 1/2" - evidence tape sealed) contg:

(6-1) - a fired plastic shotshell wad.

(6-2→11) - Small ZLPB (zipped closed + evi taped sealed) contg - ten (10) grey pellets resem fired shotshell pellets.

(2-5) → SWIF - Ex 7 (1→13) - man. env (3 1/8" x 5 1/2" - evidence tape sealed) reported to contain thirteen (13) fired shotshell pellets - not opened by JMurdock

Laboratory Worksheet

Inventory -

Lims (#3) ———— SWIFS EX (69) - small cdbd handgun box (evi tape seals open) contg a Taurus "the judge" - ultra-lite model 5 shot revolver, .45 long Colt + .410 gauge caliber, SN BX715042

(3-2) - SWIFS EX (69) - "SWIFS Test Fires" man env labeled to contain 69TF1 → 69TF2 and 69TF3 → 69TF6 } test fired from Taurus "the judge" SN BX715042 (Item 69 above)
- this TF env is evi tape sealed and contg: (see color copy of contents) p. 26.
- two fired .410 shot shells, four fired 45 COLT ctg cases, 2 pieces plastic wad, (*)

3-25-15

Lims (#3-1) - SWIFS Test Fires man. env (evi tape sealed) labeled in part: "LIMS 3-1 TF1 + 3-1 TF2" (3-3-2 + 3-3-3) and "LIMS 3-1 TF3 + 3-1 TF4" (4-1-2)

AKA (Ex69) Taurus Revolver SN BX715042

contg - (see color photocopy of contents) - p. 28
- four fired .410 shot shells

- 3 fired plastic (shotshell) wads.

(*) - Item (3-2) - continued - 4 lead pellets, fired copper jacket, 4 fired bullets (prob from 45 colt ctg cases), + rifled shotgun slug w/ red ink mark on side.

Criminalistics Laboratory
Contra Costa County Office of the Sheriff
Laboratory Worksheet

Laboratory Number: PCF 14-2
Analyst: J Murdock
Date(s): 3-25-15
Page: 5 of

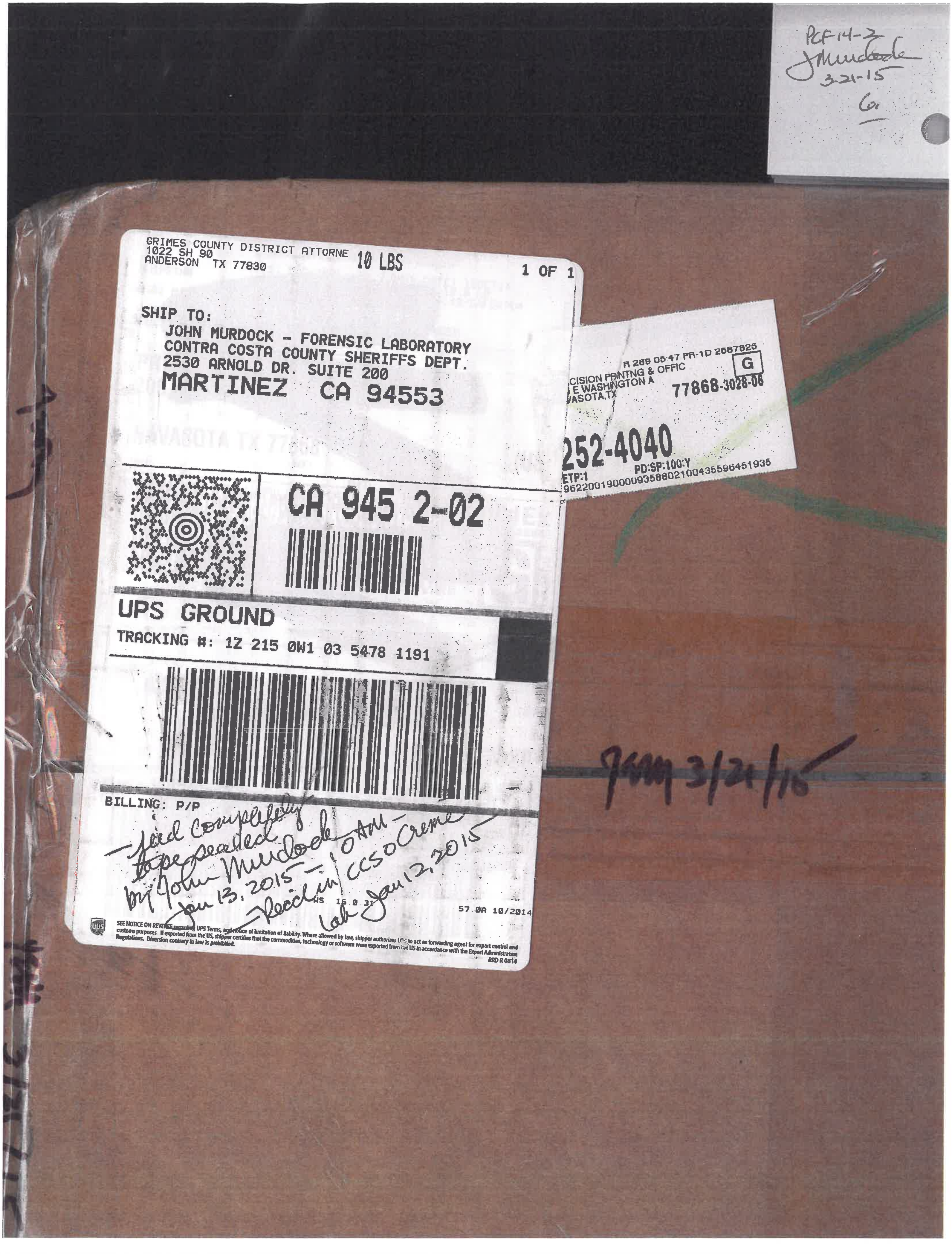
Inventory

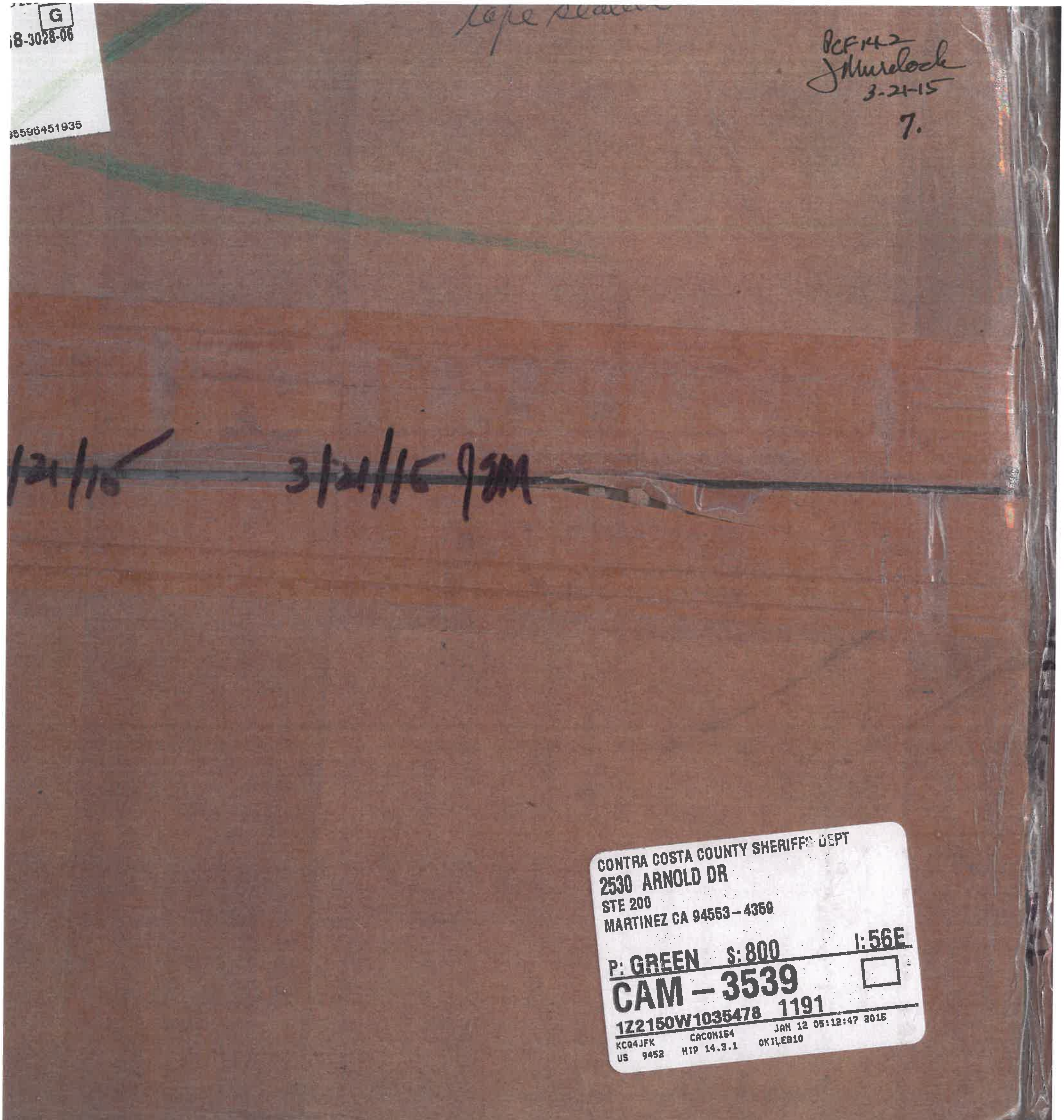
Lims (3-1) SWIFS "Test Fires" man env (ev tape sealed)
Labeled in part: "Lims 3-1-1 - 3-1TF5
AKA (Ex69) + 3-1TF6
Taurus Revolver + 3-1TF7
SN BX715042 (Cal ammo)
+ 3-1TF8
+ 3-1TF9
+ 3-1TF10
+ 3-1TF11

cont'g: (see color photo copy of contents) p.29
- Seven fired .410 shotshells

- Seven fired plastic shotshell wads.

Lims (5) - Taurus cdbd pistol box (closed) for
Taurus "the judge" model 5 shot revolver -
.45LC/410 GA - SN - DU275155 cont'g 5 and -
(see p. 30 + 31) this revolver had:
- brn paper plastic wrap
- warranty card
- Inst. manual - 21 pages
- ZLPB w/ allen wrench + 2 security keys
- ZLPB (ev tape sealed) cont'g 2 brn bore caps.
(see p.33) Lims (5-1) - Man env (ev tape sealed) - TEST firings from #5 revolver
(see p. 34) Lims (6-1) " " " " - TEST " " #6 revolver
(see p. 35 + 36) Lims (7) Taurus cdbd - pistol box (closed) for Taurus "The Judge"
model 5 shot revolver - .45LC/410 GA - SN - DU275138 cont'g and -
- Same items as listed above for Lims (5).
(see p. 38) LIMS (7-1) Man env (ev tape sealed) - TEST firings from #7 revolver.


PCF14-2
JMurdock
3-21-15
6
GRIMES COUNTY DISTRICT ATTORNE
1022 SH 90
ANDERSON TX 77830
10 LBS
1 OF 1
SHIP TO:
JOHN MURDOCK - FORENSIC LABORATORY
CONTRA COSTA COUNTY SHERIFFS DEPT.
2530 ARNOLD DR. SUITE 200
MARTINEZ CA 94553
CA 945 2-02
UPS GROUND
TRACKING #: 1Z 215 0W1 03 5478 1191
BILLING: P/P
57 0A 10/2014
Field completely tape sealed by John Murdock Jan 13, 2015 — 10 AM — Rec'd in CCSO Crime lab Jan 12, 2015
252-4040
77868-3028-06
G
PD:SP:100:Y
3/21/15


G
8-3028-06
35596451935
PCF142
JMurdock
3-21-15
7.
3/21/15 9AM
CONTRA COSTA COUNTY SHERIFFS DEPT
2530 ARNOLD DR
STE 200
MARTINEZ CA 94553-4359
P: GREEN S: 800 I: 56E
CAM - 3539
1Z2150W1035478 1191
JAN 12 05:12:47 2015
KCQ4JFK CACON154
US 9452 HIP 14.3.1 OKILEB10

PCF 14-2 J Murdock 3-2-15

8.

09P1160

Swif

Ex. #3 (1-12) LIMS 2.1

#4 (1-12) LIMS 2.2

#5 (1-11) LIMS 2.3

#6 (1-11) LIMS 2.4

#7 (1-13) LIMS 2.5

PCF 14-2
J Murdock
3-2-15
LIMS (2)
SWIF EX 3,4,5,6+7

LIMS
SCR
09P01160 (LIMS)
2 HCT
08/17/2011

J Murdock 3-2-15

09P01160
Item# 002
Manila envelope stc pellets & fi
Type: Manila envelope

2

HCT 09/05/2011

EVIDENCE

HCT 09/05/2011

...TE OF FORENSIC SCIENCES AT DALLAS

Name of Subject: Don Stolz

Date of Examination: 7/18/09

Case No. 2324-09

Manner of Death: HOMICIDE

Agency No.

Removed From: L chest by Axilla

09P1160
#3
7.20.09 SH

Signed

PCF 14-2
J Murdock
3-2-15
(2-1)
SWIF #3(1-12)

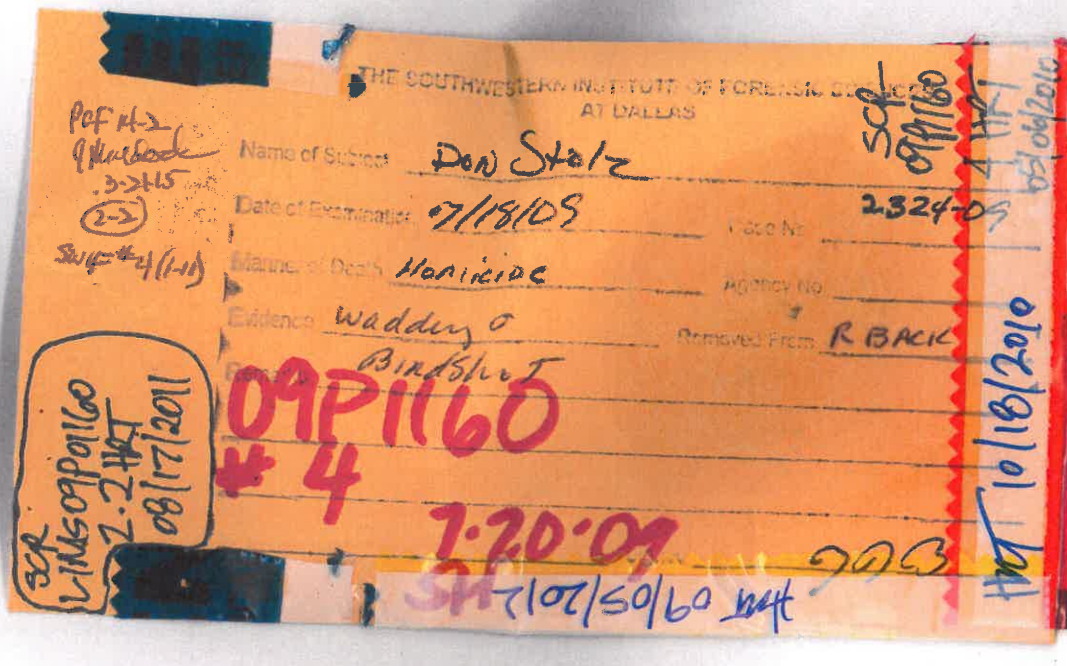
LIMS
SCR 09P01160
2.1 HCT
08/17/2011

SCR 09P1160

HCT 10/18/2010

-contains
(3-1)-wad
(3-2→12)
pellets

PCF 14-2
J Murdock
3-21-15
9.

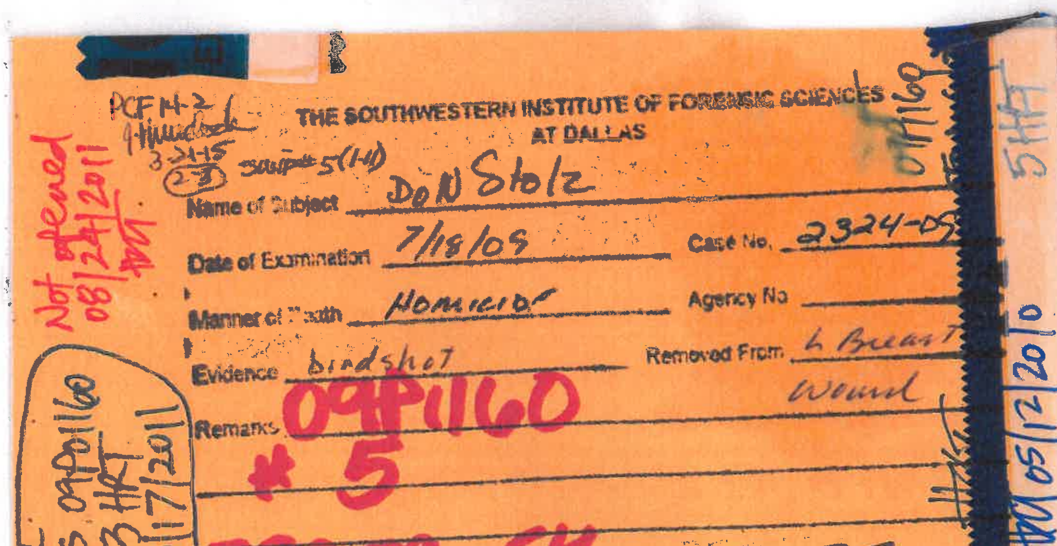

PCF 14-2
J Murdock
3-21-15
(2-2)
SWIF #4(1-11)

THE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

Name of Subject: Don Stolz
Date of Examination: 7/18/09 Case No. 2324-09
Manner of Death: Homicide Agency No.
Evidence: wadding + Birdshot Removed From: R BACK
Remarks: 09P1160 #4 7-20-09

SCR LIMS 09P01160 2.2 HAT 08/17/2011
SCR 09P1160 4 HAT 05/06/2010
HAT 10/18/2010
SH 09/05/2010 HAT

- contains: (4-1) wad
(4.2 → 10)
(4-11) pellets


PCF 14-2
J Murdock
3-21-15
(2-3) SWIF #5(1-11)

Not opened 08/24/2011 HAT

THE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

Name of Subject: Don Stolz
Date of Examination: 7/18/09 Case No. 2324-09
Manner of Death: Homicide Agency No.
Evidence: birdshot Removed From: L Breast Wound
Remarks: 09P1160 #5 7-20-09 SH
Signed: [signature]

SCR LIMS 09P01160 2.3 HAT 08/17/2011
09P1160 5 HAT
HAT 05/12/2010

- not opened by J Murdock
- contgs only "birdshot" pellets.

PCF 142
J Murdock
3-21-15
10.

THE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

PCF 142
J Murdock
3-24-15
(2-4)
SOIF #6(1-11)

Name of Subject: Don Stolz
Date of Examination: 7/18/09
Case No. 2324-09
Manner of Death: Homicide
Agency No.
Evidence: Wadding + Removed From: L Arm
Remarks: Birdshot

09P1160
6
7-20-09 SW
Signed

HAT 8/05/2012
LMS 09P01160 2.4 HAT 08/17/2011 SCP
09P1160 SCP LM 05/26/2010
LAA 10/8/2010

- contg: (6-1) wad
(6-2→11) pellets

THE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

PCF 142
J Murdock
3-24-15
(2-5)
SOIF Ex #7 (1-13)

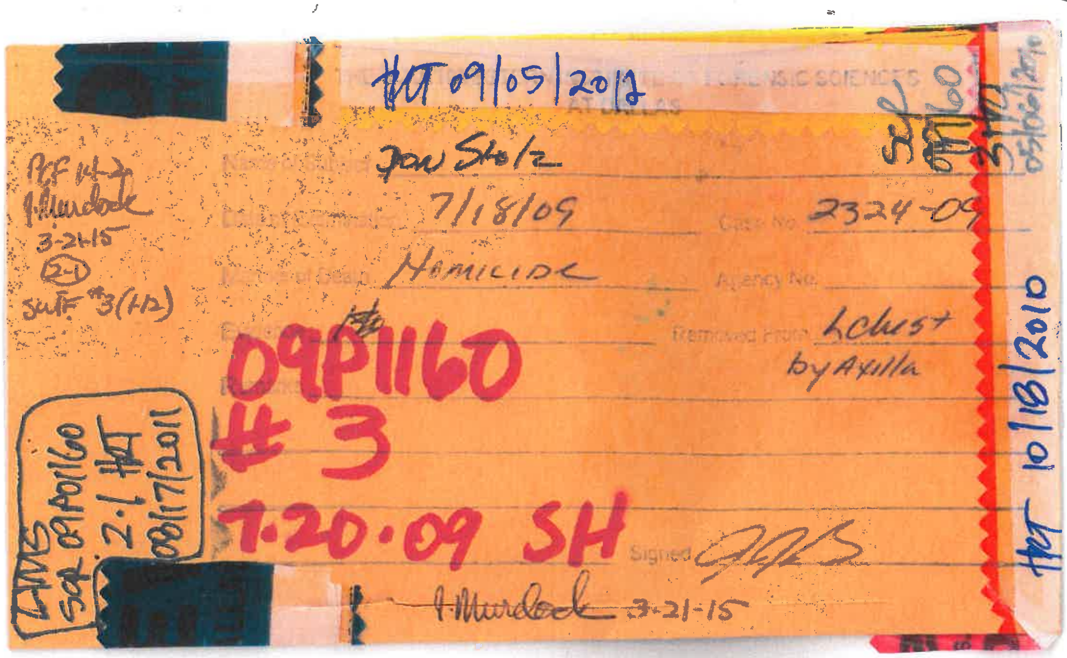
Name of Subject: Don Stolz
Date of Examination: 7/18/09
Case No. 2324-09
Manner of Death: Homicide
Agency No.
Evidence: Birdshot
Removed From: R Chest
Remarks:

09P1160
7
7-20-09 SW
Signed

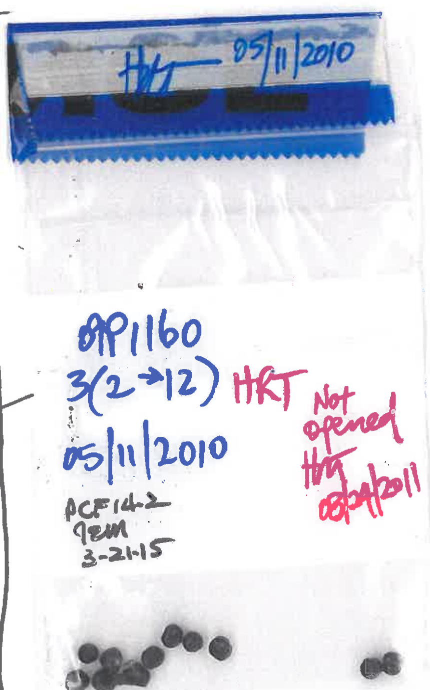
SCP LMS 09P1160 2.5 HAT 08/17/2011
Not opened 08/24/2010 LAA
HAT 05/13/2010 HRT
SCP

- not opened by J. Murdock - contains only "birdshot" pellets.

PCF 14-2
J Murdock
3-21-15



3-1 - From autopsy

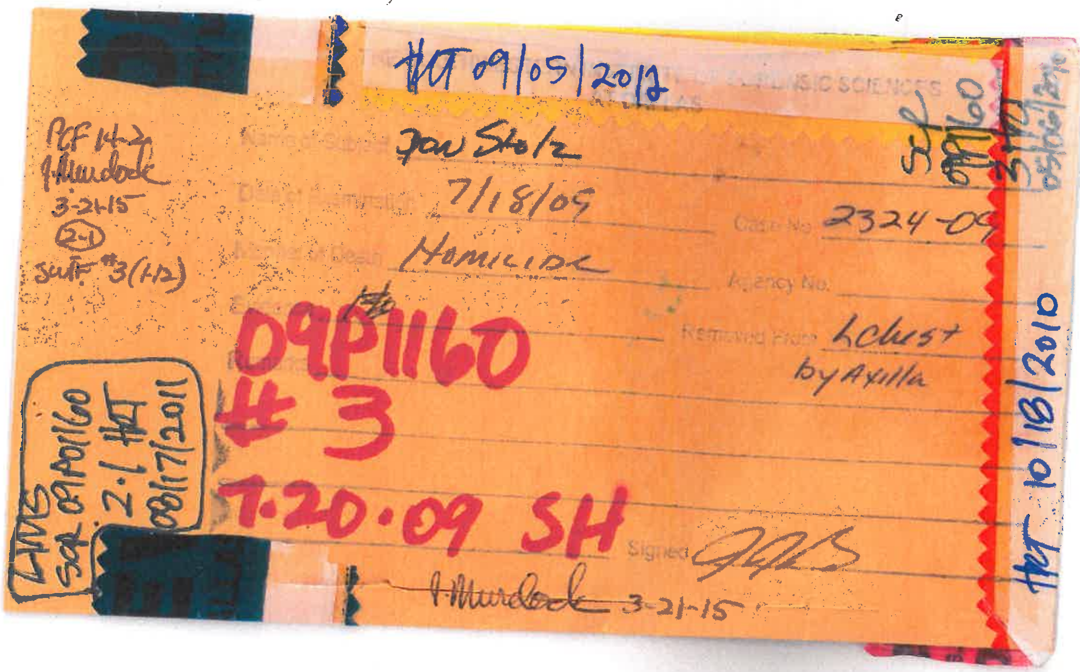


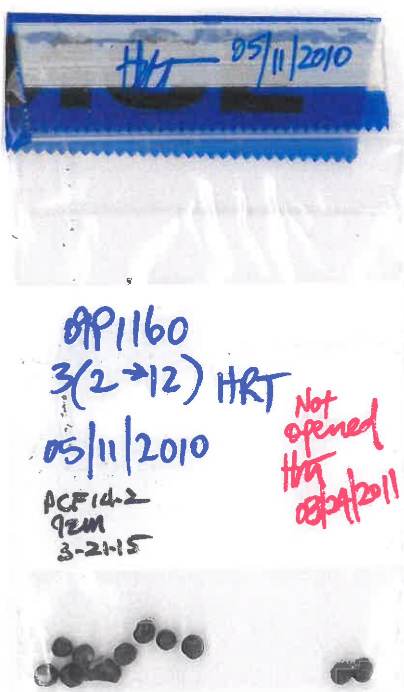
not opened by J Murdock

3-2→12

inside of wad

PCF 14-2
JMurdock
3-21-15
12



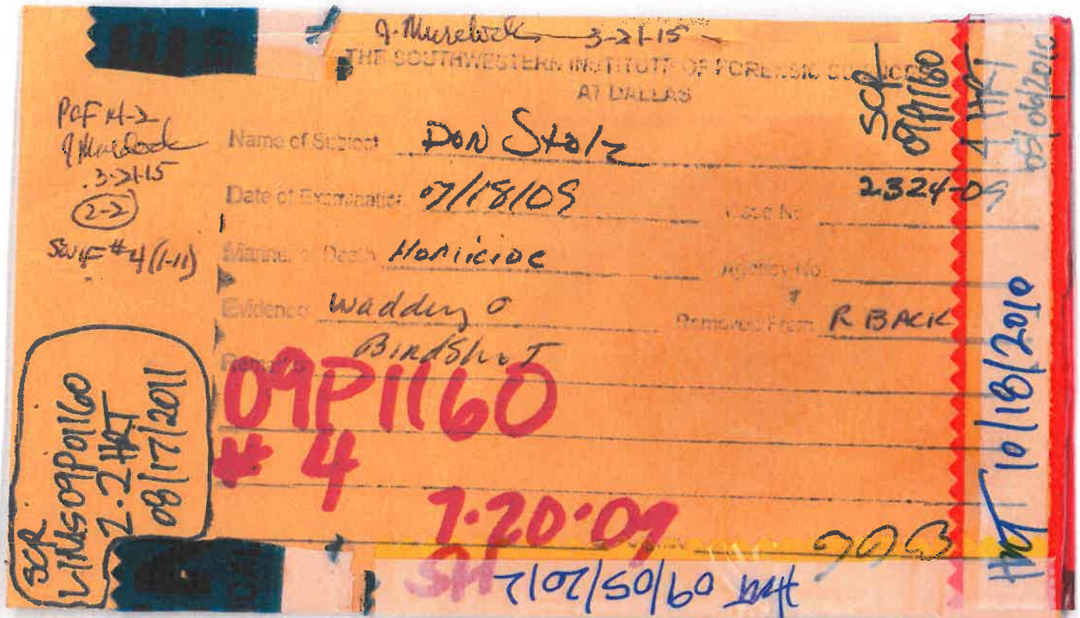


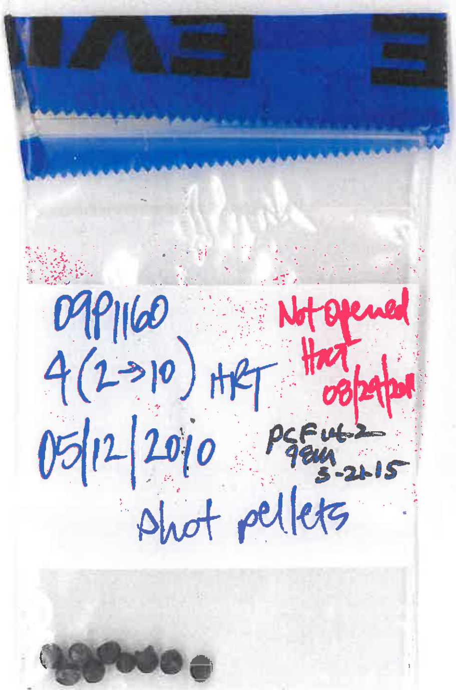
3-2 → 12

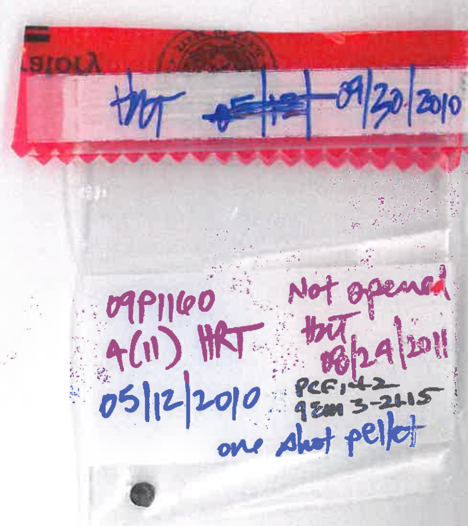
3-1 - From Autopsy

PCF 14-2
JMurdock
3-21-15

13.







(4-2→10)

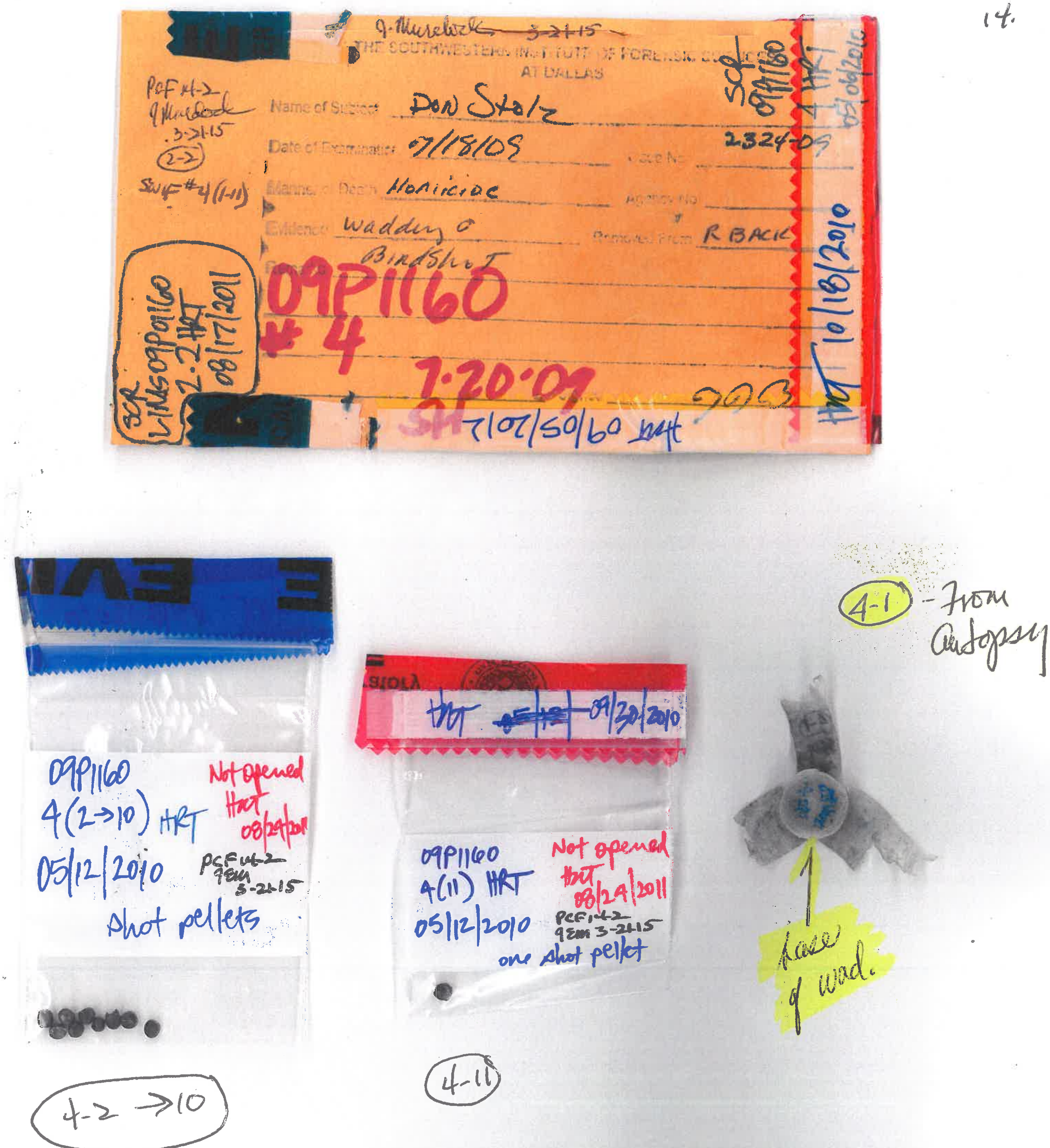
(4-11)

(4-1) from autopsy

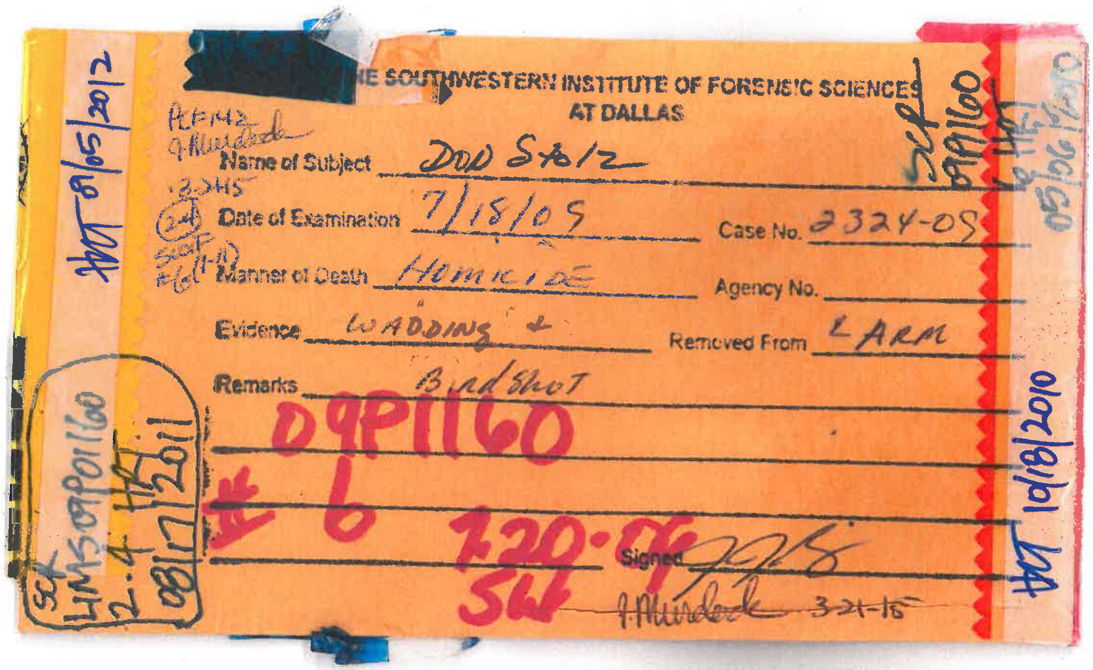
inside of wad.

neither bag opened by JMurdock

PCF 14-2
J Murdock
3-21-15
14.



PCF 14-2
J Murdock
3-21-15
15



[redacted]HE SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

Name of Subject: DOD STOLZ
Date of Examination: 7/18/09 Case No. 2324-09
Manner of Death: HOMICIDE Agency No.
Evidence: WADDING + Removed From: L ARM
Remarks: Bird Shot
09P1160
#6
7-20-09
SW
Signed
J Murdock 3-21-15

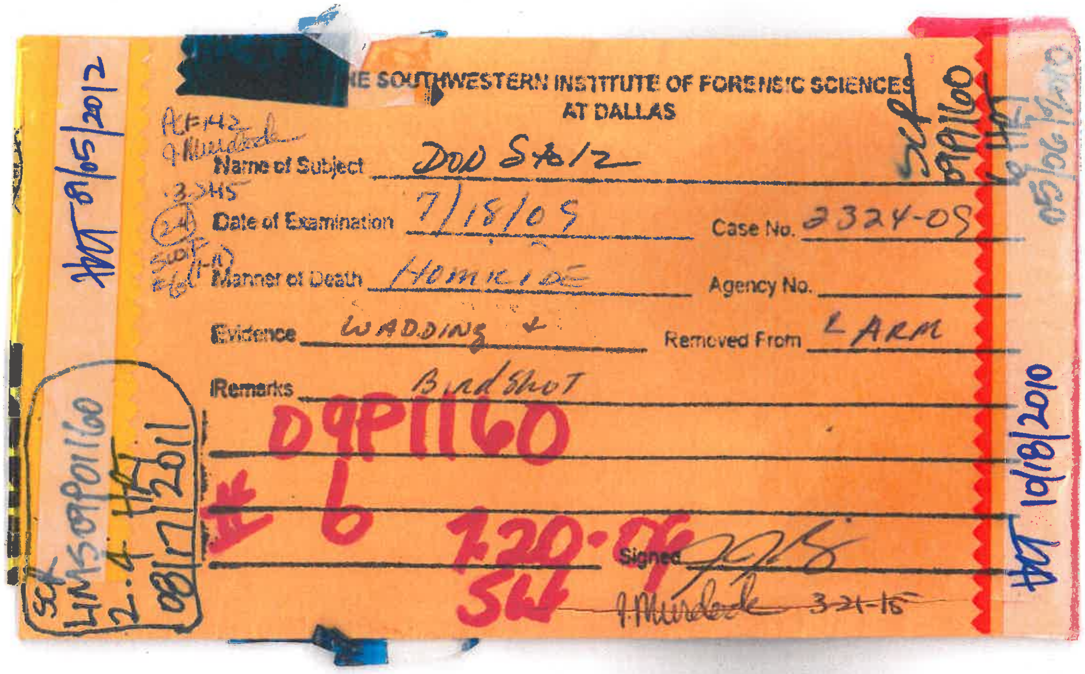
not opened by J. Murdock

6-2 → 11

6-1 ← From Autopsy

inside of wad.

PCF 14-2
J Murdock
3-21-15
16.

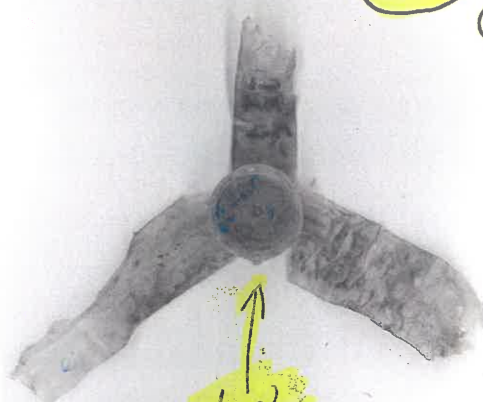

[redacted]E SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

Name of Subject: DOD Stolz
Date of Examination: 7/18/09 Case No. 2324-09
Manner of Death: HOMICIDE Agency No.
Evidence: WADDING + Removed From: L ARM
Remarks: Birdshot

09P1160
#6
7-20-09
SW
Signed

PCF 14-2 J Murdock 3-21-15
HRT 08/05/2012
HRT 10/18/2010
05/06/2010
09P1160
LIMS 09P01160 2.4 HRT 08/17/2011

6-2 → 11



6-1 - From autopsy.

base of wad.

- 203836

Don Stolz

09P01160
Item# 003
Gun box stc Tarus rev
Type: Gun box

09P1160
69-74
2.9-10 SW

PCF14-2
J Murdock
3-21-15
(#3)
and
(69)

CC [illegible]
2/18/10

SCR
09P1160
69->74 HRT
05/06/2010

3/10

NOT LOADED
Date 03/16/2011 Initials HRT

SCR
LIMS 09P01160
3 HRT
08/17/2011

HRT 09/05/2012

HRT 08/16/2011

EVIDENCE

Offense: Homicide

Collected By: WCSO

CHAIN OF POSSESSION

FROM	TO	DATE	TIME

PCF14-2
J Murdock
3-21-15
17.

PGF142 J. Murdock 3-21-15 18.

DPS - L2H-203836

L2H-203836
DD 06/24/11
#WC-01

Don Stolz

09P
#69
2.

NOT LOADED
Date 2/9/10 Initials [illegible]

NOT LOADED
Date [illegible]/16/2011 Initials [illegible]

SCR
09P1160
69→74 HRT
05/06/2010

3/10

09.0717.0101
W.C.S.O.

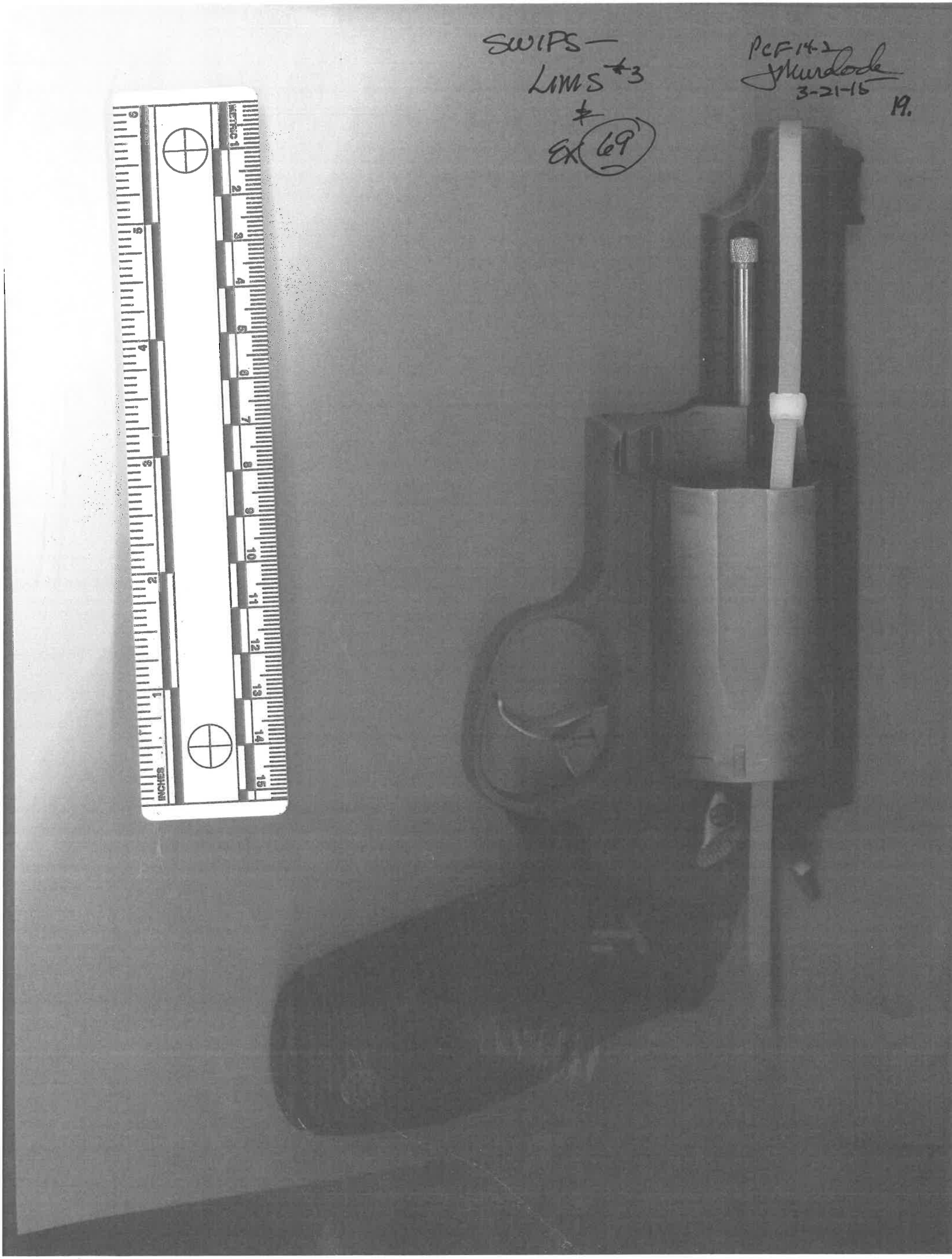
EVIDENCE

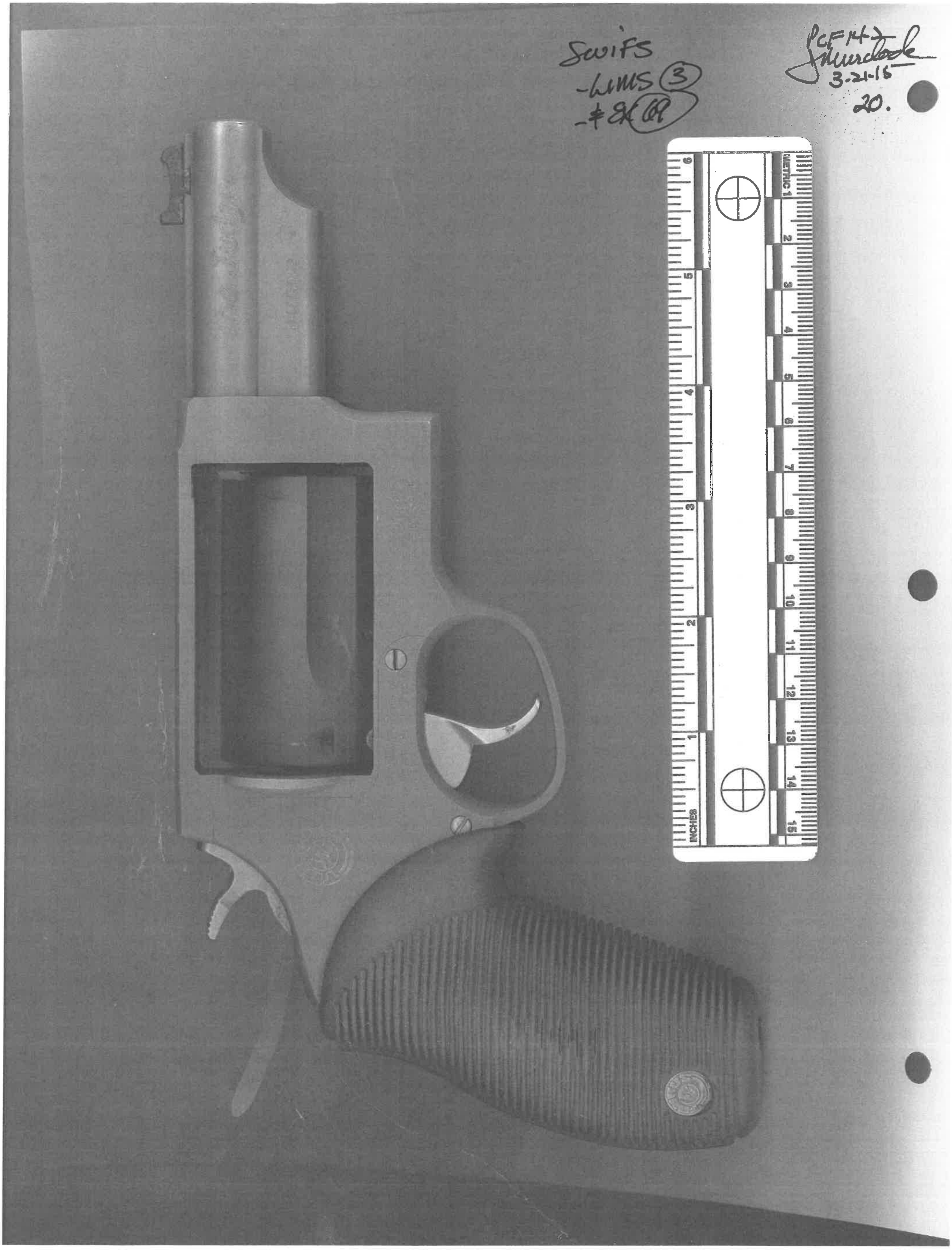
Case No.: 09.0717.0101 Item No.: WC-01 Offense: Homicide
Date Collected: 12/2/09 Time Collected: / Collected By: WCSO
Description of item: Shotgun 410 5 Bullets
Location Where Found: Washington County

CHAIN OF CUSTODY

FROM	

EVIDENCE EVIDENCE EVIDENCE


SWIPS —
LIMS #3
&
Ex 69
PCF 14-2
JMurdock
3-21-15
19.
METRIC
INCHES


PCF14-2
3-21-15
20.
METRIC
INCHES

Laboratory Number: DCF 142
Analyst: J Murdock
Date(s): 3-21-15
Page: 21 of

Firearm Examination Worksheet

Description			
Agency Item #	LIMS #3 — SWIFS Ex (69)	Overall Length:	~ 9 inches
Item #:		Barrel Length:	3 inches.
Type:	Revolver	# of Barrels:	one
Manufacturer:	Taurus	Type of Action:	double
Model:	The Judge - Ultra Lite	Exterior Color:	grey - black grips
Chamber:	45 Long Colt & .410 ga Shotshell	Condition:	Good - blade sight rusty.
Serial #:	BX715042	Grips/Stock:	rubber - one piece - Taurus
Location:	right side frame by/ ejector shroud.	Metal:	non magnetic frame - steel otherwise.

Magazine		Bore			
Number:		# of Lands and Grooves:	6	Direction of Twist:	R
Type:		Condition of Bore:			
Contents:		Fouling:			
Capacity:		Rifling Method:			

Function Testing		Chamber/Cylinder — 5 shot	
Functioned well both SA & DA.		Fouling:	not examined - has been
		Flares:	test fired.
not measured —		Contents:	-recd empty.
Dry Fire:			
Trigger Pull (SA):	Trigger Pull (DA):		

Trace Evidence

-not examined for trace evi.

designated (69-1)

Individuality (1) Bore cast, made w/ brown color forensic sil (2) exam revealed only one groove imp that has three striae that run entire length of bore - marked w/ notch cut in forensic-sil at muzzle - These three very shallow striae  are parallel w/ rifling & could have subclass potential - (nothing else present)

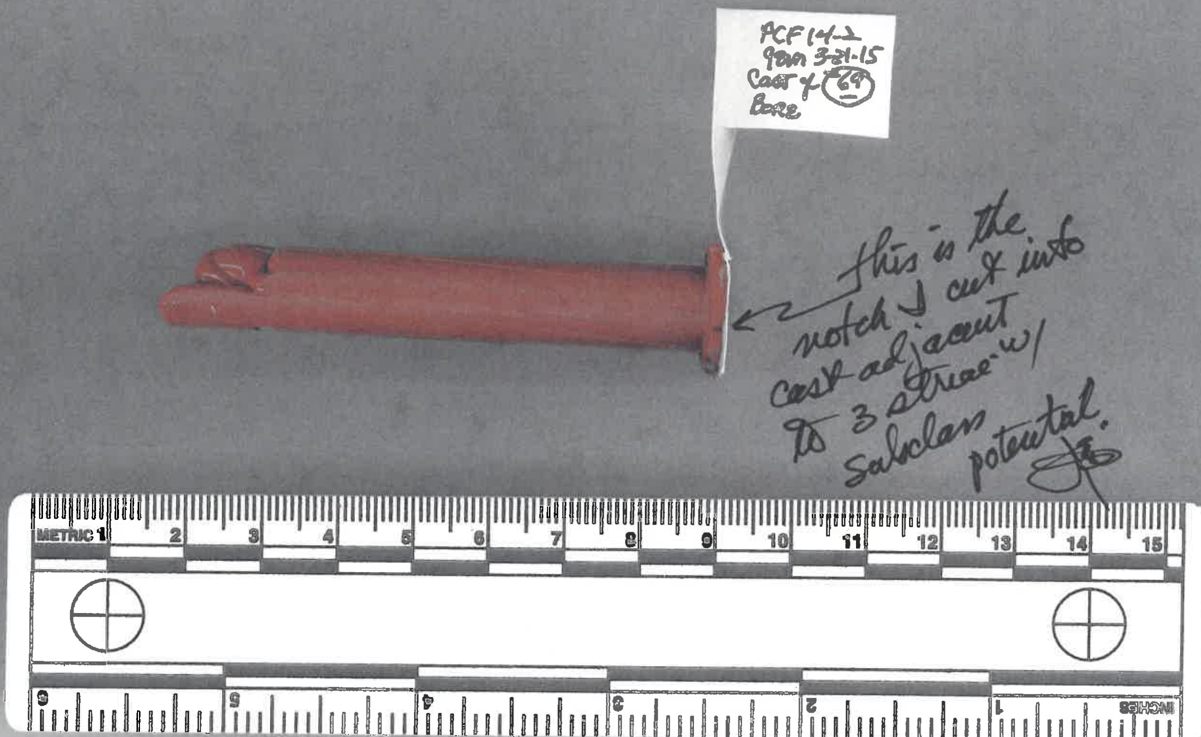
~~Breech Face~~ JM ~~Back of Barrel~~ JM

Test Firing I did not TF revolver - I worked w/ SWIFS test firings.

Prep. of Bore for Tests:				
Test #:				
Manufacturer & Cartridge:				
Bullet Weight and Type:				
Ammunition Source:				
Chamber #:				

Additional Notes: (1) Swabbed bore w/ cotton swab & acetone prior to casting - swab discarded. (2) Bore cast retained by J Murdock (3) My ID info scribed onto left side of frame adjacent to SWIFS ID. Vibratooled ID info af-scribed onto left side of bbl near muzzle near SWIFS ID info. (4) new flex tie secured thru gun bbl - for safety.

PCF 14-2
[signature]
3-21-15
22.



this is the notch I cut into cast adjacent to 3 striae w/ subclass potential. [initials]

- Bore cast made by [signature]

- designated (69-1)

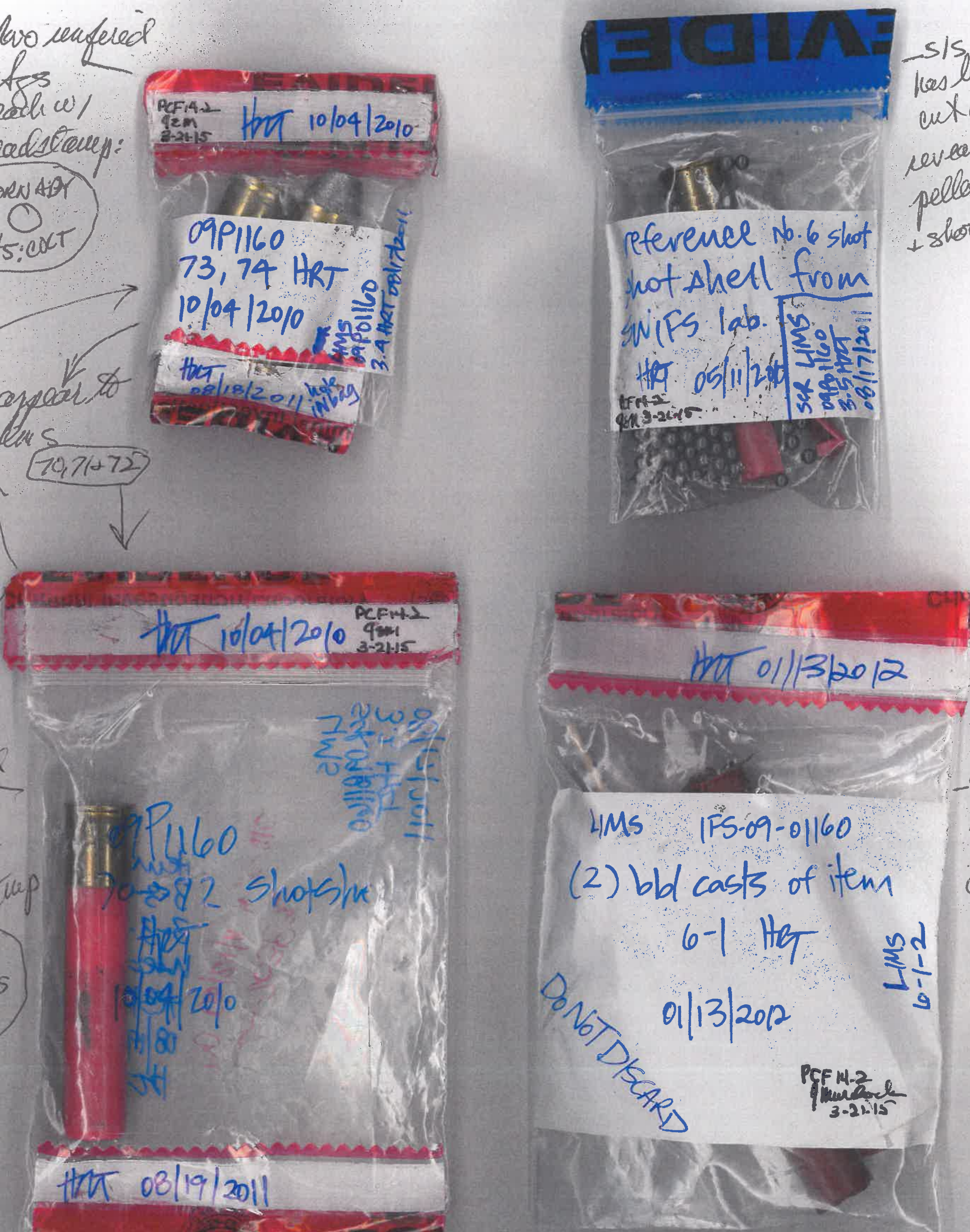
PCF 14-2
JMurdock
3-21-15
23.

-These items were not opened by JMurdock.

Two unfired ctgs each w/ headstamp:
(HORNADY O 45 COLT)

-s/s has been cut open revealing pellets + shot cup.

these appear to be items (70,71+72) and (73+74) resealed w/ evidence tape #69.

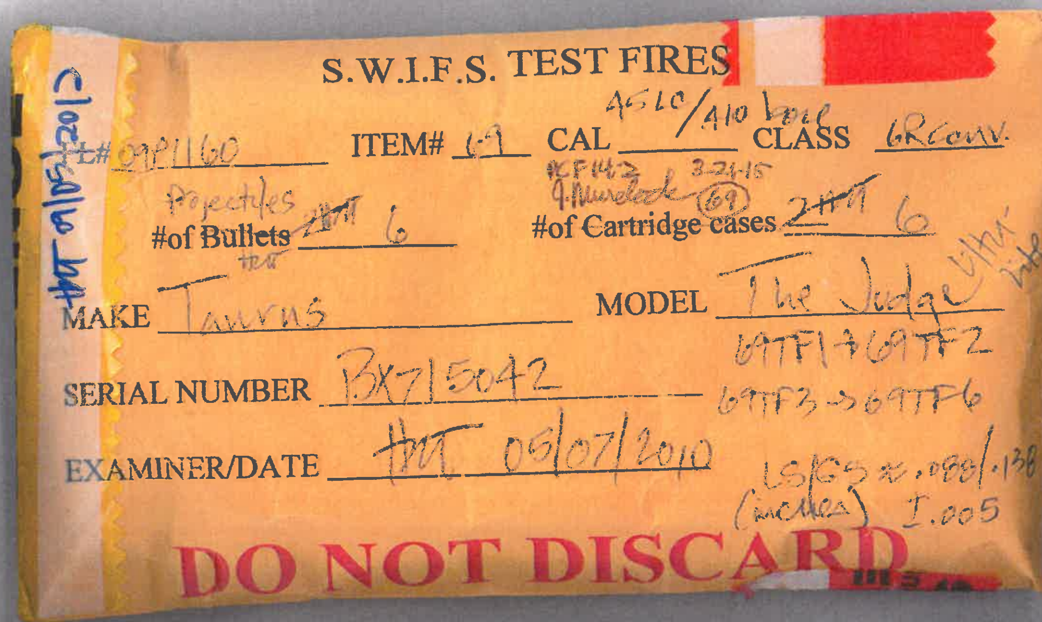


one unfired shotshell w/ headstamp
(WIN H O S 410)

-contains two bore casts.

PCF 14-2
J Murdock
3-21-15
24.

– Front of LIMS (3-2) envelope
– Item (69) TEST FIRINGS



S.W.I.F.S. TEST FIRES

L# 09R1160 ITEM# 69 CAL 45LC/410 bore CLASS 6R conv.

#of Bullets (projectiles) 6 #of Cartridge cases 6

MAKE Taurus MODEL The Judge Ultra-lite

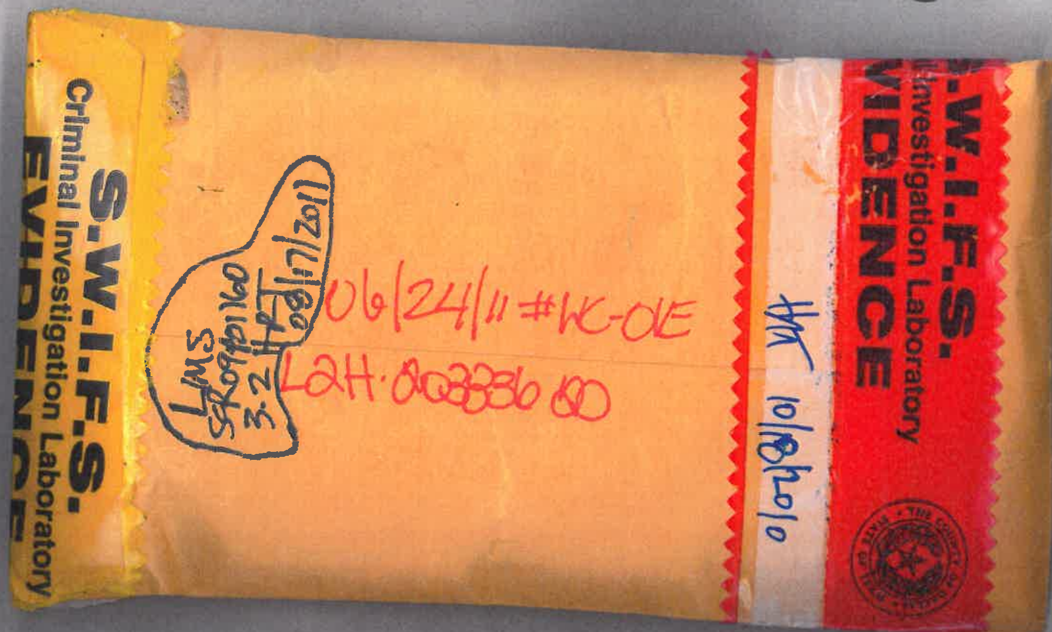
SERIAL NUMBER BX715042

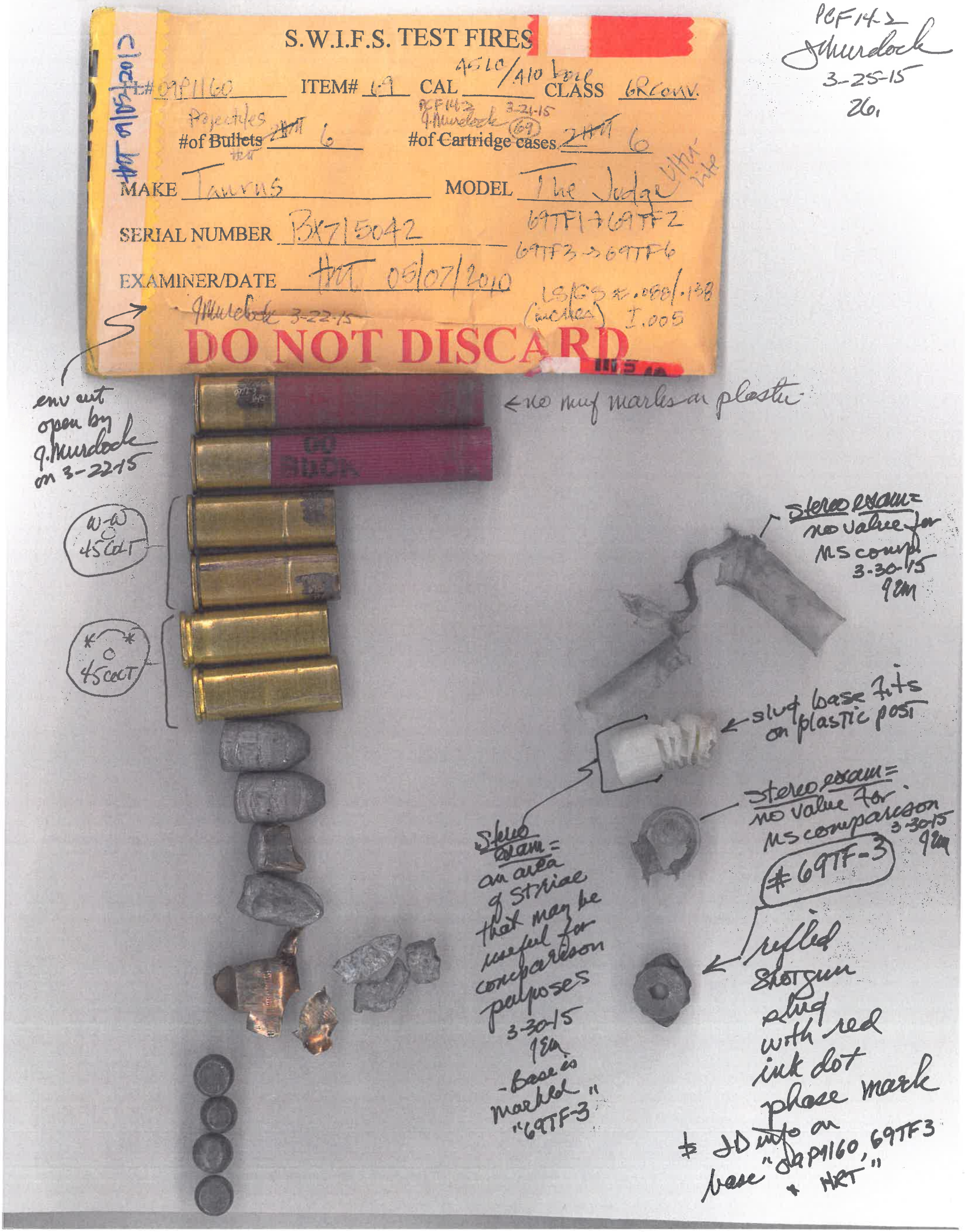
EXAMINER/DATE HMT 05/07/2010

DO NOT DISCARD

PCF 14-2
J Murdock
3-2-15
25.

- Back of envelope (3-2)
- Item (6a) TEST Firings.





PCF 14-2
J. Murdock
3-25-15
26.
S.W.I.F.S. TEST FIRES
LAB# 09P1160 ITEM# 69 CAL 45 LC/410 bore CLASS 6R conv.
PCF 14-2 J. Murdock 3-21-15 (69)
Projectiles #of Bullets 2 HRT 6
#of Cartridge cases 2 HRT 6
MAKE Taurus MODEL The Judge Ultra-lite
SERIAL NUMBER BX715042
69TF1 → 69TF2
69TF3 → 69TF6
EXAMINER/DATE HRT 05/07/2010
LS/GS ≈ .080/.138 (inches) I.005
HRT 01/05/2017
J. Murdock 3-22-15
DO NOT DISCARD
env cut open by J. Murdock on 3-22-15
← no mfg marks on plastic
W-W 45 COLT
45 COLT
Stereo exam = no value for MS comp. 3-30-15 9am
← slug base fits on plastic post
Stereo exam = no value for MS comparison 3-30-15 9am
#69TF-3
Stereo exam = an area of striae that may be useful for comparison purposes 3-30-15 9am
- Base is marked "69TF-3"
rifled shotgun slug with red ink dot phase mark & ID info on base "09P1160, 69TF3 & HRT"

PCF 14-2
J Murdock
3-21-15
21

S.W.I.F.S. TEST FIRES

IFS# ~~FL#~~ 09P01160 LIMS ITEM# 3-1 CAL 45/410 CLASS 6R cow

#of Bullets wads 3 #of ~~Cartridge cases~~ Shotshells 4

MAKE Taurus MODEL The Judge Ultra-Lite

SERIAL NUMBER BX715042 LIMS 3-1TF1 + 3-1TF2 (3-3-2 + 3-3-3)

EXAMINER/DATE 08/10/2011

PCF 14-2
J. Murdock
3-21-15 (3-1) TFs

LIMS 3-1TF3 + (4-1-2) 3-1TF4 (Eva ammo) No. 7½ shot

DO NOT DISCARD

S.W.I.F.S. TEST FIRES

IFS ~~LIMS~~ ~~FL#~~ 09P01160 LIMS ITEM# 3-1 CAL 45/410 CLASS 6R cow

~~#of Bullets~~ wads 7 #of ~~Cartridge cases~~ Shotshells 7

MAKE Taurus MODEL The Judge Ultra-Lite

SERIAL NUMBER BX715042 LIMS 3-1-1 = 3-1TF5 + 3-1TF6 + 3-1TF7 + 3-1TF8 + 3-1TF9 + 3-1TF10 + 3-1TF11 (lab ammo) No. 6 shot

EXAMINER/DATE 09/28/2011

PCF 14-2
J. Murdock
3-21-15 (3-1) TFs

DO NOT DISCARD

S.W.I.F.S. TEST FIRES

IFS-09-01160 ITEM# 3-1 CAL 45/410 CLASS 6R cow

#of Bullets slugs 2 #of Cartridge cases shotshell 2

MAKE Taurus MODEL The Judge (4510TKR)

SERIAL NUMBER BX715042 LIMS 3-1-2 3-1TF12, 3-1TF13

EXAMINER/DATE 02/29/2012

PCF 14-2
J. Murdock
3-21-15 (3-1) TFs

DO NOT DISCARD

— not opened by J Murdock (contains only slugs).

PCF14-2
J Murdock
3-25-15
28.

S.W.I.F.S. TEST FIRES

IFS# ~~FL#~~ 09Pc1160 LIMS ITEM# 3-1 CAL 45/410 CLASS ... cow

#of ~~Bullets~~ wads 3 #of ~~Cartridge cases~~ Shotshells 4

MAKE Taurus MODEL The Judge Ultra-lite

SERIAL NUMBER BX715042 LIMS 3-1TF1 & 3-1TF2 (3-3-2 + 3-3-3)

EXAMINER/DATE KT 08/10/2011

PCF14-2
J Murdock
3-21-15 (3-1) TF's

LIMS 3-1TF3 (wad lost on range) & (4-1-2) 3-1TF4

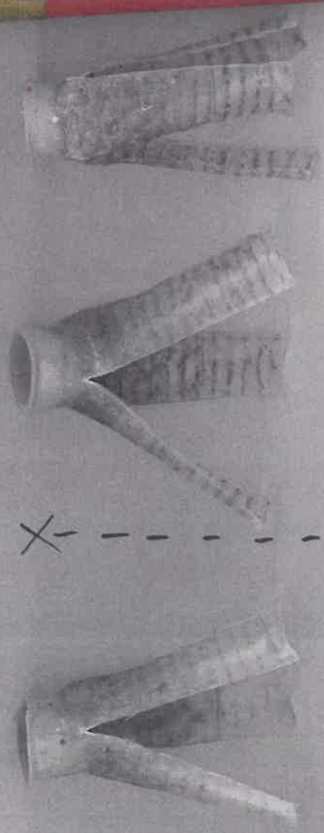
(Eva ammo) No. 7½ shot

Cut open by J Murdock →

DO NOT DISCARD ~~J Murdock 3-25-15~~

arranged in no particular TF order.

no mfg marking on plastic

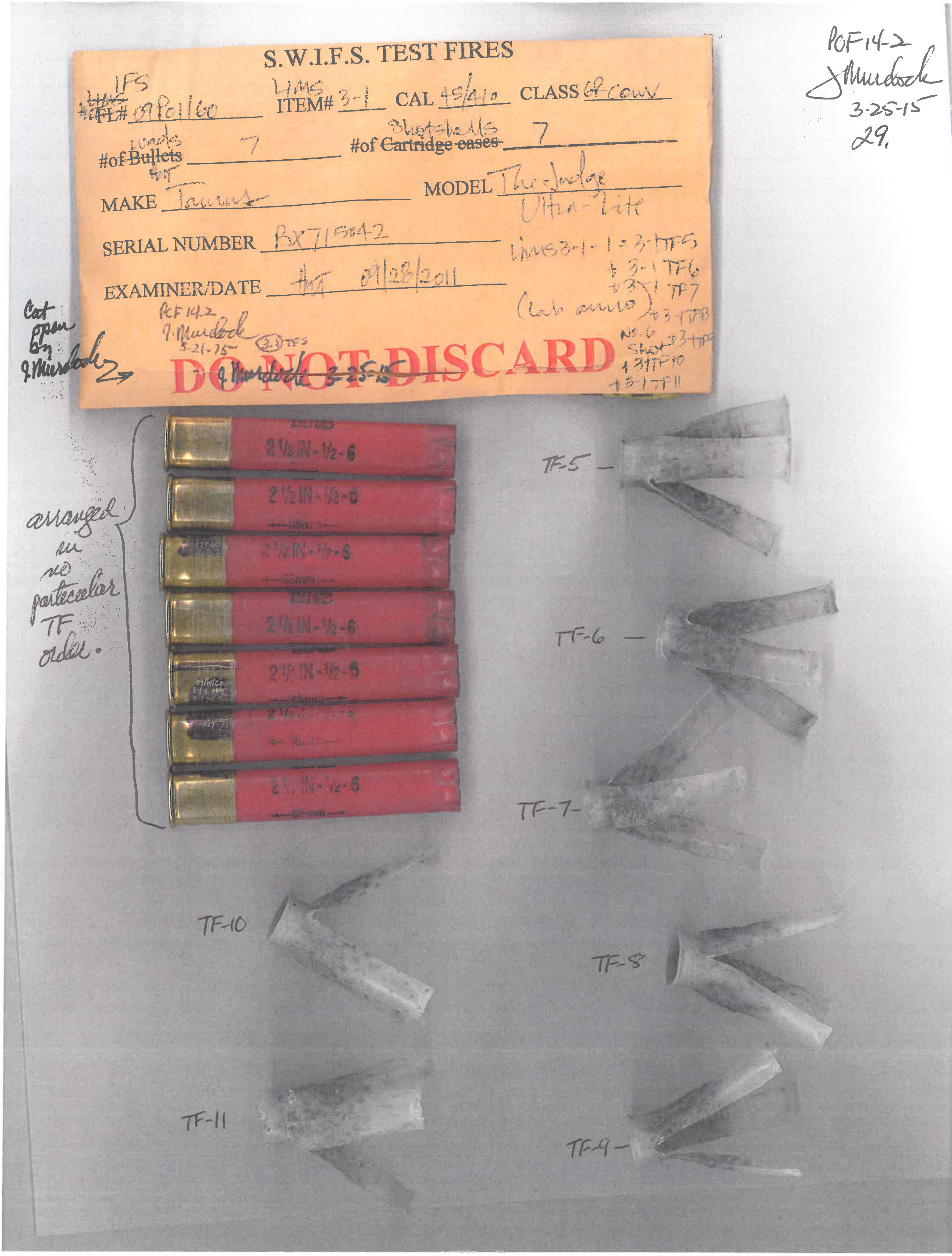


— TF-1

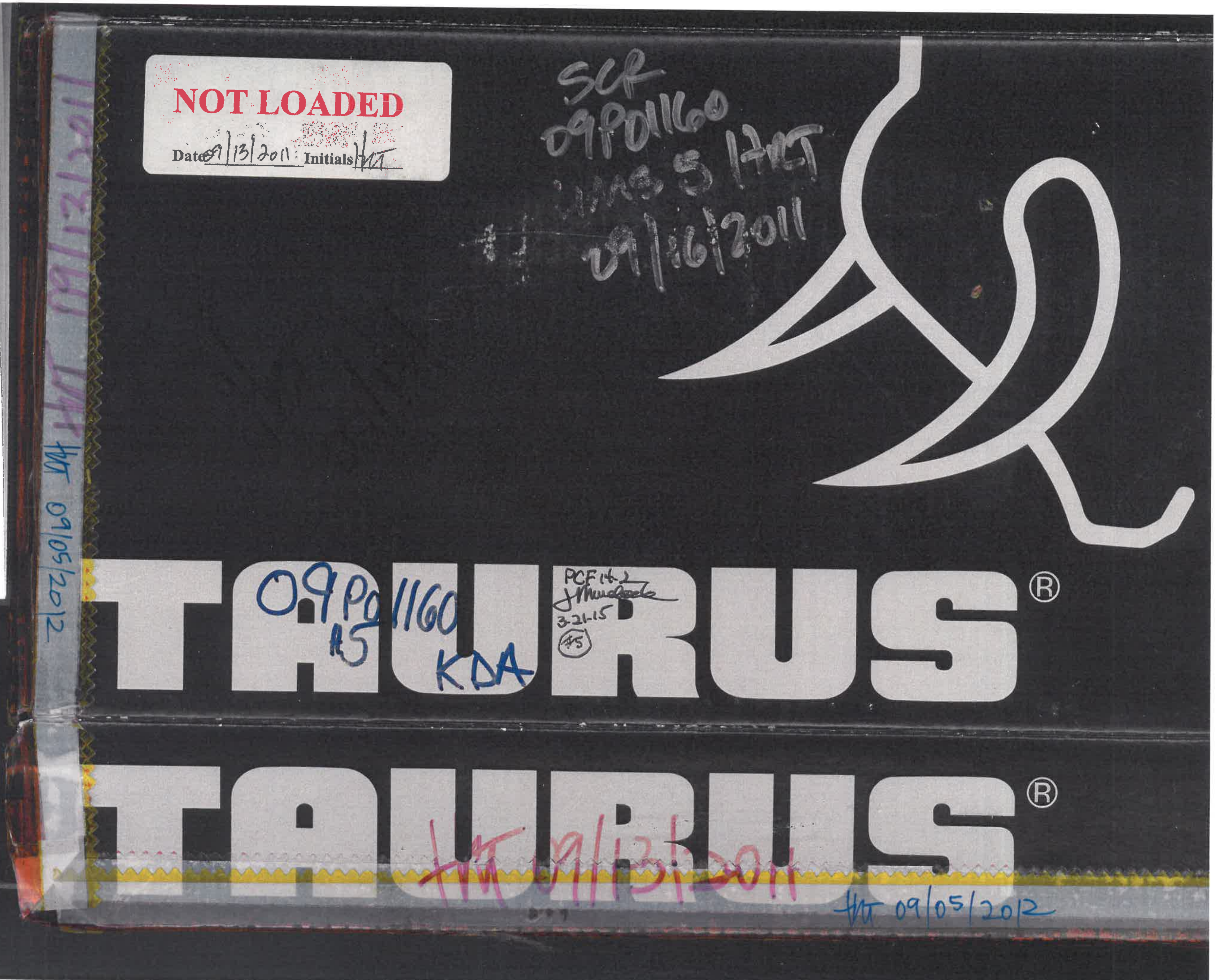
— TF-2

(no TF-3 wad present)

— TF-4

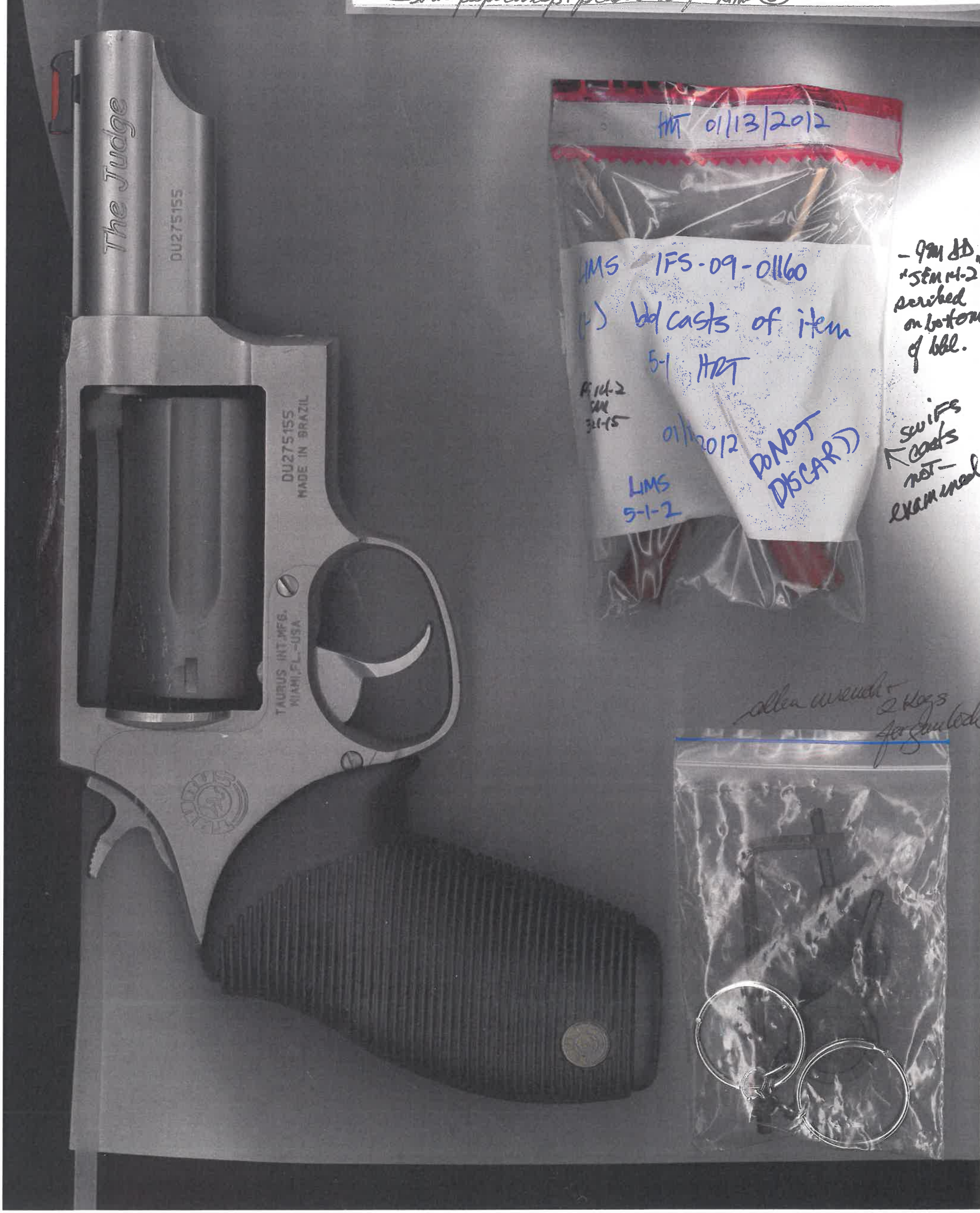

PCF 14-2
J Murdock
3-25-15
29.
S.W.I.F.S. TEST FIRES
IFS FL# 09P01160
LIMS ITEM# 3-1
CAL 45/410
CLASS GR conv
#of Bullets wads 7
#of Cartridge cases Shotshells 7
MAKE Taurus
MODEL The Judge Ultra-Lite
SERIAL NUMBER BX715842
LIMS 3-1-1 = 3-1TF5 + 3-1 TF6 + 3-1 TF7 + 3-1TF8 + 3-1TF9 + 3-1TF10 + 3-1 TF11
(Lab ammo) No. 6 Shot
EXAMINER/DATE 09/28/2011
PCF 14.2 J. Murdock 3-21-15
DO NOT DISCARD
Cut open by J Murdock
2 1/2 IN - 1/2 - 6
arranged in no particular TF order.
TF-5
TF-6
TF-7
TF-8
TF-9
TF-10
TF-11

PCF 14-2
3-21-15
30,
LIMS #(5)



—Gun box also contg:
—Taurus revolver manual
—warrantee card
—brn paper wrap + plastic bag. LIMS#5

PCF 14-2
J Murdock
3-21-15 31.



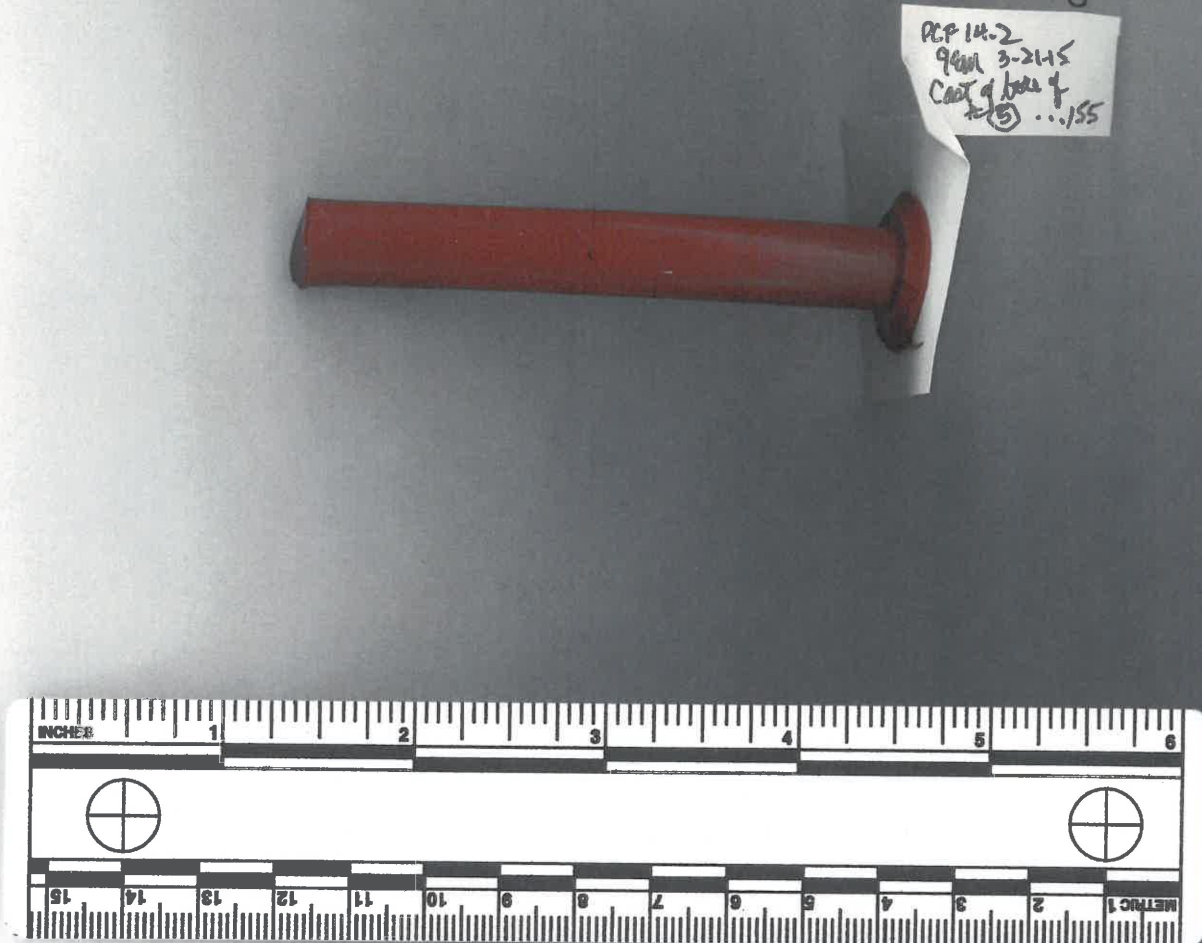
—9mm dd. "JSM 14-2" scribed on bottom of bbl.

SWIFS casts not examined

allen wrench: 2 bags
J Murdock

PCF 14-2
JMurdock
3-21-15
32.

Bore cast made by
JMurdock
Designated - (5-1A)



- An exam of bore cast w/ oblique light under Stereo MS revealed no marks w/ subclass potential.

[signature]

PCF 142
JMurdock
3-21-15
33.

SWIPS Test Fires and Standards

LIMS# 09P01160 Item# 5-1 CAL 45/410 CLASS 6R

# of wads 7 # of Shotshells 8

PCF 142
JMurdock
3-21-15
(51)

MAKE Taurus Model The Judge

Serial Number DU275155

09P01160
Item# 005-001-001
5 test fires labeled as 5-1TF4 t
Type: Test Fire

Examiner / Date [initials] 09/27/2011

← evidence ammunition
LIMS item 4-1-5 (5-1TF1, 5-1TF2, 5-1TF3)
← lab ammo
LIMS item 5-1-1 (5-1TF4, 5-1TF5, 5-1TF6, 5-1TF7, 5-1TF8

~~LIMS item [illegible]~~

↑ Test firings not examined.

PCF142
J Murdock
3-21-15
34.

LIMS# 09P01160 Item# 6-1

SWIPS TEST FIRES and S

CAL 45/.410 Class 6R conv #of wads 7

#of shotshells 7

Make Taurus Model The Judge

Serial Number DU275141

Examiner /Date [initials] 09/21/2011

09P01160
Item# 006-001-001
5 test fires labeled as 6-1TF3 t
Type: Test Fire

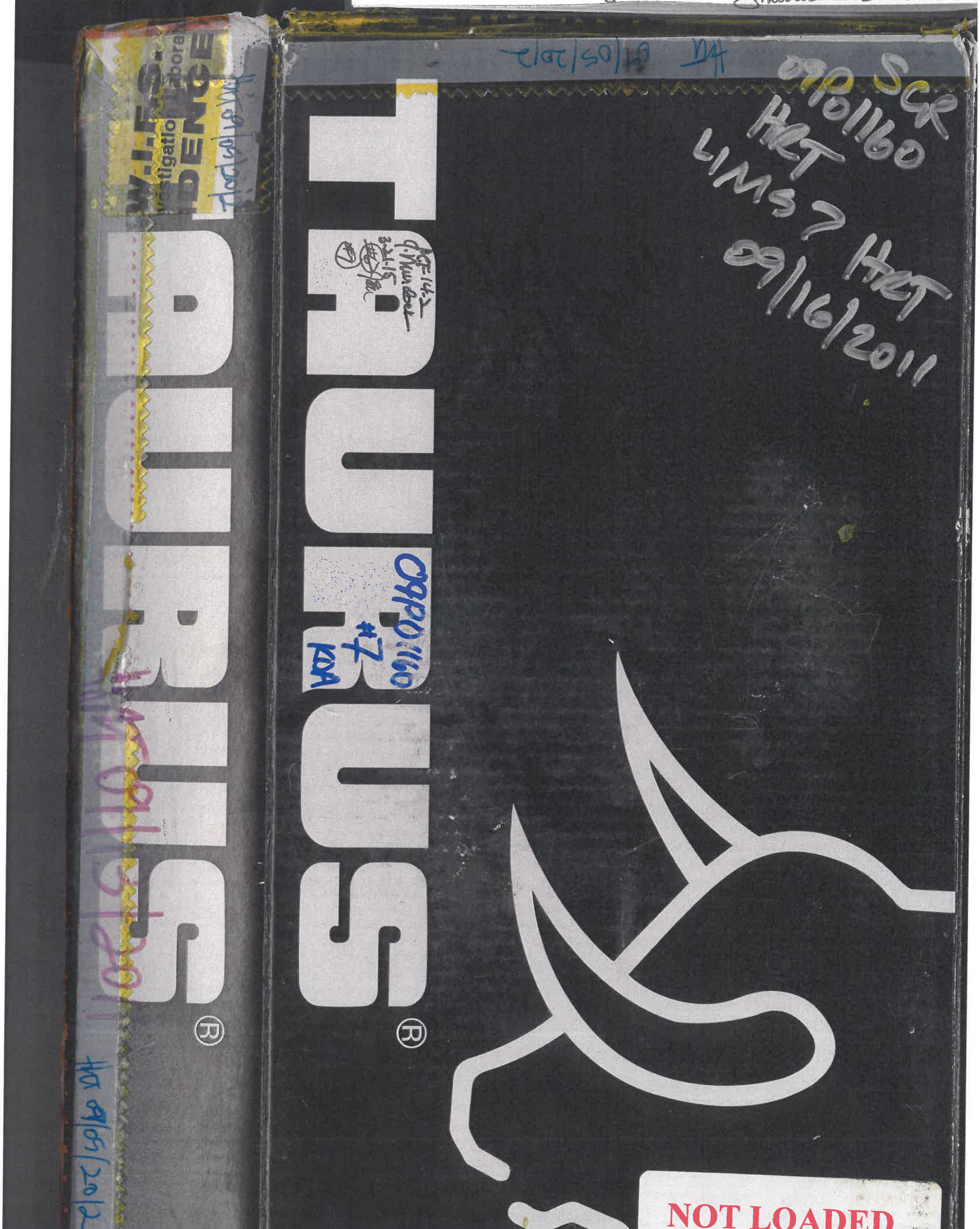
PCF142
J Murdock
3-21-15
(6-1)

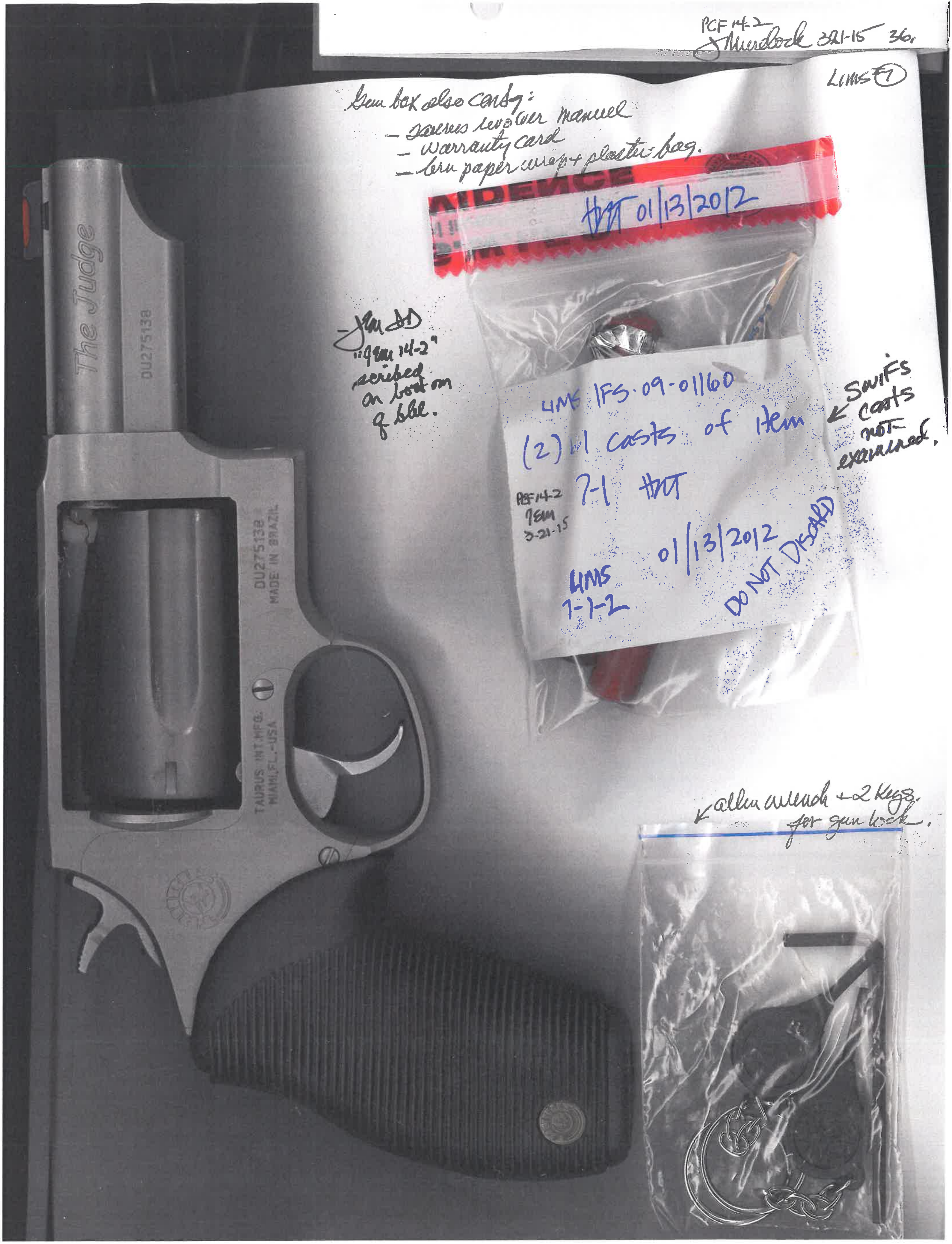
← evidence ammunition
LIMS item 4-1-4 (6-1TF1 + 6-1TF2)

← lab ammunition
LIMS item 6-1-1 (6-1TF3, 6-1TF4, 6-1TF5, 6-1TF6, 6-1TF7)

↑ Test firings not examined.

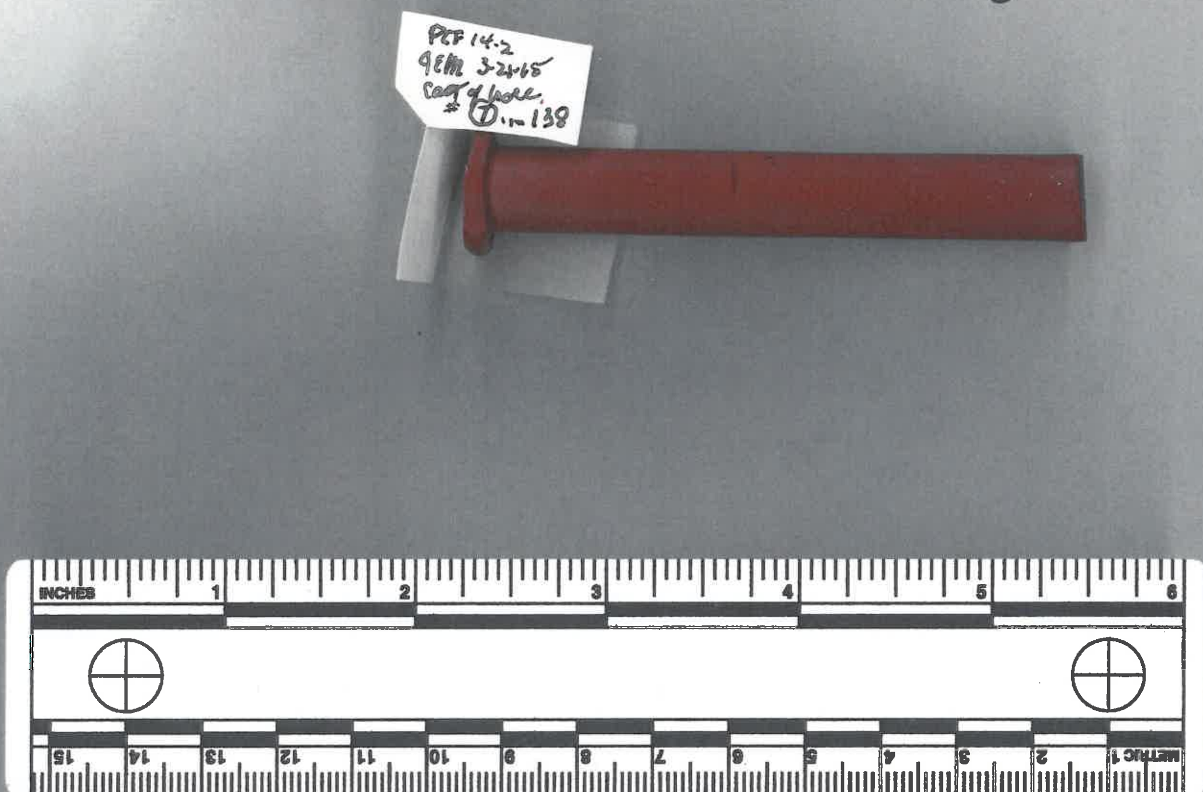
LIMS #7 PCF 14-2 3-21-15




PCF 14-2
3-21-15
LIMS #7
Gun box also contg:
– warranty card
– brn paper wrap + plastic bag.
01/13/2012
The Judge
DU275138
DU275138
MADE IN BRAZIL
TAURUS INT. MFG.
MIAMI, FL.-USA
LIMS IFS-09-01160
casts of item
7-1
PCF 14-2
3-21-15
01/13/2012
LIMS
7-1-2
DO NOT DISCARD
SWIFS casts not examined.
allen wrench + 2 keys for gun lock.

PCF 14-2
[signature]
3-21-15
37.

Bore cast made by
[signature]
Designated - 1-1A



- oblique light exam
w/ stereo MS revealed
<u>no</u> marks w/
subclass potential.

[signature]

PCF 14-2
J Murdock
3-21-15
38.

SWIFS Test Fire and Standards

LIMS # 09P01160 Item # 7-1 Cal 45/.410 Class 6R conv

Make Taurus Model The Judge

# of Wads 7 # of Shotshells 8

Serial Number DU275138

Examiner | Date HKT 09/20/2011

09P01160
Item# 007-001-001
5 test fires labeled as 7-1TF4 -
Type: Test Fire

PCF 14-2
J Murdock
3-21-15
7-1

evidence ammunition
LIMS item 4-1-3 (7-1TF1, 7-1TF2, + 7-1TF3)
lab ammunition
LIMS item 7-1-1 (7-1TF4, 7-1TF5, 7-1TF6, 7-1TF7, 7-1TF8)

Test firings not examined.

Laboratory Worksheet

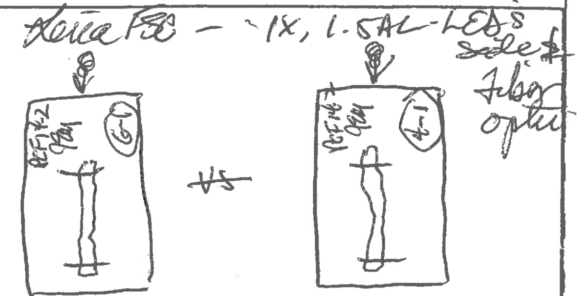
– Microscopic Comparison of Casts of Plastic Wads from Autopsy – Leica FSC –

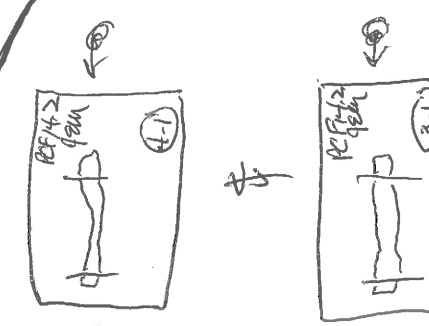
– Forensic Sil (brown) casts stapled to cardstock

① Cast of (6-1) vs Cast of (4-1) →

– Excellent agreement shown w/ fiber optic rear oblique light for pos id – > 3D QCMS criteria. (*)

An especially coarse & well marked area is in center of cast – Cut cast directly opposite this area on purpose. (*)(*)





② Cast of (4-1) vs Cast of (3-1)

– although there is much less MS detail on (3-1), there is still suff agreement > 3D QCMS criteria for pos id – 20X → 40X

–

(*) This criteria is the one proposed by Biasotti & Murdock in 1997 Chapter of "Modern Scientific Evidence – The Law & Science of Expert Testimony – Same criteria throughout these case notes.

(*)(*) This well defined area on all three autopsy wads was marked with a red ink dot by SWIFS & cut each cast in a pre-selected area opposite to this area.

- SWIFS Test Fire #69TF-3 -slug

- 360° cast made using Forensic Sil (brown)
- Cast cut opposite to red ink phase mark and stapled to piece of card stock.

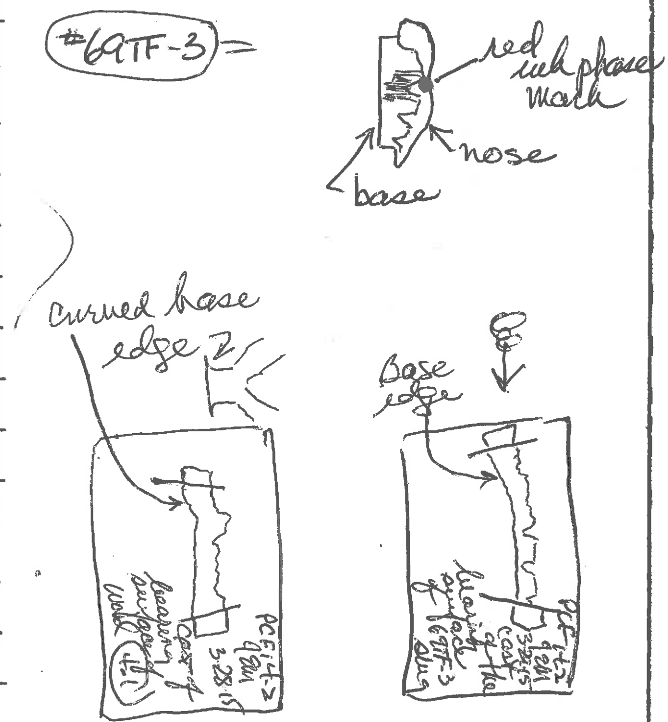
- This cast of #69TF-3 compared microscopically on Leica FSC using both diffuse LED's and fiber optics back lighting.

Results

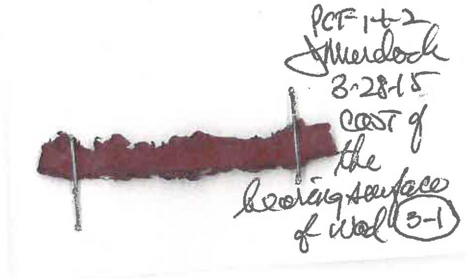
1. Bases to left (Cast of 41 (L) vs Cast of 69TF-3)
- no sig agreement - and center of each cast - where prominent doublet is located lined up. 10X→20X used. See drawing of cast orientation - these notes page - 41.

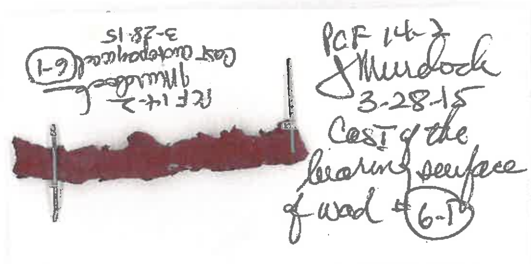
Laboratory Worksheet

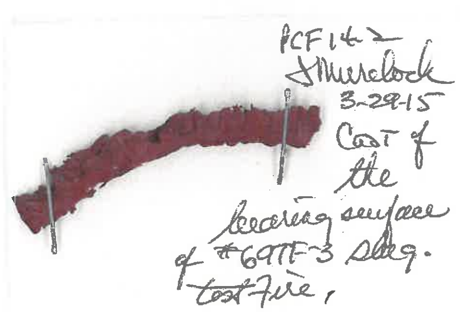
– Comparison of Cast of Autopsy Wad (4-1) w/ cast of bearing surface of slug (#69TF-3)



PCF 14-2
J Murdock
4-1-15
42.







Laboratory Worksheet

Laboratory Number: ACF142
Analyst: [signature]
Date(s): 3-30, 4-1-15
Page: 43 of

- Evaluation of plastic wads test fired in Taurus Judge SN — BX715042 by SWIFS:
- Using Stereo w/ oblique fiber optic illumination -
- Lims 3-1TF 1, 2 and 4 (#3 "wad lost on range"):

- #2 at base edge has best markings.

- Lims 3-1 TF 5, 6, 7, 8, 9, 10 and 11:

- #5, 7, 8, 9 and 11 marked best

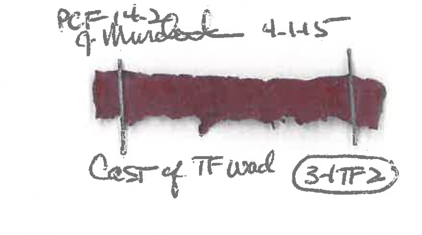
4-1-15

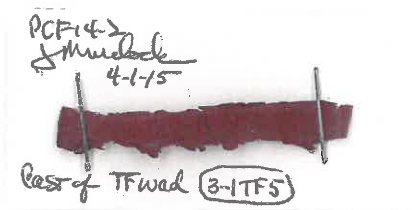
- Forensic Sil (brown color) casts made of the 360° base bearing surface of following TF wads, based on oblique light evaluation described above:

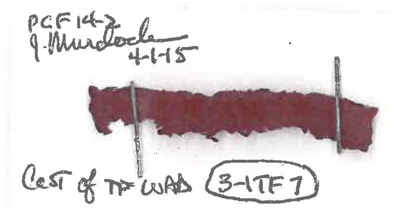
See color copy of these casts, on page 44.
- 3-1TF2
- 3-1TF5
- 3-1TF7
- 3-1TF8
- 3-1TF9
- 3-1TF11

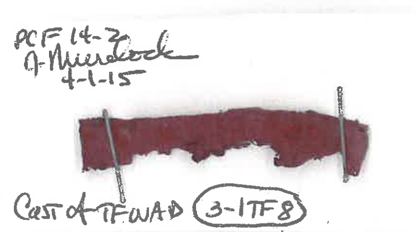
PCF14-2
J Murdock
4-1-15
44.

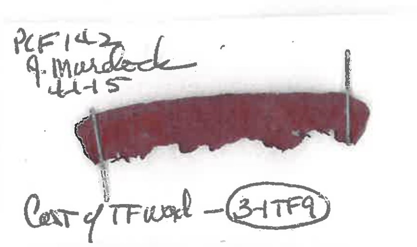
Color copy of casts —

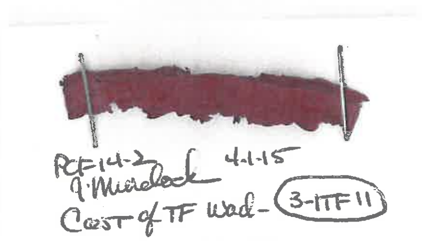












Laboratory Number: PCF 14-2
Analyst: J Murdock
Date(s): 3-28, -29, 4-1-15
Page: 45 of ____

Evidence Comparison Worksheet

Comparisons	Class	Individual	Conclusion	Remarks
Cast of wad (4-1) vs. Cast of wad (3-1)	agree	-accomp of individual ① firearm produced marks - suff agreement >QCMS for ID criteria = pos ID.		See photos ①, ② + ③.
vs.				
Cast of wad (6-1) vs. Cast of wad (4-1)	agree	"	"	see photos - ④ + ⑤
-Photos ⑥ + ⑦ → ~~vs.~~				-photos ⑥ + ⑦ are of the base of rifled TF slug - #69TF-3
3-29-15 Autopsy wad (4-1) vs. Rifled slug #69TF-3	SWIFS red phase marks at 12 o'clock	-Compared w/ base of each to right. This comparison, between lead + plastic does not show enough		see photos ⑧, ⑨ + ⑩.
~~vs.~~	-base of each on right.	agreement for a TM ID - either by Pattern Matching or using QCMS ID criteria		
Autopsy wad (4-1) vs. Rifled slug #69TF-3	SWIFS red phase marks at 12 o'clock	-Compared w/ base of each to left as they appear in SWIFS photo at the bottom of "Case Summary Worksheet",		-See photos ⑪, ⑫ + ⑬ + ⑭
vs.	-base of each on left.	dated Oct 19, 2010: - MS comparison in this SWIFS configuration also does not show enough		
vs.		agreement for a TM ID - Either by Pattern Matching or using QCMS ID criteria.		
Cast of wad (4-1) vs. Cast of Rifled slug #69TF-3	SWIFS red phase mk kept in center of cast of slug.	-no significant MS agreement is present - Casts compared all along one another ⇆.		-no photos 10X → 20X and LED's used.
4-1-15 vs.				
Cast of TF wad (3-1TF5) vs. Cast of TF wad (3-1TF8)	-base of each on left.	-Excellent agreement in individual ② firearm produced striae - all along casts - sufficient for ID - >QCMS-ID criteria		-See photos ⑮, ⑯, ⑰, ⑱ + ⑲
Cast of TF wad (3-1TF5) vs. Cast of TF wad (3-1TF9)	-base of each on left.	-Same excellent " noted above with (3-1TF5) vs (3-1TF8) - demonstrates that this ID-able detail reproduces well.		-no photos 10X, no AL LED's.
vs.				
Cast of TF wad (3-1TF5) vs. Cast of Autopsy wad (6-1)	-base of each on left.	-no significant matching toolmarks -Casts compared all along length of each ③		see ~~no~~ photos ⑳ + ㉑ TM - 0.4X, LSAL = 6X + 10X.

Additional Notes: ① Assuming these three ? autopsy wads were fired in a Taurus revolver, these bbls are not known for imparting subclass influence to projectiles fired through them. ② An exam of Taurus rev SN BX715042 revealed bore to have a sand blasted finish = no subclass influence* ③ So, autopsy wads have reproducible toolmarks; test wads from Taurus Judge SN BX715042 also has reproducible toolmarks on wads - but these two reproducible groups do not match each other ⇒ Conclusion - Autopsy wads were not fired in T.J SN BX715042.

*other than that noted on borecast by J. Murdock - see p. 22.

Laboratory Worksheet

Photo data record

Fiberoptic ill.
#1 jpg – Cast of Wad (4-1) (L) vs Cast of Wad (3-1) – 0.4X, no AL
– low power to show entire width of each cast – matching area is opposite one another.

Fiberoptic ill.
#2 jpg – " vs " – 1.0X, no AL
– closer view – matching areas separated at ÷ line

Fiberoptic ill.
#3 jpg – " vs " – 2X, 1.5AL
– Matching MS detail together at ÷ line.

Fiberoptic ill.
#4 jpg – Cast of Wad (6-1) (L) vs Cast of Wad (4-1) – 0.4X, 1.5AL
– fairly low power shows entire width of each cast – matching area is opposite one another

Fiberoptic ill.
#5 jpg – " vs " – 1.0X, no AL
– shows matching agreement – together at ÷ line.

#6 jpg – The base of #69TF-3 – Rifled Slug Test fired – 0.4, 1.5AL in Taurus Judge Rev SN – BX715042 on 5/7/10 – date according to "SWIFS Test Fires" env for Item #69.
= SWIFS lab # 09P1160, 69TF3 + initials "HRT" can be seen.

#7 jpg – Same view of #69TF-3 as shown in #6 jpg above – 0.4, 1.5AL but w/ added ~~ID~~ info "PCF 14-2 9mm" added w/ scribe.

Laboratory Number: DCF 14-2
Analyst: J Murdock
Date(s): 3-29-15
Page: 47 of ___

Laboratory Worksheet

Photo data record

LED's w/ diffusers

#8 Jpg - Autopsy Wad (4-1) (L) vs #69 TF-3 — 0.4X, no AL
both w/ red ink mark at
12 o'clock ; Separated at ÷ line

#9 Jpg — " vs " — 1.0X, 1.5 AL
- Enlarged + showing that red ink
phase marks are still at 12 o'clock -
Separated at ÷ line.

#10 Jpg — " vs " — 2X, 1.5 AL
- Two images brought together at ÷
line + some correspondence can be
seen — This agreement, between lead
+ plastic, does NOT correspond
well enough to constitute an Id —
Does not meet either 2D or 3D QCMS
criteria.

These three taken with base of wad + rifled slug to right on comp MS.
- Series below; with bases left, as they appear in SCOIFS photo at bottom of "Case Summary Worksheet" dated Oct 19, 2010.

These three taken w/ base of wad + slug to left - as in SWIFS photo ↗

#11 Jpg - Autopsy Wad (4-1) (L) vs #69 TF-3 — 0.4X, no AL
Both w/ red ink mark at 12 o'clock

#12 Jpg — " vs " — 1.0X, no AL
Enlarged but still shows red phase ink +
that both are ≈ same re top dead center

#13 Jpg — " vs " — 2X, 1.5 AL
Two image brought together at ÷ line + some
general correspondence can be seen - but clearly
not suff. for pos Id - does not come close to the
3D or 3D QCMS criteria - Pattern agreement is poor.

Laboratory Number: PCF 14-2
Analyst: J Murdock
Date(s): 3.29, 4-1-15
Page: 48 of

Laboratory Worksheet

Photo data sheet

(#14) jpg - Autopsy wad (4-1) (L) ~~vs~~ #6 TF-3 — 2X, 1.5AL
- Same view as in (#13) jpg above, except that fiber optic light tubes used - from rear -
- Same results as described for (#13) jpg -
no significant agreement.

4-1-15

LED's

(#15) jpg - Cast of TF wad 3-1TF-5 (L) ~~vs~~ Cast of TF wad 3-1TF-8 — 0.4X, no AL
- low power shows ~2/3rds of the length of each cast + some adjacent JEM ID info written on the backing cards.
Matching individual FA produced TM detail is opposite one another, separated at ÷ line - both bases are on left side ½ cast vs wad ⅟

(#16) jpg - " ~~vs~~ " — 0.4X, no AL
- Same view as #15 above - but matching detail moved closer together w/ slight cast over lap.

(#17) jpg " ~~vs~~ " — 0.4X, no AL
- Same view as #15 + 16 above - but matching detail has been moved to being adjacent at ÷ line.

(#18) jpg " ~~vs~~ " — 1X, no AL
- enlarged view of matching detail shown near bottom of photos 15, 16 + 17 above. Suff for Pos Id -> 2 or 3D QCMS

(#19) " ~~vs~~ " — 1X, no AL
enlarged view of matching detail shown near top ½ of photos 15, 16 + 17 above. Suff for pos ID -> 2 of 3D QCMS.

Laboratory Worksheet

Laboratory Number: PCF M-2
Analyst: Murdock
Date(s): 4-1-15
Page: 49 of

Photo data record -

LED's

#20 Jpg. - Cast of T. Wound (3-1TF-5) (L) vs Cast of Autopsy wound (6-1) 0.4, 10AL
- shows about ~~2/3~~ top 2/3's of each cast + some adjacent ID info on each backing card.

#21 Jpg - " ~~vs~~ " - 0.4X, 10AL
- Shows about lower 1/3 of each of the casts shown above in photo 20.

#

Crime Laboratory
Firearms/Toolmarks Section
Digital Image Record

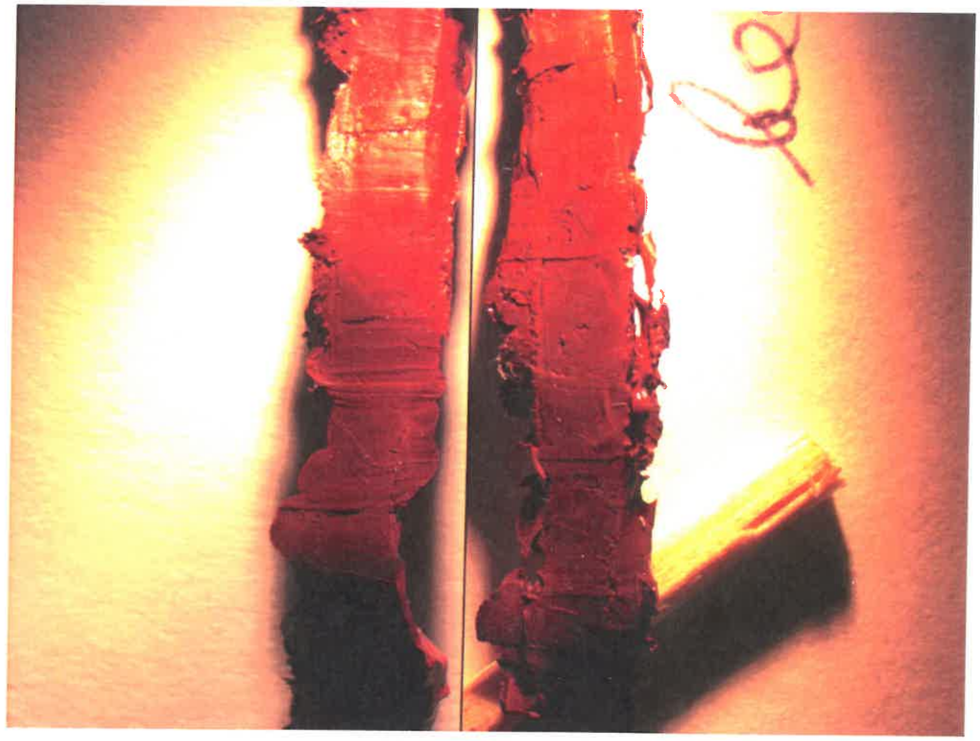
Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Image Number: 1

Subject:
Cast of Wad 4-1 (L) vs Cast of Wad 3-1 –
Low power to show about half of the length of each cast
3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	



Lighting

	LED Side light
	LED Ring light
x	Fiber Optic
	Incandescent
	Fluorescent
	Other

Image Number: 2

Subject:
Cast of Wad 4-1 (L) vs Cast of Wad 3-1 –
Closer view - matching areas separated by dividing line
3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	10
	Other Mag System	

Lighting

	LED Side light
	LED Ring light
x	Fiber Optic
	Incandescent
	Fluorescent
	Other

Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

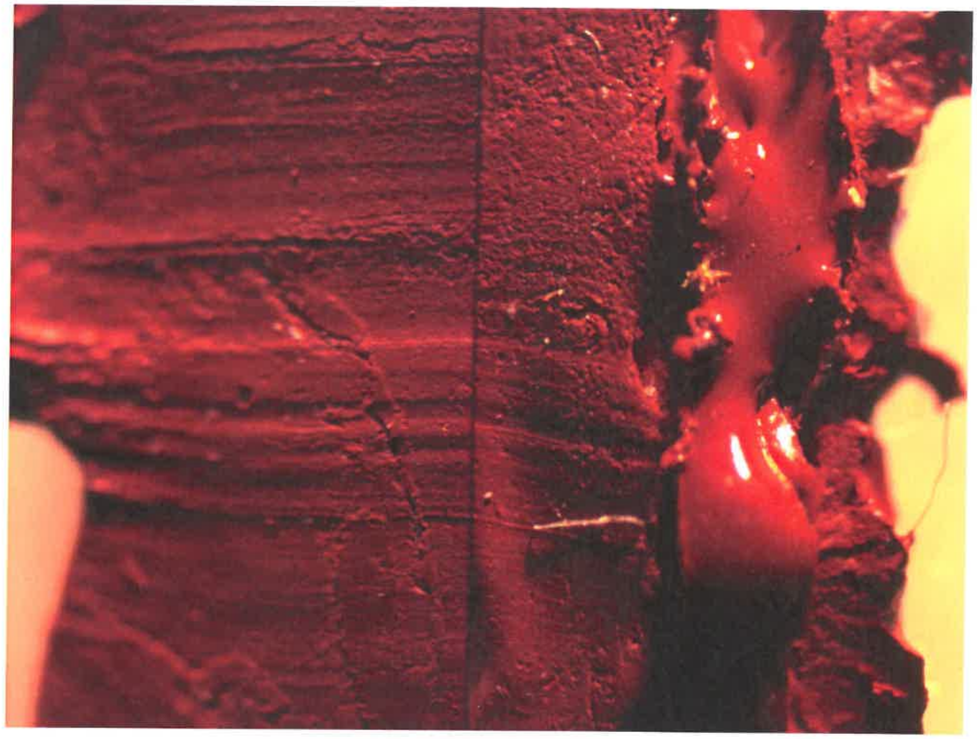
Image Number: 3

Subject:
Cast of Wad 4-1 (L) vs Cast of Wad 3-1 – Matching toolmarks together at dividing line

3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	x
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	30
	Other Mag System	



Lighting

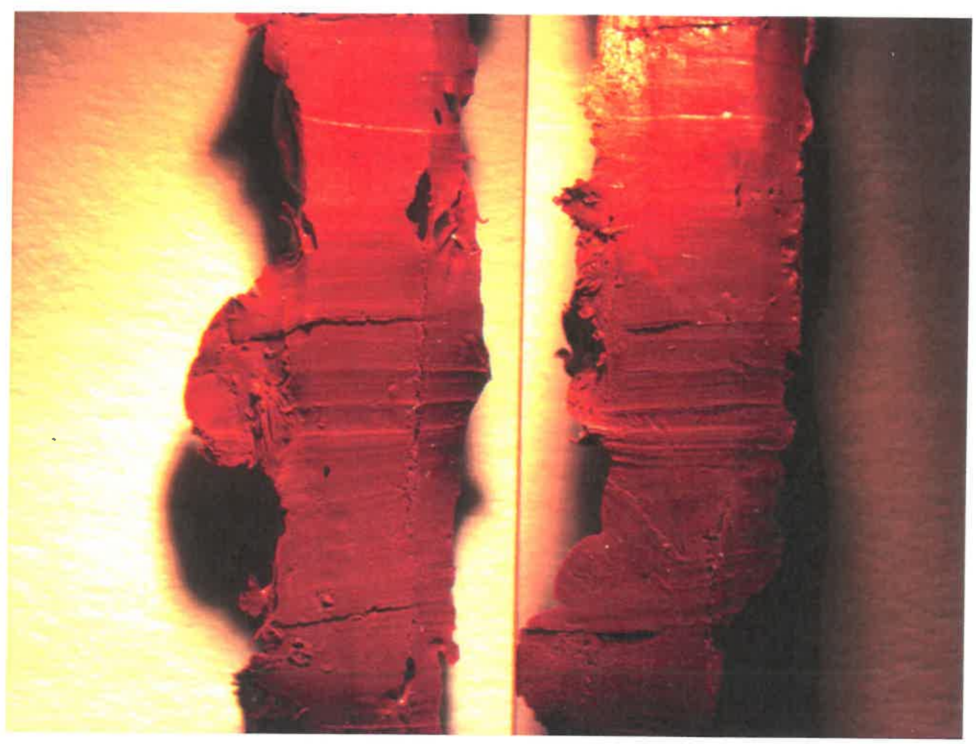
	LED Side light
	LED Ring light
x	Fiber Optic
	Incandescent
	Fluorescent
	Other

Image Number: 4

Subject:
Cast of Wad 6-1 (L) vs Cast of Wad 4-1 – Shows about 1/5th of the length of each cast – Matching toolmarks are opposite one another 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	6
	Other Mag System	



Lighting

	LED Side light
	LED Ring light
x	Fiber Optic
	Incandescent
	Fluorescent
	Other

Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Pg. 52 of ____

Image Number: 5

Subject:
Cast of Wad 6-1 (L) vs Cast of Wad 4-1 – Matching toolmarks together at dividing line

3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	10
	Other Mag System	

Lighting		
		LED Side light
		LED Ring light
	x	Fiber Optic
		Incandescent
		Fluorescent
		Other

Image Number: 6

Subject:
Slug, 69TF-3, test fired in Taurus Judge revolver, SN BX715042. Notation "09P1160, 69TF3, HRT" is present on base
3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	6
	Other Mag System	

Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other

Crime Laboratory
Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: **PCF 14-2**
Analyst: **J. Murdock**
Date: **4-2-15**

Image Number: 7

Subject: Slug, 69TF-3, test fired in Taurus Judge revolver, SN BX715042. Notation "09P1160, 69TF3, HRT" is present on base, J. Murdock ID info added. 3-29-15

Verified by: ____ Date: ____

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	6
	Other Mag System	

Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other

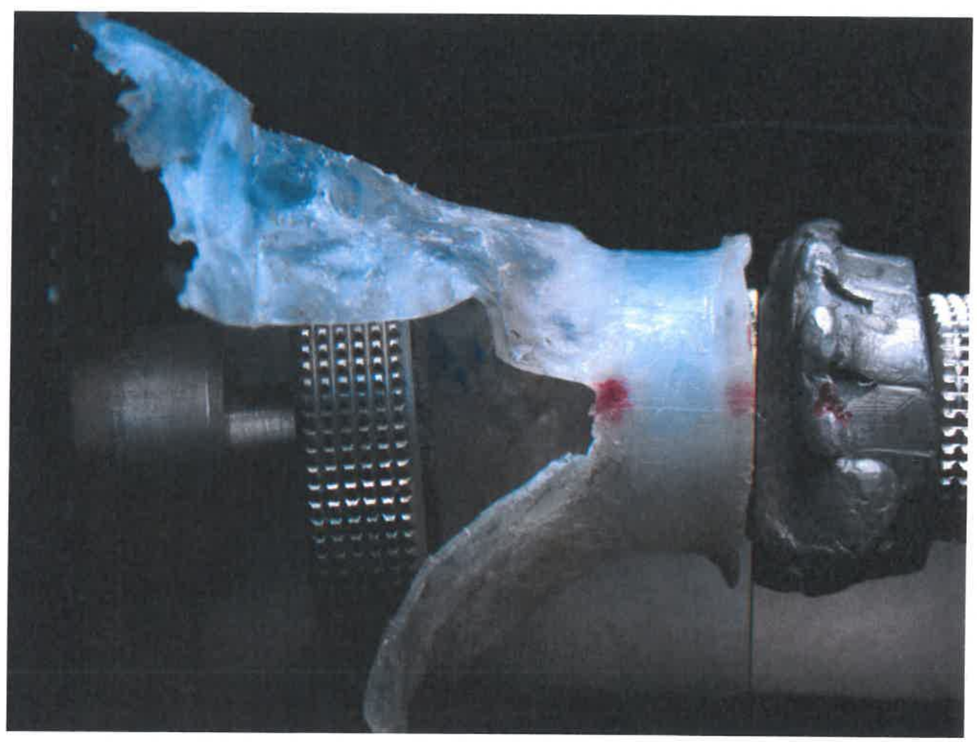
Image Number: 8

Subject: Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to right 3-29-15

Verified by: ____ Date: ____

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	

Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other



Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Image Number: 9

Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to right
3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	15
	Other Mag System	

Lighting

- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

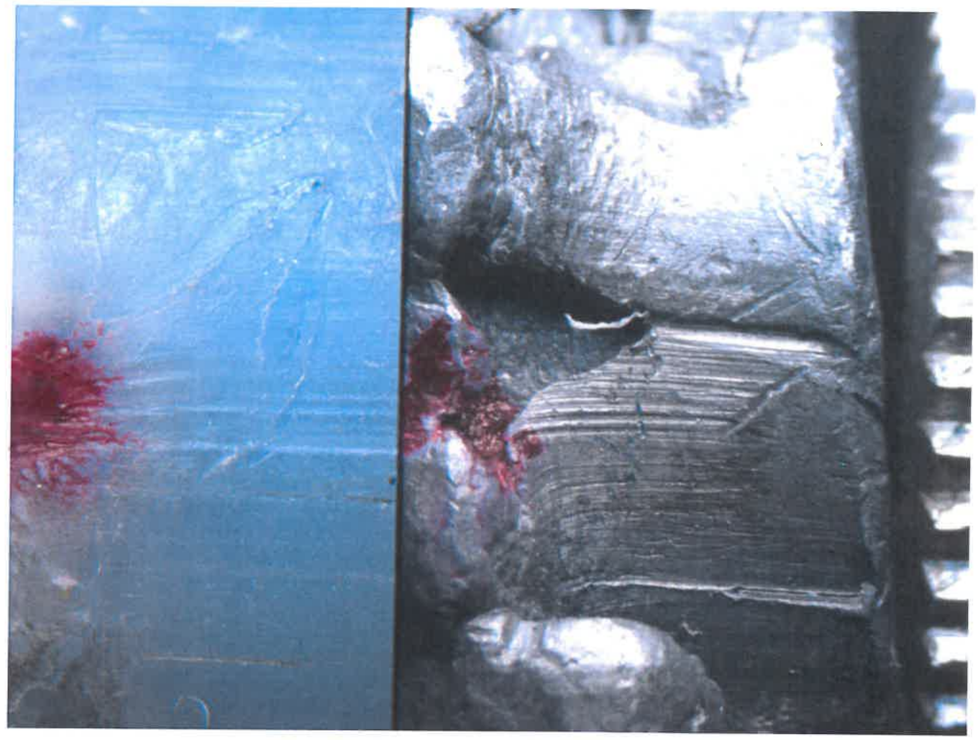


Image Number: 10

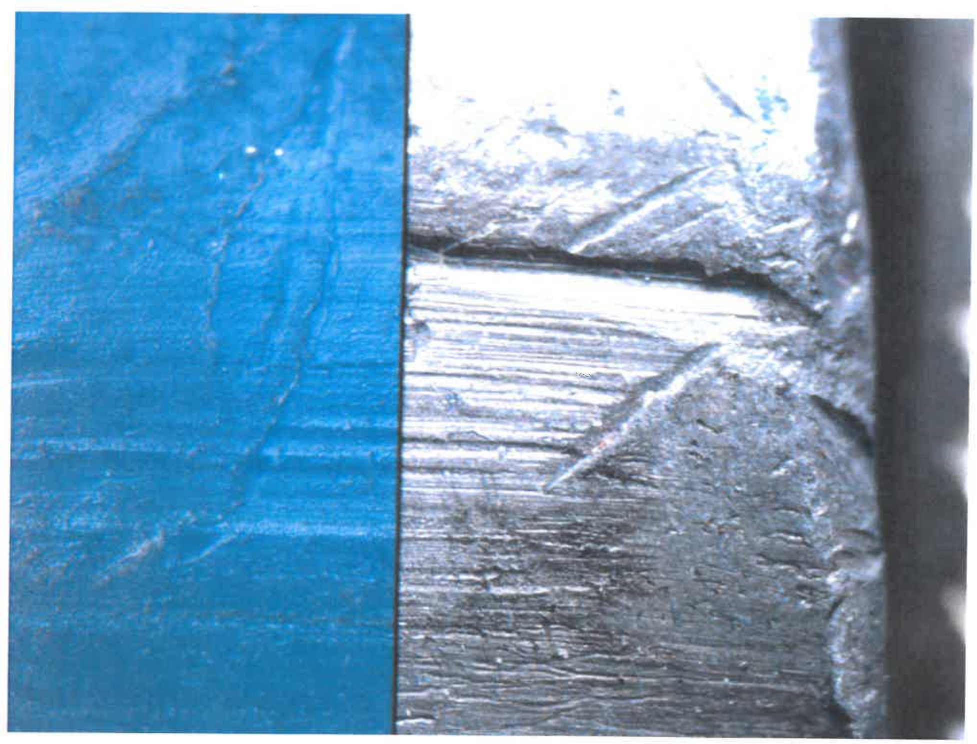
Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to right; some ms agreement is present, Insufficient for ID 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	x
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	30
	Other Mag System	

Lighting

- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other



Crime Laboratory
Firearms/Toolmarks Section
Digital Image Record

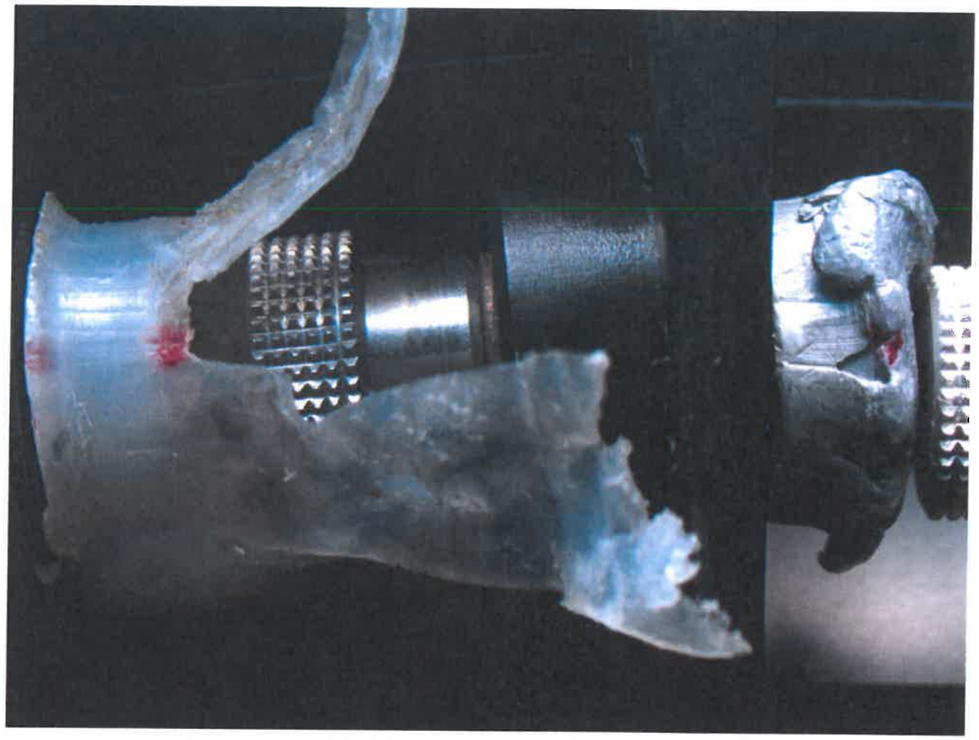
Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Image Number: 11

Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to left, as in SWIFS "Case Summary Worksheet" photo 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	



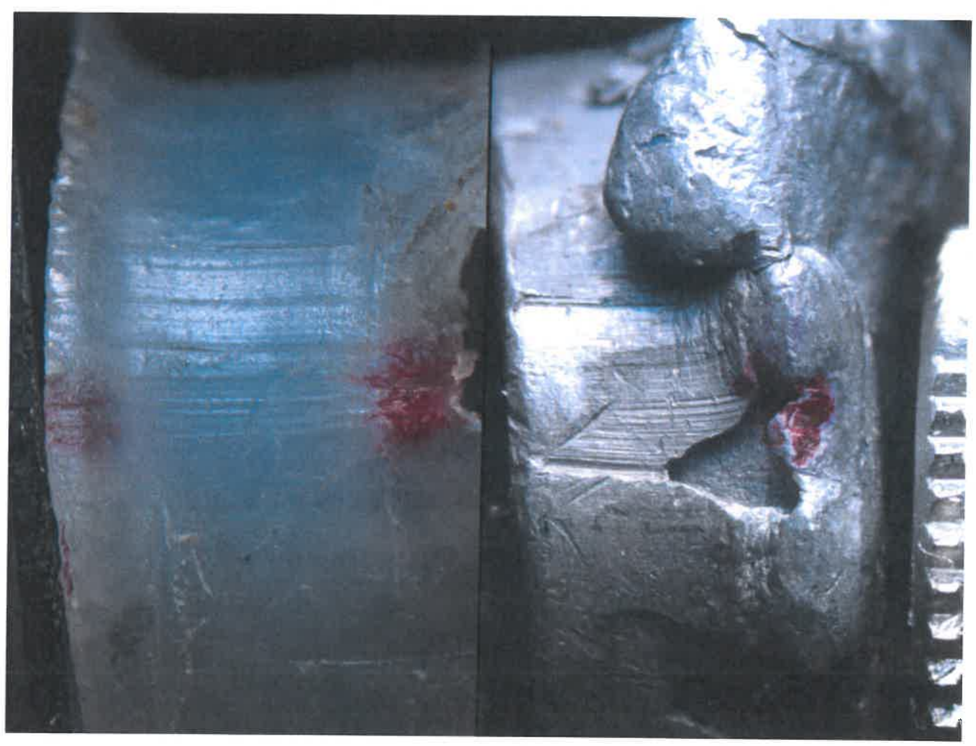
Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other

Image Number: 12

Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to left, as in SWIFS "Case Summary Worksheet" photo 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	10
	Other Mag System	



Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other

Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Pg. 56. of ____

Image Number: 13

Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to left, Some ms agreement is present, Insufficient for ID 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	x
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	30
	Other Mag System	

Lighting

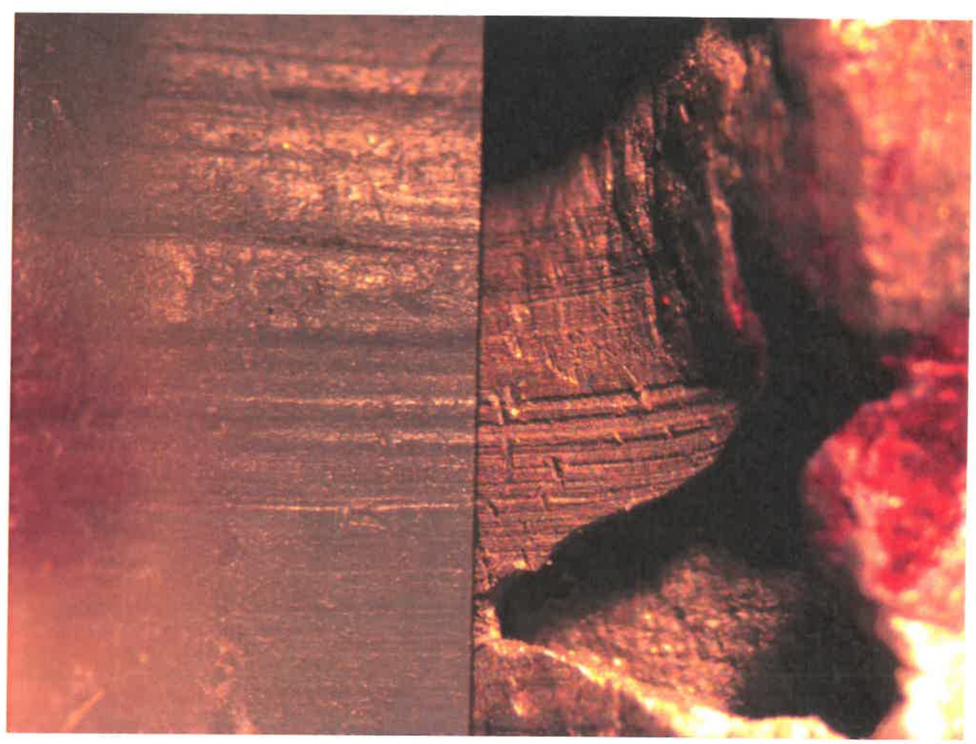
- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Image Number: 14

Subject:
Autopsy Wad 4-1 (L) vs TF Slug 69TF-3 – With SWIFS red phase marks at 12 o'clock, and bases to left, Some ms agreement is present, Insufficient for ID 3-29-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	x
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	x
Other --	Total Magnification:	30
	Other Mag System	



Lighting

- [ ] LED Side light
- [ ] LED Ring light
- [x] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

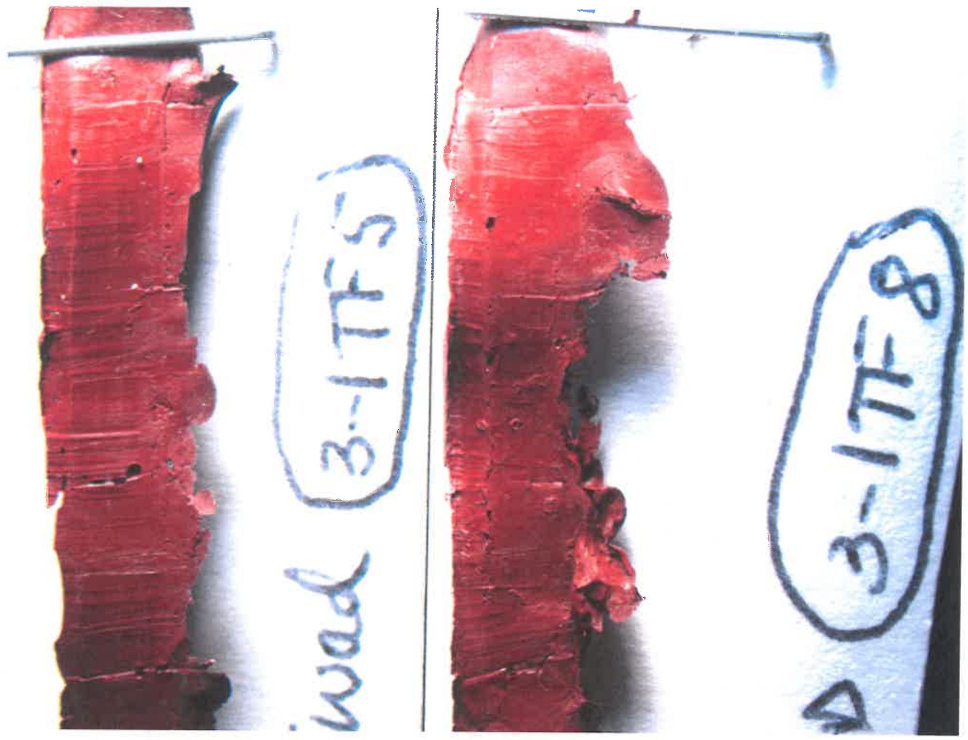
Laboratory Number: PCF 14-2
Analyst: J. Murdock
Date: 4-2-15

Image Number: 15

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of TF Wad 3-1TF-8 – Shows about 2/3rds of cast length – Matching TM's opposite one another, bases on left 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other –	Total Magnification:	4
	Other Mag System	



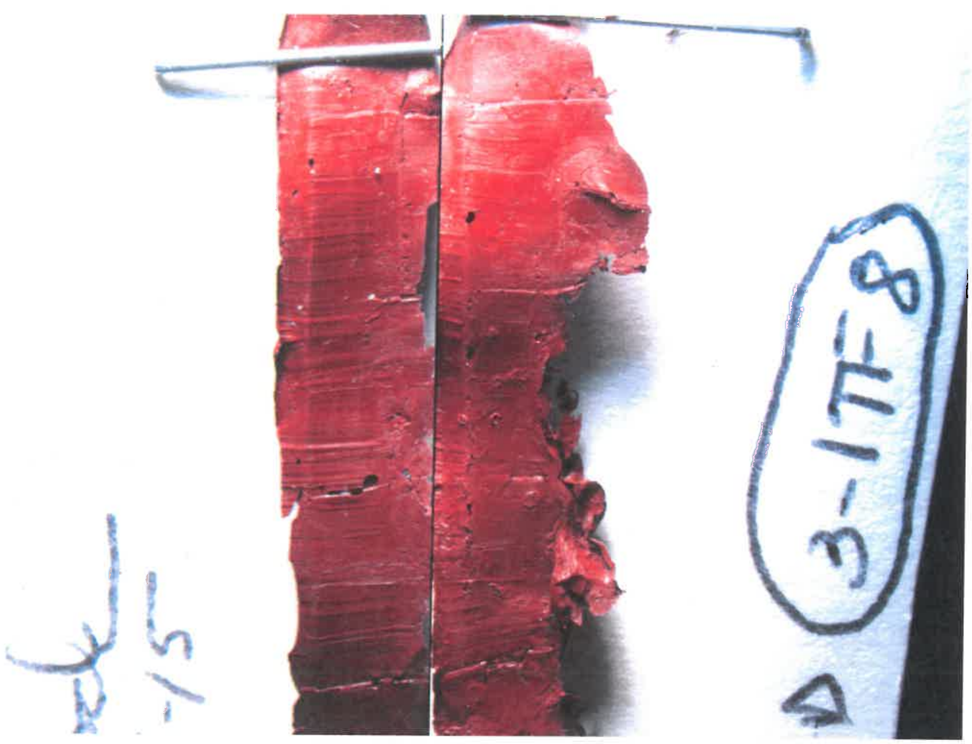
Lighting
- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Image Number: 16

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of TF Wad 3-1TF-8 – Shows about 2/3rds of cast length – Matching TM's opposite one another, bases on left 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	



Lighting
- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Crime Laboratory

Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: **PCF 14-2**
Analyst: **J. Murdock**
Date: **4-2-15**

Pg. 58 of ____

Image Number: 17

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of TF Wad 3-1TF-8 – Shows about 2/3rds of cast length – Matching TM's opposite one another, bases on left 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	

Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other

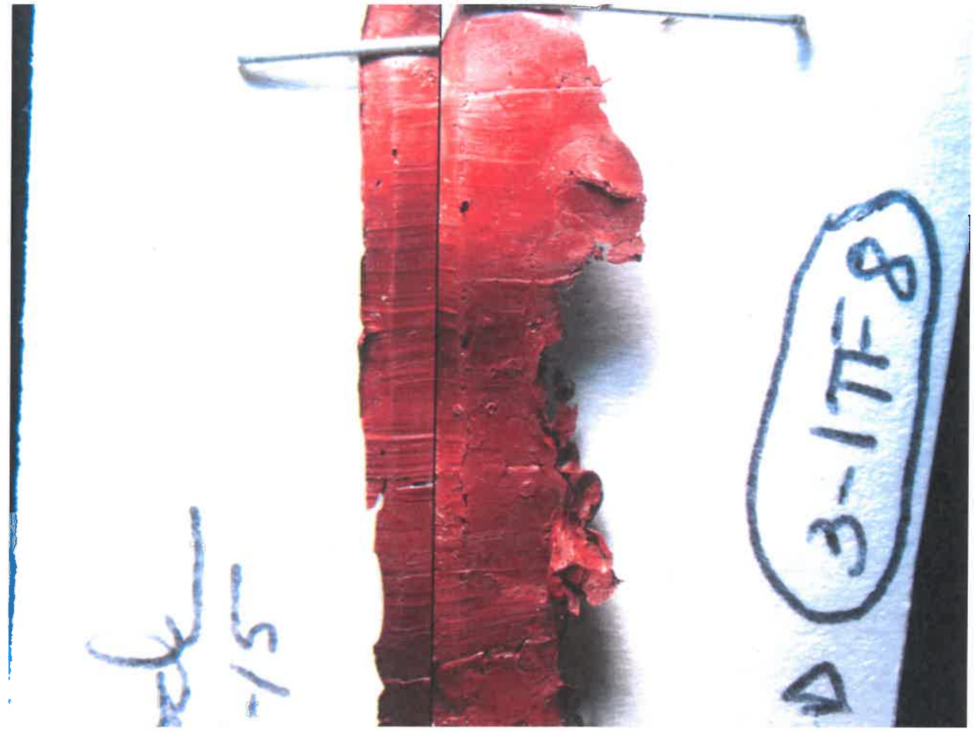


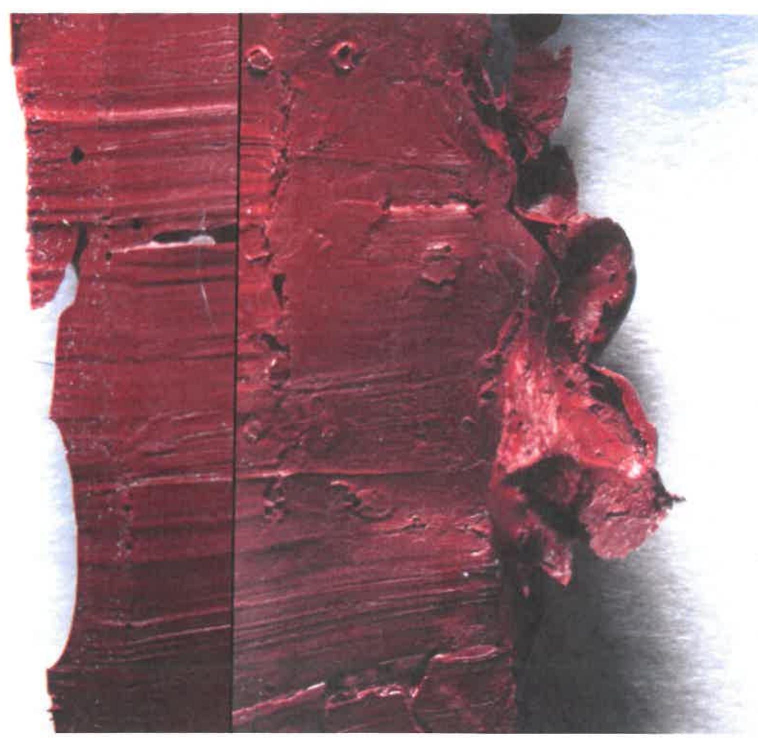
Image Number: 18

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of TF Wad 3-1TF-8 – Shows matching TM's near lower half of photos 15, 16 and 17 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	10
	Other Mag System	

Lighting		
	x	LED Side light
		LED Ring light
		Fiber Optic
		Incandescent
		Fluorescent
		Other



Crime Laboratory
Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: **PCF 14-2**
Analyst: **J. Murdock**
Date: **4-2-15**

Pg. 59 of ______

Image Number: 19

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of TF Wad 3-1TF-8 – Shows matching toolmarks at top half of photos 15, 16 and 17. 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	x
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	10
	Other Mag System	

Lighting

- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

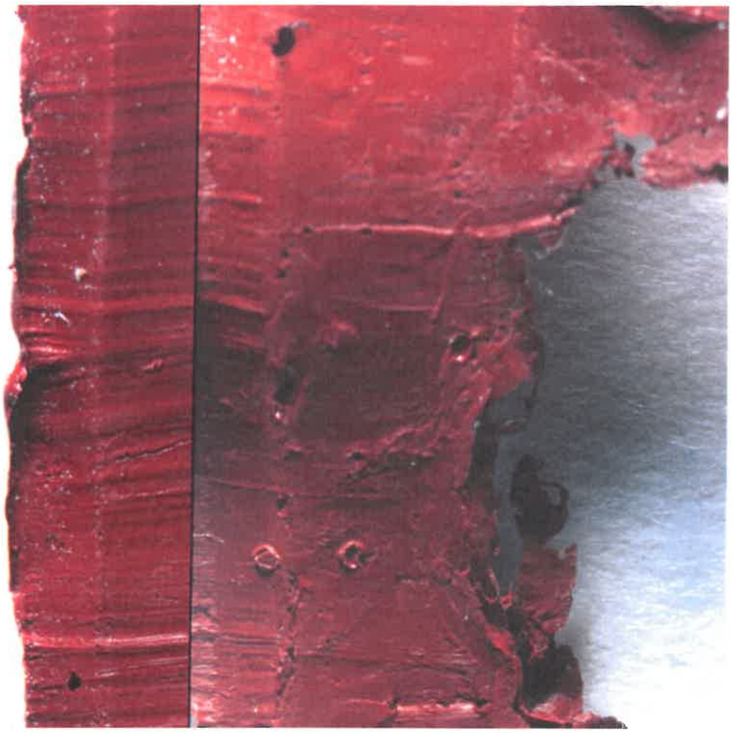


Image Number: 20

Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of Autopsy Wad 6-1 – Shows top 2/3rds of each cast. No significant matching toolmark agreement. 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	

Lighting

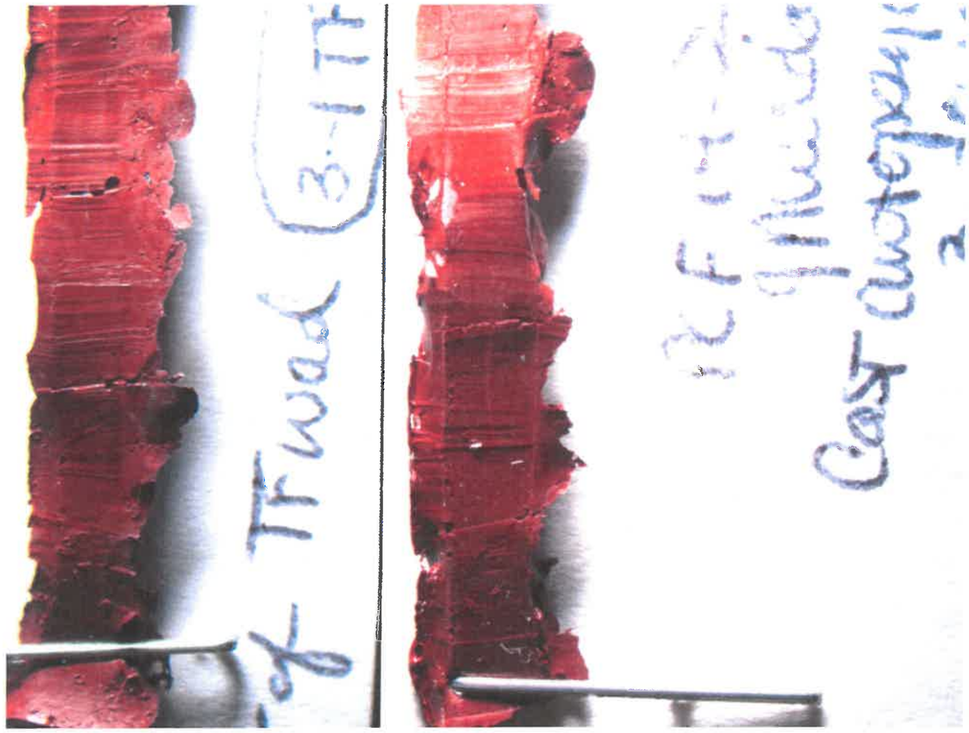
- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Crime Laboratory
Firearms/Toolmarks Section
Digital Image Record

Laboratory Number: **PCF 14-2**
Analyst: **J. Murdock**
Date: **4-2-15**

Pg. 60 of ____

Image Number: 21



Subject:
Cast of TF Wad 3-1TF-5 (L) vs Cast of Autopsy Wad 6-1 – Shows lower 1/3 of each cast shown in photo 20. No significant matching toolmark agreement. 4-1-15

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	x
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope with Leica	4.0x Objective	
Software.	8.0 Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	4
	Other Mag System	

Lighting
- [x] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Image Number: ____

Subject:

Verified by: Date:

Digital Imaging	lens/objective	
Leica DFC 500	0.4x Objective	
Camera on Leica	1.0x Objective	
FSC Comparison	2.0x Objective	
Scope and Leica	4.0x Objective	
Software.	8.0x Objective	
	Zoom (1.5x)	
Other --	Total Magnification:	
	Other Mag System	

Lighting
- [ ] LED Side light
- [ ] LED Ring light
- [ ] Fiber Optic
- [ ] Incandescent
- [ ] Fluorescent
- [ ] Other

Laboratory Worksheet

Laboratory Number: PCF 14-2
Analyst: J Murdock
Date(s): 4-13-15
Page: 61 of ____

- Cast of plastic base wad for Rifled Slug # TF - (69TF3)
made w/ ForensicSil (brown)

Found written on edge of base in blue ink.

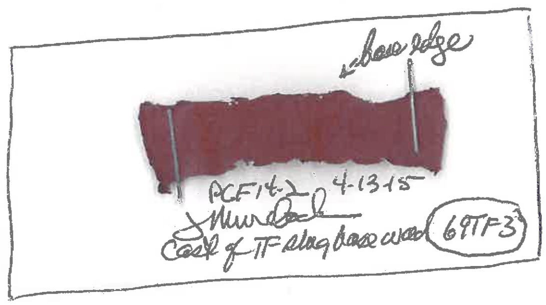
1. - Exam (pre-cast):
- Very little striae are present in L/impressions
- An especially coarse group of striae noted near base, axial to wad - not at L of L + G impressions.
- black "x" placed in an area of very little striae info - so cast will be cut here.

2. - Cast prepared - (see page 62 for copy of this cast.
3. - Cast cut + stapled to backing card - base side marked. (see photocopy of stapled cast) - p. 62.
4. - Cast of (69TF3) (plastic base wad) compared at coarse striae grouping w/ following casts of test wads / cast shot.

{ 3-1TF-2
3-1TF-5
3-1TF-7
3-1TF-8
3-1TF-9
3-1TF-11

Results - no sig agreement - Leica FSC-10X w/ no Lenses. no photos taken. LED's w/ diffusers.

PCF 142
J Murdock
4-13-15
62/62



PCF 14-2 – attachment 14 –
P. 641 and 679 – 730
(52 pages total)

Chapter 35 – 2011-2012 Edition.

Firearms and Toolmark Identification

I. LEGAL ISSUES

§ 35:1 Generally

Reported judicial examinations of the scientific evidence on which toolmark and firearms examination (formerly, and incorrectly, termed "ballistics") expertise rests are relatively few, and the resulting opinions tend to be both empty and opaque. While expert evidence on toolmarks

1997, 1st Edition

Biasotti, A. and Murdock, J., "The Scientific Basis of Firearms and Toolmark Identification" Chapter 23, Section 23-2.0, Modern Scientific Evidence: The Law and Science of Expert Testimony (D. L. Faigman, D. H. Kaye, M. J. Saks, and J. Sanders, West Publishing Co., edition 1997); Currently: Biasotti, A., Murdock, J. and Moran, B., Chapter 35, Vol. 4, pp 641 – 730 in Modern Scientific Evidence: The Law and Science of Expert Testimony (Faigman, DL, Blumenthal, JA, Sanders, J, Chen, EK., Mnookin, JK, and Murphy, EE. edition 2011 – 2012), Eagan, MN: Thompson –Reuters/ West.

ful force for pushing for the creation and development of this information. If courts continue to engage in band-aid cures instead of forcing deeper solutions, and continue to justify admissibility through forms of grandfathering, firearms and toolmark practitioners have limited incentives to devote the resources, time, and energy to developing better data and better information about the strengths and weaknesses of their field.

II. SCIENTIFIC ISSUES

by Alfred Biasotti, John Murdock** & Bruce R. Moran****

§ 35:7 Introductory discussion of the science

Forensic firearms examiners are concerned with such varied tasks as:

(1) serial number restoration;
(2) examination of suspected gunshot residues;
(3) function testing of firearms;
(4) determination of muzzle to target distance;
(5) determining what kind of firearm was responsible for firing recovered bullets or cartridge cases;
(6) aiding in the reconstruction of crime scenes through the examina-

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*Alfred A. Biasotti (1926–1997), M.S. in Criminalistics, U.C. Berkeley, was a criminalist, supervising criminalist, and administrator from 1951 to 1990, retiring as Assistant Chief of the Bureau of Forensic Sciences, California Department of Justice. He helped establish the California Criminalistics Institute; authored numerous articles on firearms and toolmark identification; was a Fellow of the American Academy of Forensic Sciences; and a distinguished member of the Association of Firearm and Toolmark Examiners. He passed away on June 24, 1997, from complications associated with Parkinson's Disease.

**John E. Murdock, M.C. in Criminalistics, U.C. Berkeley, is an author of a number of articles on firearms and toolmark examination, he is past president of the California Association of Criminalists, an emeritus member of the American Society of Crime Laboratory Directors, and a distinguished member of the Association of Firearm and Toolmark Examiners. Murdock served as co-chairman for the AFTE Certification Committee, whose efforts resulted in the creation of a certification program for firearm and toolmark examiners. Teaches "Criteria for the Identification of Toolmark" courses for the California Criminalistics Institute (CCI).

***Bruce R. Moran, B.S. in Forensic Science with a minor in chemistry, California State University, Sacramento, is a Criminalist / Firearm and Toolmark Examiner with the Sacramento County District Attorney's Laboratory of Forensic Services, Sacramento, CA. Author of numerous articles related to the topic of firearm and toolmark examination/identification; teaches forensic firearms and toolmark identification courses as an instructor for the California Department of Justice—California Criminalistics Institute (CCI). Past board member of the California Association of Criminalists, a life member of the International Association for Identification, and a distinguished member of the Association of Firearm and Toolmark Examiners (AFTE). Participated in the creation of the AFTE Firearm and Toolmark Certification Examination for firearm and toolmark examiners that has been implemented within the United States and is available to examiners in other countries. Served as a member of the Scientific Working Group for Firearm and Toolmark Examination (SWGGUN), 1999–2004.

tion and evaluation of firearms evidence;

(7) intercomparison of both unknown evidence and test fired bullets, cartridge cases, and shotshell components with one another; and

(8) comparing toolmarks[1] on unfired cartridges and shotshells which can occur when unfired ammunition has been worked through the action of a firearm, as well as on fired bullets, cartridge cases, and shotshell components with test toolmarks produced deliberately on similar items in an attempt to identify whether a particular firearm made toolmarks on evidence items, to the practical exclusion of all other firearms.

Task number eight overlaps into the area of forensic toolmark examination. Members of this related profession are concerned mainly with attempting to determine whether submitted tools[2] such as screwdrivers, hammers, pliers, drill bits, punches, etc., were used to make toolmarks on portions of a crime scene or on materials found at or related to a crime scene, to the practical exclusion of all other tools. Typical toolmarks submitted in a non-firearms case would be those found on certain components of homemade bombs, on locks and window or door parts in forced entry cases, and just about anywhere that a tool has been used. The word "tool" must be considered in the broadest possible sense. Thus the steel bumper of a truck backing through an aluminum framed supermarket door may leave toolmarks on the relatively soft aluminum doorframe. The truck and bumper would be the tool and the specific portion of the bumper contacting the aluminum doorframe causing the toolmarks would be the working surface of the tool. Conversely, the medium the toolmark is produced in should be considered in the broadest sense. As long as the medium is capable of faithfully recording the details of the toolmark with sufficient clarity for comparison and possible identification purposes, the specific type or composition of the medium is inconsequential. Therefore, toolmarks produced in unusual material, such as bone, etc., are not regarded by examiners as being "new" or "novel."

This chapter is concerned with the individualization of firearms and toolmarks and not with the myriad of other tasks, such as those described above, because it is the individualization process that leads to the strong associative evidence which links a defendant to a crime. The defendant is connected to the crime scene by virtue of having possessed a firearm or tool that has been identified as having made toolmarks found on submitted evidence.

[Section 35:7]

[1]When two objects come into contact, the harder object may mark the surface of the softer object. The tool is the harder object. The relative hardness of the two objects, the pressures and movements, and the nature of the microscopic irregularities on the tool are all factors that influence the character of the toolmarks produced.

[2]A tool is defined as an object used to gain mechanical advantage. It also is the harder of two objects, which produces toolmarks when brought into contact with the softer one.

§ 35:8 Introductory discussion of the science—The scientific questions

The individualization of firearms and toolmarks involves the physical comparison of one solid object with another solid object to determine through pattern recognition whether or not they were: (1) once part of the same object; (2) in contact with each other; or (3) share similar class or individual characteristics.[1]

Physical comparisons of this nature have evolved as distinct forensic disciplines, namely, firearm and toolmark identification, tire and footwear impressions, and latent fingerprint identification.[2] This evolution as separate disciplines has occurred apparently due to differing bodies of background knowledge required, although these comparisons are based on the same physical phenomena, i.e., the imparting or transfer of a presumably unique combination of patterns or contours from one solid surface to another.

[Section 35:8]

[1]*Class characteristics* are measurable features of a specimen that indicate a restricted group source. They result from design factors, and are therefore determined prior to manufacture. *Individual characteristics*, on the other hand, are marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are produced either incidental to manufacture or are caused by use, corrosion, or damage. They are considered unique to that tool and therefore are believed to distinguish it from all other tools. The individualization process relies on pattern recognition, which results from complex interactions between the eyes and the brain. Taroni et al., Statistics: A Future in Toolmarks Comparison?, 28 Ass'n Firearm & Toolmark Examiners J. 227 (1996).

[2]Biasotti, Firearms and Toolmark Identification—A Forensic Science Discipline, 12 Ass'n Firearm & Toolmark Examiners J. 12 (1980); Meyers, Firearms and Toolmark Identification—An Introduction, 25 Ass'n Firearm & Toolmark Examiners J. 281 (1993).

Figure 1

PHYSICAL COMPARISONS

PATTERN FIT
("Physical Match")
The examination of 2 or more objects either through physical, optical, or photographic means which permits one to conclude whether the objects were either one entity or were held or bonded together in a unique arrangement. Also called Fracture Match.

PATTERN TRANSFER
("Toolmarks and Other Impression Marks")

TWO DIMENSIONAL
(SURFACE/IMPRINT MARKS)

(1) IMPRESSION TYPE* examples:
  (a) finger, palm and foot imprints
  (b) tire and footwear imprints

(2) STRIATED TYPE** examples:
  (a) rubber wiper blade marks on glass
  (b) toolmarks in general which lack depth.

(3) COMBINATION OF (1)&(2)***

THREE DIMENSIONAL
(CONTOUR/IMPRESSION MARKS)

(1) IMPRESSION TYPE* examples:
  (a) tools, shoes, tires or other compression marks
  (b) breechblock, firing pin marks

(2) STRIATED TYPE** examples:
  (a) fired bullets
  (b) chisel, plane and other cut marks

(3) COMBINATION OF (1)&(2)***

* IMPRESSION denotes perpendicular movement of the "tool" relative to the surface marked.
** STRIATED denotes lateral movement of a "tool" relative to the surface marked or lateral movement of the surface marked relative to the tool.
*** Denotes imprints or marks formed by a combination of lateral and perpendicular movements.

FIGURE 1: A generic classification of contemporary physical comparisons that utilize various forms of pattern recognition to identify two separated objects which were: 1) once part of the same object, 2) in contact with each other, or 3) which share some other class or individual characteristics.

The methodology applied to the various physical comparisons outlined in Figure 1 is directed to recognizing and determining whether or not a particular combination or pattern of surface characteristics is randomly distributed and, if so, whether the agreement between evidence and test grouping is greater than what has been observed in known non-matches.[3]

The methodology necessary to recognize, measure and demonstrate a unique combination of class and individual characteristics among diverse objects varies, depending on the type of objects compared, e.g., fired bullets, cartridge cases, footwear, tire impressions or fingerprints. The fundamental rationale for individualizing a mark or impression, however, is that the pattern or combination of individual characteristics is presumed to be unique to the practical exclusion[4] of all other possible patterns or combinations of characteristics.

The physical comparisons traditionally and routinely covered under the heading of "firearms and toolmark identification" will be discussed under the two basic physical phenomena of "Pattern-Fit" and "Pattern Transfer" (Figure 1).

The "pattern-fit" category is a simple concept. This category is defined as a "physical match" by the forensic scientist, or the "jigsaw puzzle fit" by the lay person. Most people readily recognize that each piece is unique in

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[3] *Known non-match*: Toolmarks known to have been made by different tools, or made by the same tool but deliberately placed in a non-matching position.

[4] Dr. John Thornton makes the following observations about absolute certainty: "... absolute certainty is not a goal that is or can be achieved anywhere in the forensic sciences, or just about anywhere else for that matter. If the expectation is absolute certainty, we will all be forever disappointed. With DNA, we say that a particular suite of alleles could be expected at a rate of one in a squillion; we don't say that there is no possibility whatsoever of a chance replication, i.e., that the denominator is infinity." Personal communication with Murdock (July 15, 2008).

In the context of a scientific conclusion, practical certainty occurs when an examiner can affirm all of the following necessary conditions:

(1) He or she believes the conclusion to be true and accurate;

(2) He or she has rational grounds for believing the conclusion is true and accurate; and

(3) He or she acknowledges that, in the abstract, it is not possible to achieve absolute certainty for results flowing from a scientific theory or technique.

Bunch states that "consecutively manufactured firearms produce individual toolmarks that can be distinguished from one another and can be matched to a single firearm, to a high degree of reliability. However, there is no way to be absolutely (100%) certain of any identification without comparing a particular set of marks to marks created by every firearm produced since the invention of the modern day firearm. Such an endeavor is impossible. Because an examiner cannot rule out with absolute certainty the highly unlikely event that two different firearms produce indistinguishable individual characteristics, an examiner, if asked, must properly qualify an identification. One way an examiner can qualify his or her identification is to conclude that the match is one of "practical certainty," rather than one of "absolute certainty." Practical certainty means that the determination of identity correlates to features whose frequency (or likelihood) of reoccurrence by another tool is so remote that it can be considered practically impossible." Statement of Stephen G. Bunch for U.S. v. Worsley (in preparation, May 29, 2008).

completing a puzzle, or that the broken pieces of a once solid object uniquely fit together to make the whole. The unique character of a physical match depends on the complexity of the random contours of the separated surfaces. The greater the complexity of the contours formed by the separated surfaces, the more probable that the match is unique.[5]

The "pattern transfer" category, in contrast, is more difficult to understand and demonstrate. Consequently, identification involving pattern transfer is subject to more challenges and controversies. Toolmarks made by firearm components, other tools, and other solid objects in the "Pattern Transfer" category in Figure 1 are, therefore, the main focus of this chapter. We will discuss both "three-dimensional" (contour/impression) and "two-dimensional" (surface/imprint) toolmarks, recognizing that the fundamental criterion for determining the probability that a toolmark is unique remains the same.

The "three-dimensional" pattern transfer-type marks are further classified into "impression" and "striated" marks.[6] Toolmarks produced by firearm components and other tools typically are a combination of both impression and striated marks. Toolmarks produced on bullets fired through a gun barrel are primarily striated.

With either two or three-dimensional toolmarks, the primary factor to consider, for individualization purposes, is the nature of the surface suspected of having made the toolmark. The portion of a tool that can come into contact with, and cause markings on other objects, is called the working surface. Toolmarks can be identified as having been made by a specific tool to the practical exclusion of all other tools only when the responsible working surface has been determined to be unique and

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[5]Miller & Neel, Metal Fractures: Matching and Non-Matching Toolmark Examiners J. 133 (2006). This research includes examples of various types of fracture patterns described in the literature, and provides a brief discussion about the process of fracturing of metal. The authors also examine actual fractured samples in order to observe the pattern of the external break and the pattern of the internal fracture.

[6]*Impressed toolmarks* are produced when a tool is placed against another object and enough force is applied to the tool so that it leaves an impression. The class characteristics (shape) can indicate the type of tool used to produce the mark. These marks can contain *class* or *individual characteristics* of the tool producing the marks. These also are called *compression marks*. *Impressed toolmarks* consist of contour variations on the surface of an object caused by a combination of force and motion where the motion is approximately perpendicular to the plane being marked.

Striated toolmarks are produced when a tool is placed against another object and with pressure applied, the tool is moved across the object producing a striated mark. *Friction marks, abrasion marks,* and *scratch marks* are terms commonly used when referring to striated marks. These marks can contain *class, subclass*, and/or *individual characteristics*. *Striations* are further defined as contour variations, generally microscopic, on the surface of an object caused by a combination of force and motion where the motion is approximately parallel to the plane being marked. Additional discussion of striated toolmark striae, with regard to practical interpretation by Examiners, appears in § 35:12.

therefore capable of making unique or, in other words, individual marks. The examiner uses knowledge of: (1) machining processes; (2) the microscopic appearance of the working surface; and (3) the results of research performed on consecutively manufactured tools in making this determination.

In this context, various parts of firearms are considered simply as tools. For example, the inside of a rifled gun barrel acts as a tool when it marks a bullet fired through it; an extractor acts as a tool when it extracts fired cartridge cases or unfired cartridges from the chamber of a firearm; and a firing pin acts as a tool when it strikes the primer portion of a cartridge, and so on.

Some working surfaces are unique the moment they are produced by the manufacturer. This is because some machining processes such as grinding generally produce a uniquely finished surface. Numerous toolmark studies of ground working surfaces have demonstrated that in most instances a different random distribution of individual characteristics is formed each time a working surface is ground.[7] Other machining processes, such as those where hardened cutters are used, often produce very similar toolmarks on items consecutively manufactured. A good example of this is the persistence of matching toolmarks in.25 auto caliber cartridge case extractor grooves described by Johnson.[8] These similar (sometimes matching) toolmarks are composed of sub-class characteristics.[9] The manufacturer's goal is to produce many items of the same shape that are, within

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[7]Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Butcher & Pugh, A Study of Marks Made by Bolt Cutters, 15 J. Forensic Sci. Soc'y 115 (1975); Watson, The Identification of Toolmarks Produced from Consecutively Manufactured Knife Blades in Soft Plastic, 10 Ass'n Firearm & Toolmark Examiners J. 43 (1978); Cassidy, Examination of Toolmarks from Sequentially Manufactured Tongue-and-Groove Pliers, 25 J. Forensic Sci. 798 (1980); Burd & Gilmore, Individual and Class Characteristics of Tools, 13 J. Forensic Sci. 390 (1968); Diamond, The Scientific Method and The Law, 19 Hastings L.J. 179 (1967).

[8]T. Johnson, The Persistence of Toolmarks in R-P.25 Auto Cartridge Case Extractor Grooves, Presented at the Annual A.F.T.E. Training Seminar, Orlando, Florida (May 10–14, 1982). See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984), for illustrations of these toolmarks.

[9]*Subclass characteristics* are discernible surface features of an object which are more restrictive than *class characteristics* in that they are: (1) produced incidental to manufacture; (2) are significant in that they relate to a smaller group source (a subset of the class to which they belong); and (3) can arise from a source which changes over time. Examples would include: bunter *marks* (headstamps produced on cartridge cases) produced by bunters made from a common master, *extrusion marks* on pipe, etc.

Subclass characteristics are manufactured toolmarks that repeat virtually unchanged from one manufactured item to another. When these toolmarks are present on or near the working surfaces of tools, the toolmarks they produce can be mistaken for individual working surface features. Therefore, subclass influences must be recognized so the toolmarks they produce will not be used for identification purposes. It is imporcertain tolerances, the same size. They also want each of these items to have an acceptable surface finish or appearance. Items that look the same to the unaided eye are said to have the same class characteristics. The manufacturers are not, however, concerned that many or all of these items may bear toolmarks composed of subclass characteristics depending on the way in which they were manufactured. The firearms and toolmark examiner must be alert to the possibility that evidence toolmarks may have been produced by a tool working surface having subclass characteristics.

A classic example of the evaluation of the working surface of a tool and the determination of the presence of subclass characteristics was reported by Murdock in 1974.[10] In this example, the working surfaces of desk stapler rams from two different brands of desk staplers were evaluated. The ram is the tool in a desk stapler that consists of a hardened piece of metal that comes into contact with a staple when the staple is driven out of the stapler. It was determined that in the finished product, the rams in one brand of desk stapler had unique working surfaces whereas the rams in the other brand of desk stapler had matching subclass characteristics. When new, the desk staplers with the matching subclass characteristics probably would not be capable of leaving unique toolmarks on the top of staples driven from them. After these working surfaces become worn and the subclass characteristics become partially or completely obliterated, the toolmarks produced by them would be unique.[11]

A tool may have subclass toolmarks near the working surfaces and yet because of the relative position of the subclass toolmarks they have no effect on the ability of that tool to leave unique toolmarks. For example, the teeth on slip joint pliers often are formed by a cutting process that leaves subclass toolmarks. When these teeth grip objects and the tool is used in the normal way, sliding toolmarks (from slippage) often are made 90 degrees from the orientation of the subclass toolmarks. Thus the subclass characteristics have no effect on the unique signature left behind by the pliers teeth. The examiner, must, therefore, for any specific tool, be able to: (1) recognize the presence of subclass characteristics; and (2) properly evaluate the significance of subclass toolmarks when they are present by determining whether or not they are influencing the nature of any evidence toolmarks that are under consideration.

Having considered the nature of the tool working surface suspected of

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tant to note that although subclass toolmarks may be present near the working surface of the tool, they may, either because of their position or manner in which the tool is normally used, have no influence on the individuality of toolmarks made by this working surface or edge.

[10] Murdock, The Individuality of Toolmarks Produced by Desk Staplers, 6 Ass'n Firearm & Toolmark Examiners J. 23 (1974).

[11] For a highly favorable evaluation of this forensic research, see Crime Laboratory Management Forum 177–178 (R.H. Fox & F.H. Wynbrandt eds., 1976).

being responsible for making an evidence toolmark, a critical question arises. How much agreement is needed between an evidence and test toolmark before a conclusion of identification to the practical exclusion of all other tools is justified? This is the basic question asked first by science and then by the law. We will discuss how much agreement is needed following a description of the steps taken by an examiner during a typical toolmark comparison case.

§ 35:9 Introductory discussion of the science—The scientific methods applied in firearms and toolmark examination

A typical toolmark comparison case usually starts with questioned toolmarks of some sort that are evaluated for evidentiary purposes. The submitted evidence, consisting either of actual objects or pieces of objects or replicas (casts) of suspected toolmarks found on immovable objects, is microscopically examined for toolmarks and any toolmarks found are evaluated in order to determine: (1) what type and configuration of tool was used; and (2) whether the toolmarks have potential value for comparison and identification purposes. Toolmarks have potential value for comparison and identification purposes if a sufficient number of microscopic features are present and if they possess sufficient clarity and definition. The toolmarks also are examined for the presence of trace evidence, such as paint.

If tools are submitted for comparison, they are examined for trace evidence and a determination is made as to whether the class characteristics of any specific tool agrees with the class characteristics found in the toolmarks. If the class characteristics agree, test toolmarks are made for comparison with the submitted evidence toolmarks. When test toolmarks are made, every attempt is made to duplicate the general appearance of the evidence toolmarks by varying the tool angles and degree of pressure. This is fairly easy with firearms toolmark evidence since ammunition feeds into and out of firearms in a predictable way that is usually easy to duplicate simply by operating the firearm mechanism in the normal way.

With non-firearm toolmarks, numerous test toolmarks sometimes have to be made because the first test toolmarks produced are sometimes of no value for comparison, since the angles and pressures used did not create test toolmarks having the general appearance of the evidence toolmark(s). Early test marks of no value can be, but certainly do not have to be, discarded when they have been made in a relatively soft material such as lead, which will not generally cause alteration of the tool's working surface. If a relatively soft test material proves to be inappropriate because the right kind of test toolmarks are not being produced, the examiner may have to use some of the same type of material, usually harder than lead, that bears the evidence toolmark(s). If this is a relatively hard material, all test marks made in it should be retained since there is a possibility that making test marks in this harder material may alter the working surface of the tool thereby making future comparisons very difficult. As a general rule, any time the test media show any sign of causing alteration to a tool working surface, all test marks should be retained.

Regardless of the media used for test marks, the goal of test mark production is to vary the angle and pressure of the working surface of the tool so that a test mark is produced by every part of every working surface that could reasonably have been used to produce the evidence toolmark. The examiner stands the best chance of identifying the tool when a comprehensive series of test marks has been prepared, assuming that the four conditions described in the next paragraph are true. It is possible, however, that if a comprehensive series of test marks is not produced, an examiner may falsely exclude the tool.[1] A false inclusion is highly improbable because no matter how many different test marks are produced, the likelihood is remote that any of them will exhibit sufficient agreement for a positive identification if the tool was not the tool used to produce the evidence toolmark. For practical purposes, examiners regard this probability as so small that the probability of a false inclusion is considered to be zero.

Appropriately prepared test toolmarks, having the general appearance of the evidence toolmarks, are next compared to one another to see if the tool is capable of leaving reproducible toolmarks. If it is, one would expect to be able to identify the tool as having made the evidence toolmark provided that:

(1) it was used to make the evidence toolmark;
(2) the responsible working surface has not been damaged since having been used;
(3) the evidence toolmark bears sufficient, unique impression or striated markings for identification purposes; and
(4) the responsible working surface of the tool consists of an individual surface finish and not merely class or subclass features.

Subclass characteristics are toolmarks that, because of their well defined, continuous over virtually all of the tool working surface, often prominent, and sometimes equally spaced appearance without changing significantly over some distance, can be suspected of being found on other similarly manufactured tool working surfaces. The presence of toolmarks of this nature on working surfaces must prompt the examiner to conduct research, such as the desk stapler example cited above, into the effect on individuality caused by their presence.[2]

The retention of only those test toolmarks used for the identification, as-

[Section 35:9]

[1]A false exclusion occurs when the tool actually used to produce the evidence toolmark is excluded.

[2]The consideration of subclass influence exhibited within toolmarks requires a systematic approach for differentiating between such markings and those that may be individual. The examiner's greatest chance for success is when the responsible tool is available for examination. The examiner must consider the following three questions: Is there potential for subclass influence

present on the responsible tool working surface? If such influence is present, is it successfully transferred to the toolmark? If present in the toolmark, will such influence preclude a conclusive identification or can a positive identification still be made despite its presence? The ability to most reliably answer these questions is dependent on a number of factors and considerations, as follows.

(1) General Knowledge in Recognition of Tool Surfaces Resulting From Machining Operations and Their Relative Potential for Contributing to Subclass Influence.

During the inspection of the working surface(s), the recognition of potential of subclass characteristics is based, in part, on the examiner's training and experience in being able to recognize various machining operations by the characteristic surfaces produced by such operations. Generally, by recognizing the machining operation responsible for producing the finish on the tool working surface, the examiner can make an assessment of its general potential for contributing to subclass influence. For example, the potential for subclass influence in a general hierarchy of decreasing order is as follows: molding or casting > stamping > shearing > CNC milling > lathe operations > non-controlled milling > broaching > drilling > static machine grinding > free hand grinding > free hand filing. (The preceding ordered list reflects Moran's thinking about the general decreasing order and is not based on empirical testing.) Such general knowledge should cause an examiner to be cautious in the interpretation of the agreement that is observed and the approach to resolving any potential for subclass influence that could be present.

(2) Direct Inspection of Tool Working Surface With Ability to Differentiate Between Subclass Features and Individual Characteristics.

The most reliable way to assess the potential for subclass influence in a toolmark is by direct examination of the responsible tool working surface that produced the mark. Evaluation of the responsible tool working surface upon which sufficient agreement has been found to support identification, if warranted, is conducted to differentiate between subclass features and individual characteristics. This is normally accomplished using some form of magnification typically with the aid of the stereomicroscope to inspect the accessible tool surfaces. Less accessible tool surfaces—such as the interior of a gun barrel or the chamber surfaces of a firearm—can be visually inspected with specialized equipment such as borescopes. Additionally, when tool working surfaces are inaccessible for direct viewing, indirect methods such as casting with Mikrosil (or similar products) and examining the surface characteristics on the cast(s) can be employed. For example, casting the face of extractors or the interior surface of a gun barrel bore will allow a detailed examination of toolmarks present. During the inspection of the working surface(s), recognition of potential subclass characteristics is based on the examiner's training and experience in recognition of "indicators" that signal the possibility of subclass influence. Examples of such subclass feature indicators include but are not limited to: (a) evenly appearing (non-random) contours either impressed or striated), (b) prominent striated markings on the interior of a gun barrel bore that remain unchanged throughout the entire length of the barrel (typically the heavier the marking the greater the chance of this occurring), (c) impressed striations transferred onto the tool working surface that remain relatively unchanged across the entire working surface (typical on some ejector or breech faces, for example). These features suggest that the manufacturing tool responsible for placing the final finish on the tool working surface remains relatively unchanged during the machining process such that it is reasonable to expect that the same features (subclass characteristics) will be repeated on similar tool working surfaces. The presence of such indicators should make the examiner doubt the uniqueness of these features, leaving the possibility that another tool could produce such markings.

In contrast, the examiner must be able to recognize the presence of randomly produced defects that stand a very remote chance of being repeated from tool working surface to tool working surface that provide a basis for the tool's individuality (or individual signature). Such individual features that can be considered unique to the tool working surface include: (a) nicks and gouges produced by random pieces of metal which mark the tool surface being produced because of pressures/movement coincidental to the manufacturing process, (b) machine chatter in milling operations, (c) fracture patterns caused by the mechanical separation or tearing of metal in certain machining operations such as shearing, (d) striated markings that change rapidly within the boundaries of the tool working surface, during its manufacture.

If, by inspection of the tool working surface the examiner observes an absence of subclass features, he/she can be confident that there is no subclass influence and that markings produced by this surface can be used as a basis for trying to individualize the tool.

(3) Potential for Transfer of Subclass Features Within Questioned Toolmark.

If subclass features are present on the tool working surface, the examiner must consider whether such subclass toolmark influence is actually transferred to the questioned toolmark. This is accomplished by comparing the subclass features exhibited on the tool working surface to toolmarks produced by that surface. For example, comparing the markings on bullets test fired from a gun to Mikrosil casts of the barrel bore to see if any pre-identified subclass markings on the cast also appear on the bullets. There is generally a higher potential for the transfer of such characteristics to soft lead bullets than for copper jacketed bullets that have a relatively harder surface. It is possible that such subclass features will not transfer to the toolmark surface.

In certain cases, there may be several working surfaces on a tool, each bearing its own potential for subclass influence. For example, a standard screwdriver blade also exhibits four sides, four edges, and a tip, as well as the shank. Each of these surfaces is likely to exhibit finishes from different machining processes with differing potential for the presence of subclass influence. The orientation of the screwdriver during its application will dictate what tool working surfaces will be responsible for producing a toolmark, each with differing potential for the existence of subclass features. Likewise, the face of a pistol ejector may exhibit high potential for subclass influence while the sides or edges of the ejector may bear no subclass influence at all. Depending on the orientation of the ejector relative to the cartridge case, any of these surfaces of the ejector may contact the head of the cartridge case during the normal cycling of the firearm, imparting toolmarks from whatever surface made contact. Toolmark comparisons and identifications must be made by using only that portion of the ejector mark which has no subclass influence.

The specific orientation of the tool working surface should also be considered as an element in the potential for transfer of subclass influence to the toolmark surface. For example, if a tool with a subclass striated surface travels across a toolmark surface in a parallel fashion, there is a great chance for subclass carry-over to be transferred to that surface. However, if the tool moves over the toolmark surface perpendicular to the direction of subclass striated markings, the potential for subclass markings is very low. For example, if a bullet passes parallel to potential subclass striations created by the manufacturing process in the broach cut groove surface of a barrel bore, while the bullet at the same time passes over the reamer markings on the tops of the lands in a perpendicular fashion, the resulting striated markings produced within the groove impressions will likely have a much higher potential for the transfer of subclass influence than on the land impressions.

Given the above considerations, if there is no transfer of subclass features from the tool working surface(s) to the toolmark, there is no subclass influence present. Therefore the tool can be considered to have been identified as the source of the mark to the practical exclusion of all other similarly marking tools. If subclass features are transferred from the tool working surface(s) to the toolmark(s) produced, the examiner must consider if such influence is sufficient to preclude an individualization of a tool. For example, if the majority of the tool working surface is comprised of subclass features, and there are insufficient individual characteristics present, the tool can only be identified as a possible source of a questioned toolmark within a limited group of tools that share the subclass characteristics. Even if the potential for subclass influence cannot be ruled out, its agreement can be very significant in inferring a potential association of the questioned toolmark to the tool, especially in cases where it can be determined that the number of tools in this "family" of tools with shared subclass features, is small. However, if only limited areas of the tool working surface exhibiting subclass features are present, and there are sufficient individual characteristics also present that are sufficient for identification, the tool can be identified as the source of the mark despite the presence of subclass characteristics among individual characteristics.

(4) Subclass Evaluation Without the Benefit of Having The Responsible Tool. It is not uncommon to compare a series of toolmarks on different items to determine if they have been produced by the same tool without having the responsible tool available. Even in the absence of the responsible firearm/tool, examiners rely on their experience in evaluating the toolmark for potential for subclass influence. This is a more difficult to do, but does not preclude being able to identify a common toolmark source without having the responsible tool. To do this the examiner must rely on: (1) general knowledge of the appearance of subclass features that stem from different machining operations as previously discussed, and (2) experience and training in recognizing the "indicators" of subclass influence from manufacturing operations that have been transferred to the toolmark surface.

In this situation, the same considerations with respect to the potential for subclass influence are applied to the toolmarks being examined as has been previously outlined. If there is no indication of subclass influence present in the markings being compared, and there is sufficient agreement of individual characteristics, it can be concluded that a common tool source produced them. If the potential for the presence of subclass influence cannot be eliminated, some lesser conclusion must be considered until the responsible tool can be obtained for examination of the working surface(s). The following is an example of such a conclusion:

> During the comparison of the questioned toolmarks, I observed agreement of discernable class characteristics and sufficient agreement of potentially individual characteristics to indicate that it is very likely that these markings have been produced by the same tool. However, without the benefit of examining the surface of the tool that caused these marks, I am unable to eliminate the possibility of subclass influence, leaving a small possibility that another tool could have produced them. If, however, an examination of the working surface of the tool reveals that it is indeed capable of leaving an individual toolmark, these marks can be identified as having been produced by the same tool.

An excellent discussion of this general consideration in toolmark identification can be found in Miller, An Introduction to the Forensic Examination of Toolmarks, 33 Ass'n Firearm and Toolmark Examiners J. 233, 241–244 (2001). Additionally, Nichols specifically discusses the evaluation of barrel bore working surfaces in regard to potential for subclass influence in Nichols, Firearm and Tool Mark Identification: The Scientific Reliability and Validity of the AFTE Theory of Identification Discussed Within the Framework of a Study of Ten Consecutively Manufactured Extractors, 36 Ass'n Firearm and Toolmark Examiners J. 67 (2004). Moran also discusses practical considerations with reference to magazine marks and rifling impressions in the following reference. Moran, The Application of Numerical Criteria for the Identification in Casework Involving Magazine Marks and Land Impressions, 33 Ass'n Firearm and Toolmark Examiners J. 41 (2001). Moran additionally describes his approach to the consideration of subclass influence present in the grooves of the barrel bore of a questioned firearm and provides photomicrographs of these features in the following reference. Hess and Moran, The Removal of Superficial Rust/Corrosion From the Working Surfaces of Firearms For the Purpose of Revealing Their Potentially Identifiable Signature and suming that the discarded toolmarks were made in test material softer than the tool working surface and caused no changes in the working surface, does not create a bias against an accused. Most tool working surfaces will have a number of surfaces capable of producing toolmarks. For example, one of the authors identified a hack saw blade as being used to produce a series of seven teeth marks on the end of a length of copper pipe that had been fashioned into a pipe bomb. The toolmark identified was a striated mark caused by a sidewise motion of the blade; it was not a cutmark. Many of the hack saw teeth were broken; of the approximately 173 teeth on the blade, only a seven tooth section could have been used! Approximately 300 test marks were made using sheet lead before an identification was made. It was necessary to make this many testmarks because of the saw blade length, the numerous possible blade angles when it traveled sideways during the production of approximately 24 different sets of seven teeth wide marks, and because many teeth were broken. Most of these test toolmarks have no bearing on the identification and could be remade if necessary.

When sufficient agreement is found between the evidence toolmark and a test toolmark, a positive identification of the tool is made to the practical exclusion of all other tools. All test toolmarks relied upon for the final comparison results must be retained.

The comparison process just described assumes that the examiner has the tool working surface available for comparison so that an evaluation can be made, as described above, to see whether or not it is capable of producing a unique toolmark. Situations occur where an examiner does not have a tool and is simply comparing toolmarks from a series of crimes to see if the crimes are connected. In these situations, if the toolmarks from a series of crimes *are identified* as having been produced by the same tool, the examiner is relying on general knowledge of how the working edges of such tools are produced. For example, the cutting edges of twist drills are finished by grinding. This machining process has been demonstrated to produce a microscopically unique working surface on twist drill cutting edges.[3] A series of twist drill impressions (where the hole is *not* drilled all the way through) from a series of crimes can, therefore, be determined to have been drilled with the same twist drill if sufficient microscopic agreement is present.

When there is, however, a chance that microscopic subclass characteristics, having their origin in the manufacturing process, can be present in the type of toolmarks recovered in a series of crimes, a more cautious approach should be taken. It is not uncommon in these cases for the examiner to write a report that states that sufficient microscopic agreement is pres-

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an Application of this Technique in a Firearms Identification, 38 Ass'n Firearm and Toolmark Examiners J. 112 (2006).

[3]Reitz, An Unusual Toolmark Identification Case, 7 Ass'n Firearm & Toolmark Examiners J. 40 (1975).

ent to *suggest* that the same tool made the series of toolmarks, but that a conclusive opinion can be rendered only after an examination of the responsible tool.[4] Once the examiner has the tool, the working surface can be evaluated to determine if the tool produces a unique toolmark, or is one that contains subclass characteristics that are capable of being transferred to toolmarked surfaces.

With respect to toolmarks associated with firearms evidence, Bonfanti and De Kinder have provided a comprehensive summary of the influences of manufacturing processes on the identification of bullets and cartridge cases. Their summary clearly illustrates that not every manufactured tool surface is unique and that firearm and toolmark examiners must consider the possibility of sub-class (family) carry over on consecutively manufactured tool working surfaces before positively identifying a toolmark as having been made by one particular tool, to the practical exclusion of all other tools.[5]

We return now to the issue of how much agreement between crime scene evidence toolmarks and test toolmarks made with a suspect tool is required to determine that the working surface(s) of only one particular tool made the mark, to the practical exclusion of all other tools.

§ 35:10 Areas of scientific agreement

The theory of identification, as it relates to toolmarks, adopted by the Association of Firearm and Toolmark Examiners (A.F.T.E.),[1] gives a nonquantitative answer to the question of how much agreement is needed. This theory is reproduced below in its entirety.

Theory of Identification as it Relates to Toolmarks

a) The theory of identification as it pertains to the comparison of toolmarks enables opinions of common origin to be made when the unique surface contours of two toolmarks are in "sufficient agreement."

b) This "sufficient agreement" is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the

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[4]See footnote 2, § 35:8, for an example of such a report.

[5]Bonfanti & De Kinder, The Influences of Manufacturing Processes on the Identification of Bullets and Cartridge Cases—A Review of the Literature, 39 Sci. & Justice 3 (1999).

[Section 35:10]

[1]Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions—An AFTE Criteria For Identification Committee Report, 24 Ass'n Firearm & Toolmark Examiners J. 336 (1992).

second set of surface contours. Agreement is significant when it exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.[2] The statement that "sufficient agreement" exists between two toolmarks means that the agreement is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.[3]

However, A.F.T.E. did not define "sufficient agreement" in quantitative terms. Instead, it has adopted the following position statement:

c) Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

Section (c) states in part that the interpretation of individualization/identification is founded on scientific principles. The research directed toward criteria for identification in firearm and toolmark identification was reviewed and discussed by Biasotti and Murdock in 1984.[4] All examinations utilizing mathematical models, mechanical models, and actual toolmarks, made with new or used tools, up to 1984 indicated that sufficient agreement of striated or impression toolmarks could be expressed by agreement of a relatively small number of individual characteristics. This research is described in some detail in § 35:12. This research was carried out by adherence to the process known as the scientific method. In this process, variables were limited and observations were made that have allowed examiners to *predict* the ability to individualize "pattern-transfer" toolmarks. This *prediction* has been continually tested empirically and has stood the test of time, resulting in the general principle (Theory) adopted by A.F.T.E. in 1992.[5] The AFTE theory of identification is a working hypothesis of toolmark identification that has been empirically tested. See § 36:12, note 29. By formulating this theory, AFTE anticipated one of the principal questions that would be asked of the discipline in 1993 in *Daubert*. The studies leading up to this theory have been peer reviewed, published, and thus have been available for replication by the relevant scientific com-

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[2]This provision makes it necessary that the examiner *know the quantitative difference between an ID and a non-ID*. So it implies that examiners *must know what "best agreement" is*.

[3]The term "sufficient agreement" in this statement clearly includes both quality and quantity of agreement that must be observed so that *the likelihood that another tool could have made the mark is so remote as to be considered a practical impossibility*. This statement, therefore, does not support an absolute identification, but is a probabilistic inference of practical certainty.

[4]Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

[5]Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions—An AFTE Criteria For Identification Committee Report, 24 Ass'n Firearm & Toolmark Examiners J. 336 (1992).

munity of forensic scientists. Nichols reviewed thirty-four articles that pertained to identification criteria for firearm and toolmark identification. These articles included empirical studies of consecutively manufactured barrels, firing pins, breechfaces, assorted tools as well as mathematical and computer models. Although not all of these articles generated quantifiable numbers, Nichols felt that " . . . all of these appear to be based at least in part on the scientific method . . ."[6]

Research conducted by adherence to the scientific method allows *predictions* to be made and thus serves as a guide to future situations, which in this specific instance is the identification of toolmarks. In contrast, most of the day-to-day measuring and careful observation that occurs in firearm and toolmark sections of crime laboratories is essential to the completion of casework, but is not carried out by using scientific methodology. Firearm and toolmark examiners apply science and scientific methods, procedures and instruments in a practical way, but most are more skilled in the art of applying those methods and procedures than they are in the basic sciences involved.[7] Diamond put it succinctly during a discussion of the scientific method, when he said: (1) that the value and truth of science lies in its methods, not its numbers and diagrams; and (2) determinations of specific measurements only define unique observations, but do not allow predictions to be made about future situations.[8]

As stated in section (c) of the A.F.T.E. *Theory of Identification*,[9] "currently the interpretation of individualization/identification is subjective in nature . . ." Because decisions are based on subjective estimates of probability, the Association of Firearm and Toolmark Examiners has adopted the following range of conclusions to be used when comparing toolmarks:[10]

Range of Conclusions Possible When Comparing Toolmarks

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[6]Nichols, Firearm and Toolmark Identification Criteria: A Review of the Literature, 42 J. Forensic Sci. 466 (1997). Nichols brought his literature review up to date with Firearm and Toolmark Identification Criteria: A Review of the Literature, Part II, 48 J. Forensic Sci. 318 (2003).

[7]Letter from John E. Davis to John Murdock (Dec. 27, 1977) (on file with the author).

[8]Diamond, The Scientific Method and The Law, 19 Hastings L.J. 179 (1967). Moran and Murdock, in Appendix No. 2, The Application of the Scientific Method to Firearm and Toolmark Examination, [Zen and the Art of Motorcycle Maintenance—Contribution to Forensic Science (an Explanation of the Scientific Method)] in Grzybowski, Miller, Moran, Murdock, Nichols, and Thompson, Firearm/Toolmark Identification: Passing the Reliability Test under Federal and State Evidentiary Standards, 35 Ass'n Firearm and Toolmark Examiners J. 2 (2003). Moran and Murdock provide a detailed explanation of the uses of the scientific method in (1) lamp repair; (2) routine casework; and (3) research in validating the identification of toolmarks.

[9]Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions—An AFTE Criteria For Identification Committee Report, 24 Ass'n Firearm & Toolmark Examiners J. 336 (1992).

[10]Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions—An AFTE Criteria For Identification Committee Report, 24 Ass'n Firearm & Toolmark Examiners J. 336 (1992).

The examiner is encouraged to report the objective observations that support the findings of toolmark examinations. The examiner should be conservative when reporting the significance of these observations. The following represents a spectrum of statements:

1) *Identification*: Agreement of a combination of individual characteristics and all discernible class characteristics where the extent of agreement exceeds that which can occur in the comparison of toolmarks made by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.[11]

2) *Inconclusive*:

A. Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification.

B. Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.

C. Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

3) *Elimination*: Significant disagreement of discernible class characteristics and/or individual characteristics.

4) *Unsuitable*: Unsuitable for comparison.

The introductory paragraph to the A.F.T.E. *Range of Conclusions Possible when Comparing Toolmarks,* encourages examiners to report the objective observations that support their findings. This means that the examiner is free to express how he feels about the comparative evidentiary value of the toolmark comparisons. For example, a comparison conclusion of inconclusive may be further described as consisting of considerable agreement, such as that described in § 35:7, which may allow the examiner to conclude that it is very likely that the submitted tool was the tool used to make the submitted toolmark.

Since the interpretation that forms the basis for these conclusions is subjective, Murdock has suggested a series of questions designed to test the witness's qualifications for making a conclusion of identity when striated toolmarks have been identified.[12] The thrust of these questions is to evaluate the witness's knowledge of the extent of agreement that can be found when comparing striated toolmarks known to have been made by different tools. Some of these questions, together with suggested appropriate responses may be found in Appendix 34B. A similar line of questioning could also be developed for impression type evidence, including toolmarks. Although these fourteen questions focus on the witness's knowledge of the extent of microscopic agreement that can be found when comparing striated toolmarks known to have been made by different tools, qualified

[11]This statement emphasized that the extent of agreement must exceed that which can occur in the comparison of toolmarks made of different tools. This is a quantitative inference and, therefore, all Examiners are responsible for knowing how much this is.

[12]Murdock, Some Suggested Court Questions to Test Criteria for Identification Qualifications, 24 Ass'n Firearm & Toolmark Examiners J. 69 (1992).

examiners need to demonstrate that they also have spent considerable time studying the extent of agreement in known matches as well as various forms of inconclusive examples.

§ 35:11 Areas of scientific disagreement—Disagreement about the scientific foundations

The disagreement that exists in the field centers around whether objective quantifiable standards can be developed as criteria for the identification of toolmarks. While most would probably agree that the development of such criteria is desirable, some consider it impossible. John Davis[1] expressed it this way:

> Since all toolmarks are "unique" in a sense, I doubt that "universal criteria" can be found that would apply to all such marks to permit conclusions purely "objective" in nature. Since even the "application" of predetermined criteria calls for degrees of expertise itself, it is generally my position that the "minimum criteria" required for an identification must themselves vary with the degree of expertise and experience of the examiner and therefore minimum criteria cannot be fixed except in "unstable form."[2]

There is no question, however, that conclusions of identity in firearms and toolmarks are possible. The examiner qualified to render such conclusions should be familiar with:

(1) empirical studies of consecutively manufactured tools;

(2) the significance or impact upon individuality of the various means used to manufacture tool edges or working surfaces;

(3) theoretical studies where both mechanical and mathematical models have been used to study toolmark consecutiveness; and

(4) the quantity and quality of matching agreement found in comparisons of toolmarks known to have been produced by different tools. (Known non-matches.)

The authors sincerely hope that the objective quantitative criteria[3] will be applied universally to the evaluation of striated toolmarks. Progress in

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[Section 35:11]

[1]Author of John E. Davis, An Introduction to Tool Marks, Firearms and the Striagraph at 35 (1958).

[2]Personal notes of John E. Davis (April 1984) (on file with the author); personal communications between Davis and the author (June, 1984).

[3]Grzybowski, Miller, Moran, Murdock, Nichols, Thompson, Firearm/Toolmark Identification: Passing the Reliability Test Under Federal and State Evidentiary Standards, 35 Ass'n Firearm and Toolmark Examiners J. 2 (2003). In addition to a comprehensive discussion of error rate in general, the authors calculated the CTS error rates for both firearm and toolmark proficiency tests from 1992 to 2002 in the same manner used by Joseph L. Peterson and Penelope N. Markham, Crime Laboratory Proficiency Testing Results, 1978–1991, II: Resolving Questions of Common Origin, 40 J. Forensic Sciences No. 6 (Nov. 1995). That is, the number of false identifications was compared to all of the comparisons reported by the responding laboratories, and these data were combined with Peterson and Markham's. For the years 1978 to 2002 the false identification rate for the firearm

this area is described infra § 35:12. Until this is done, however, the correctness of subjective evaluations must continue to be based upon individual expertise gained mostly by training and experience. In addition, a working knowledge of the research that has been done in the four categories listed above will help ensure that conclusions of identity, when made, are fully justified.

§ 35:12 Areas of scientific disagreement—Disagreement among practitioners in particular applications

In spite of the research efforts described supra §§ 35:9 and 35:12, occasionally forensic experts differ in their opinion about the identification of toolmarks. It has been the authors' experience, limited almost exclusively to striated toolmarks in firearms cases, that many of these disagreements stem from one examiner ascribing too much significance to a small amount of matching striae and not appreciating that such agreement is achievable in known non-match comparisons.

Hodge[1] discusses other sources of error, such as: (1) rushing through laboratory examinations due to excessive pressure from investigators; (2) not being thorough; and (3) trying to be helpful. Hodge goes on to discuss some ways to minimize these sources of error.

Will errors continue? We suppose so, but hope that the concept of known non-match comparisons, the thorough understanding of the influence of sub-class characteristics, and in-laboratory peer review by skilled coworkers will hold them to an absolute minimum.

Based on present data, the field is in a poor position to calculate error rates. Thornton[2] recently addressed known or potential rate of error by saying that test results hinging on judgment calls do not lend themselves to analysis by conventional statistics. No doubt Thornton was not saying that the products of human judgment cannot be measured statistically, since most if not all of cognitive science does precisely that, but rather that forensic science researchers have not managed to calculate them for the forensic specialties like firearm and toolmark comparison that depend in part on subjective judgment. With modern statistical technology, forensic science decision-making could be subjected to quantitative analysis.[3] But to date it has not been.

Some have used the results of the proficiency testing program adminis-

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produced toolmark proficiency tests is 1.0% and for the years 1981 to 2002 the false identification rate for the non-firearm toolmark proficiency tests is 1.3% (non-firearm produced toolmark proficiency tests started in 1981).

[Section 35:12]

[1]Hodge, Guarding Against Error, 20 Ass'n Firearm & Toolmark Examiners J. 290 (1988).

[2]Thornton, Courts of Law v. Courts of Science: A Forensic Scientist's Reaction to *Daubert*, 1 Shepard's Expert & Sci. Evidence Q. 480 (1994).

[3]Phillips et al., Signal Detection Theory and Decision-making in Forensic Science, 46 J. Forensic Sci. 294 (2001).

tered by the Forensic Sciences Foundation as the major information about error rates.[4] Admittedly, this is tempting since they represent virtually the only information collected on a large scale, but it is at the same time a flawed approach. These declared (not blind) proficiency tests were designed to be used by individual crime laboratories as a quality assurance tool and were never intended to be used as the basis for a nationwide study of forensic error rates. Some crime laboratories treat them formally, requiring that they be completed by the due dates so that their results will be among the tabulated data sent out following each test. Other laboratories treat them much less formally, asking only that they be worked on as time permits, and it usually does not. Still other laboratories work harder on the proficiency tests than on their regular caseload, because they are "a test." In addition, some examiners may be more conservative when reporting the results of a declared proficiency test, feeling that they have little to gain but much to lose if they make an error. It has generally been the case that although proficiency test results have been reviewed by a supervisor before being reported, they were not peer reviewed. Peer review is an important process that is widely used in crime laboratories. This process helps prevent errors in casework from seeing the light of day. In cases where the supervisor was not a subject matter expert in the proficiency test subject there would be, essentially, no peer review. In these circumstances, the reported error rates would, therefore, closely approximate an individual examiner's error rate. The American Society of Crime Laboratory Directors' Laboratory Accreditation Board (ASCLD/LAB) approved a program in December 1997 that suddenly moved proficiency test results into a hi-stakes game. In December 1997 ASCLD/LAB approved the Proficiency Review Program (PRP). Under this program, in ASCLD accredited crime laboratories, the results of an individual's proficiency tests must be released to a Proficiency Review Committee (PRC) established by ASCLD/LAB. The PRC will review the proficiency test results and, if a discrepancy is found, the laboratory will be notified and appropriate action must be taken. The type of action will depend on the level of discrepancy (class 1, 2 or 3). Failure to properly address the discrepancy may result in sanctions, which could include revocation of ASCLD/LAB Accreditation. It is clear that in such a high stakes game, laboratory administration will do everything possible, including technical peer review, to ensure that the proficiency test results are correct before reporting them. Prior to the PRC it was a more low-stakes game, with the individual examiners rising or falling on their own merit. The reputation of the laboratory is now at stake. Consequently, we cannot know if pre-1998 proficiency studies overstate or understate the accuracy of examinations. But, it seems fairly certain that post-1998 proficiency studies may overstate the accuracy of the error rate of the individual examiner, but should more closely ap-

[4] Jonakait, Real Science and Forensic Science, 1 Shepard's Expert & Sci. Evidence Q. 446 (1994).

proximate the error rate of technical peer reviewed casework.

It would be more instructive if the crime laboratories completing the proficiency tests by the due dates were required to indicate if normal laboratory procedures were followed, whether this included technical peer review and supervisorial scrutiny, whether the test was used as a test for a trainee, and so on. With this additional information, more meaningful comments could be made about these proficiency test results. Or, better, that they be submitted to examiners as if they were part of the regular caseload—that is, blind proficiency testing.

Moreover, there are inherent difficulties associated with the production of toolmark proficiency tests. Due to the nature of this evidence, each sample is unique. Since there are dynamic forces involved in producing the toolmark samples, there are opportunities for variations between samples. Since all proficiency test subscribers examine unique samples, can widespread test results be used for more than a general indication of error rates? Probably not.[5]

§ 35:13 Development of objective criteria for identification

In 1984, Biasotti and Murdock concluded that existing research was insufficient to validate using quantitative consecutive matching striae

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[5]For further details on proficiency tests and their findings, see Peterson & Markham, Crime Laboratory Proficiency Testing Results, 1978–1991, I: Identification and Classification of Physical Evidence, 40 J. Forensic Sci. 994 (1995); Peterson & Markham, Crime Laboratory Proficiency Testing Results, 1978–1991, II: Resolving Questions of Common Origin, 40 J. Forensic Sci. 1009 (1995). Grzybowski & Murdock, Firearms and Toolmark Identification-Meeting the *Daubert* Challenge, 30 Ass'n Firearm & Toolmark Examiners J. 3 (1998), summarized Peterson & Markham's data for firearms and toolmark proficiency tests as follows: Calculating an error rate based on the total number of decisions reached (that is, including inconclusive responses, which in fact are neither correct nor incorrect), the error rate is 12% for firearms and 26% for toolmarks. But if one calculates an error rate based only on incorrect responses, as Grzybowski & Murdock believe it should be, the results are far better: 1.4% for firearms and 4% for toolmarks.

Grzybowski, Miller, Moran, Murdock, Nichols, Thompson, Firearm/Toolmark Identification: Passing the Reliability Test Under Federal and State Evidentiary Standards, 35 Ass'n Firearm and Toolmark Examiners J. 2 (2003). In addition to a comprehensive discussion of error rate in general, the authors calculated the CTS error rates for both firearm and toolmark proficiency tests from 1992 to 2002 in the same manner used by Joseph L. Peterson and Penelope N. Markham, Crime Laboratory Proficiency Testing Results, 1978–1991, II: Resolving Questions of Common Origin, 40 J. Forensic Sciences No. 6 (Nov. 1995). That is, the number of false identifications was compared to all of the comparisons reported by the responding laboratories, and these data were combined with Peterson and Markham's. For the years 1978 to 2002 the false identification rate for the firearm produced toolmark proficiency tests is 1.0% and for the years 1981 to 2002 the false identification rate for the non-firearm toolmark proficiency tests is 1.3% (non-firearm produced toolmark proficiency tests started in 1981).

(CMS) criteria for the identification of striated toolmarks.[1] To develop these criteria they recommended that examiners become familiar with the extent of agreement, both in quantity and quality, observed in comparisons of toolmarks known to have been produced by different tools. This recommendation, subsequently referred to as known non-match (KNM) comparisons, is an essential part of the non-quantitative theory of identification and the hypothesis adopted by the Association of Firearms and Toolmark Examiners (A.F.T.E.) in 1992.[2]

The authors thus added a quantitative dimension to this fundamental hypothesis. The probability that a questioned striated toolmark can be identified as having been made by an individual tool working surface can be determined by the number and complexity (i.e., size, shape, depth) of randomly occurring matching individual characteristics in excess of the number of characteristics observed and documented in KNM comparisons.

No probability estimates were calculated for KNM comparisons because determining the maximum number of well defined matching individual characteristics in large statistical samples (i.e., more than 100) of KNMs for a variety of different types of tools is the most direct and conclusive way of determining that the probability of a false positive identification is beyond a practical possibility.

Probability estimates for the number of matching individual characteristics for known matches[3] and KNMs historically have been based on theoretical assumptions using mathematical calculations unsupported by published empirical studies of actual toolmarks. Consequently, no objective, quantitative, criteria for determining the individuality of toolmarks were presented in any of the leading texts or dissertations on this subject

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[Section 35:13]

[1]Alfred A. Biasotti & John E. Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

[2]Theory of Identification, Range of Striae Comparison Reports, and Modified Glossary Definitions—An AFTE Criteria For Identification Committee Report, 24 Ass'n Firearm & Toolmark Examiners J. 336 (1992).

[3]*Match* is a term traditionally and commonly used to denote an identification between two physical objects based on the correspondence of an unspecified quantity and quality of randomly distributed individual characteristics. In a general sense, *match* simply means that two things are equal or similar to one another. In forensic identification the term *match* has come to mean that two things share a common origin. For example, two fingerprints being made by the same person, or two toolmarks, one a test and one questioned, being made by the same tool. When two toolmarks match forensically, they have been individualized to a common source; one tool to the practical exclusion of all others. See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959) (a summary of Biasotti's thesis, Bullet Comparison: A Study of Fired Bullets Statistically Analyzed (1955) (on file with the University of California at Berkeley)); Biasotti, The Principles of Evidence Evaluation as Applied to Firearms and Toolmark Identification, 9 J. Forensic Sci. 428 (1964).

until 2005.[4]

The first published empirical study intended to test theoretical probability estimates using actual toolmarks was conducted by Biasotti and published in 1959.[5] Two groups of .38 Special Smith and Wesson revolvers were examined in this study. The first group consisted of sixteen used guns from which six to twelve 158 grain lead bullets were fired. The second group consisted of eight new guns from which six 158 grain lead bullets and six 158 grain metal-jacketed bullets were fired. The data for comparisons made between bullets fired from the same gun were obtained by considering the first bullet as the primary reference, and then comparing the succeeding five test firings with it. This made a total of 400 land and 400 groove impressions compared for the group of sixteen used guns, plus a total of 200 land and 200 groove impressions compared for each group of lead and metal-jacketed bullets from the eight new guns. The data for bullets fired from different guns were obtained by comparing the first bullet from each gun with the first bullet from a different gun, for a total of 36 different combinations, giving a total of 180 land and 180 groove impressions compared for each of the following groups of guns and tests: (1) used, lead bullets; (2) new, lead bullets; and (3) new, metal-jacketed bullets.

Two basic types of data were recorded: (1) the total line count and total matching lines[6] per land or groove impression from which the percent

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[4]See G. Burrard, The Identification of Firearms and Forensic Ballistics (1934); Jack D. Gunther & C.O. Gunther, The Identification of Firearms (1935); A. Lucas, Forensic Chemistry and Scientific Criminal Investigation (3rd ed. 1935); J.S. Hatcher, Textbook of Firearms Investigation, Identification and Evidence (1935); J.S. Hatcher, F.J. Jury & J. Weller, Firearms Investigation, Identification, and Evidence (1957); John E. Davis, An Introduction to Tool Marks, Firearms and the Striagraph (1958); J. Mathews, 1 Firearms Identification (1962); T.A. Warlow, Firearms, the Law and Forensic Ballistics (1996); Brian J. Heard, Handbook of Firearms and Ballistics (1997). In T.A. Warlow, Firearms, the Law and Forensic Ballistics (2d ed. 2005) at 330–331, presents the quantitative CMS criteria for striated toolmark identification first introduced by Biasotti and Murdock in the 1997 first edition of the present work, along with supporting research published by Jerry Miller (citations collected in margin of § 35:12).

[5]Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

[6]*Matching lines* is a term used for brevity to denote matching striae either consecutive or non-consecutive which have a unique character, i.e., width, height, length, and contour. See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Biasotti, The Principles of Evidence Evaluation as Applied to Firearms and Toolmark Identification, 9 J. Forensic Sci. 428 (1964); and Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

Lines is a term that has largely been replaced with the term striae (or striations). Lines are two-dimensional and have length and width. They do not have height. Striations on the other hand have length, width and height.

A *striation*, viewed through the comparison microscope, consists of a segment of contour that has length, width, and height.

matching lines[7] was calculated; and (2) the frequency of occurrence of each series of consecutive matching lines[8] for which probability estimates were

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In order for striae to have significance the striated mark must be reproducible. These are striae that are made by the tool, not by non-reproducing artifacts (i.e., lead fouling, dirt, extraneous debris). Therefore, they should also have continuity (sustained length).

[7]*Percent matching lines* denotes the percent of matching striae without regard to consecutiveness. See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

[8]*Consecutively matching lines* are striae that correspond or match with respect to each striae's width, depth and contour and are of sufficient length to assure that striae are parallel to one another. The term *striae* is today more commonly used than "lines" although the latter term is still used by some to describe striae that are very shallow and thus appear virtually two dimensional. See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Biasotti, The Principles of Evidence Evaluation as Applied to Firearms and Toolmark Identification, 9 J. Forensic Sci. 428 (1964); Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

Consecutively matching striae (CMS) are striae within an array of striated markings that agree in their spatial relationship, their width and their morphology. Such agreement is inherent in defining a pattern. For purposes of striated toolmark identification, it is the extent of runs of consecutively matching striae (CMS) that defines the measure of striated pattern agreement when assessing the potential for associating questioned toolmark(s) with test toolmarks produced by a submitted tool(s).

From a theoretical standpoint, all striated toolmarks are three-dimensional (3D) and have height. With sophisticated measuring equipment it is becoming increasingly possible to measure the height of any striae. While this may be possible to do, especially with today's sophisticated instrumentation, this is of little practical value for toolmark identification work using the comparison microscope. This is because such measuring equipment is not commonly used or available in forensic laboratories and, until it is, examiners must estimate whether they are viewing two-dimensional (2D) or 3D striae on the basis of the perceived gradations in shadow caused by contour revealed by side (oblique) lighting. If variation in contour is perceived in this way, the toolmark is 3D for CMS quantitation purposes. For the purpose of practical interpretation under the comparison microscope, the following 2D and 3D definitions are offered to assist the examiner in the interpretation of CMS runs.

2D striated toolmarks are any impressed or striated toolmark that lacks discernable depth or: (1) occupies only the very surface of a recording medium in which the toolmark appears; (2) has been made in a recording medium that is very thin or; (3) results from the application of the tool to the medium in such a way that only superficial markings are produced. Examples of 2D striated surface toolmarks would include rubber wiper blade marks on a glass windshield; scratches in sheet film produced by dragging a glass microscope slide across it; markings resulting from dragging a fractured edge of a wooden tongue depressor over a sheet of carbon paper; and similar processes.

3D striated toolmarks are any impressed or striated toolmark that displays discernable contour because the medium the toolmark is in has been displaced. Examples of potential 3D striated toolmarks would include striae appearing on fired bullets, and striae produced from chisels and screwdrivers in wood or metal softer than the tool.

Any of these examples can also be 2D if the markings are very superficial. For example, there are cases when extremely calculated.

For same gun comparisons, the author strictly held to the criteria for consecutive matching lines, while for different gun comparisons the criteria were liberally interpreted. To add a further subjective bias toward higher consecutive line counts, each land and groove impression of reference bullets from different guns was compared with other land or groove impressions appearing most similar in overall contour and degree of marking.

Probability estimates for the *same* gun comparisons showed a high frequency of two or more consecutive lines; however, more significantly, no more than three consecutively matching lines were found for all lead bullets, or more than four for metal-jacketed bullets from all *different* gun comparisons.

The concept of "consecutiveness" is a simplified way of expressing the matching of a segment of contour, or a pattern of matching individual characteristics in a striated toolmark. These results, therefore, support the validity of the hypothesis adopted by A.F.T.E. and further developed by the authors.

This fired bullet study also demonstrated the unsuitability of using "percent matching lines" as a criterion of identification, particularly for fired bullets where the percent matching striae in known matches can be approximately the same as the percent matching striae found in known non-matches. In this study, bullets fired from different barrels (i.e., "known non-matches") ranged from 15 to 20% matching striae, whereas bullets

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polished firearm bores produce very little information in the way of striated markings simply because there are few irregularities on the bore surface that produce striated toolmarks of any discernable depth. These striae will be sparse and will appear as very thin "lines" with no apparent depth.

Historically, when applying these two considerations to CMS tabulations, it was found that striated toolmarks that lacked discernable depth resulted in slightly higher CMS counts among known non-matches (the best KNM being six consecutive (6X) matching striae in two dimensional toolmarks, reported by Miller and McLean, Criteria for Identification of Toolmarks, 30 Ass'n Firearm and Toolmark Examiners J. 15 (1998)) compared to striated markings with discernable depth (best KNM being 4X observed on land impressions on fired copper jacketed bullets and reported in Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959)). This difference in CMS KNMs is due to the fact that in cases where striated markings have so little depth, they appear as lines (even though they are technically striations). The lack of perceived depth of these 2D appearing striae diminishes the examiner's ability to discern differences in contour and is the likely reason for the slightly higher CMS tabulations in these cases compared to 3D striated toolmark KNM comparisons (where the element of height can be used as an additional means of critically evaluating consecutiveness).

Tabulation of CMS: CMS is defined as striated markings that "line up" exactly (close doesn't count) with one another without a break or dissimilarity in between them. These are striae that agree in their spatial relationship, width and morphology. For practical purposes CMS are counted as follows: For 2D, only striae that match exactly in relative position and width are counted. For 3D, only the ridges (which can be white/gray) are counted and not the valleys between the ridges (that are dark gray/black).

fired from the same barrel (i.e., "known matches") ranged from 21 to 38% matching striae. These ranges for known matches versus known non-matches were obtained from all the striae on all the bullets compared and appear to offer a criterion for identification. However, because of the difficulty in judging the qualitative agreement of individual striae spread over several land or groove impressions, a percent matching number often can be misleading and may result in a false identification.

Analogous studies have reported up to 28% matching striae in known non-matches produced by the ground working surfaces of tools; i.e., knives, bolt cutter blades, and tongue-and-groove pliers.[9] Striae produced by a ground working surface are typically similar in height, width, spacing (often due to grit size), and lack much three dimensional contour. Therefore they are viewed as two-dimensional parallel "lines." These type of shallow striae, combined with less than a two millimeter wide striated toolmark available for comparison, and the absence of clear class characteristic limits, can result in a false identification if percent match is the only criterion used.[10]

Other published research designed to validate quantitative probability estimates for matching striae have been conducted using mechanical or mathematical models. In one such study[11] a comparison of 1003 positions of known non-match of a 25 striae wide two-dimensional toolmark found that a five consecutive striae match occurred only at one position. No greater consecutive matching occurred and no 4X matching, but a greater number of 3X and 2X matching was found.[12] The features of toolmark depth and contour were not present in those two-dimensional toolmarks and so were not considered in this experiment.

In 1970, Brackett[13] explored the application of mathematical models to the study of striated toolmarks. This work reports an attempt to idealize striated marks in order to develop a theoretical basis (i.e., mathematical model) for their analysis. It is possible to take Brackett's ideal models and convert them into mechanical models which may be compared with actual toolmarks, the goal being to obtain sufficient information to enable establishment of objective criteria of identity of two sets of marks.

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[9]Butcher & Pugh, A Study of Marks Made by Bolt Cutters, 15 J. Forensic Sci. Soc'y 115 (1975); Watson, The Identification of Toolmarks Produced from Consecutively Manufactured Knife Blades in Soft Plastic, 10 Ass'n Firearm & Toolmark Examiners J. 43 (1978); Cassidy, Examination of Toolmarks from Sequentially Manufactured Tongue-and-Groove Pliers, 25 J. Forensic Sci. 798 (1980).

[10]Butcher & Pugh, A Study of Marks Made by Bolt Cutters, 15 J. Forensic Sci. Soc'y 115 (1975).

[11]Conducted in 1968 by Murdock, Barnett and McJunkins, reported in Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

[12]"5X" would be shorthand for "five consecutive striae," "4X" for "four consecutive striae," and so on.

[13]Brackett, A Study of Idealized Striated Marks and Their Comparison Using Models, 10 J. Forensic Sci. Soc'y 27 (1970).

Brackett made a finding of great practical importance. Using *actual* consecutive line counts from a randomly selected example from Biasotti's bullet study,[14] he was able to demonstrate that a plot of the distribution of these actual run counts closely approximated those predicted by the general equation (i.e., mathematical model) that he derived. Brackett thus succeeded in deriving an equation which simulates the run distribution[15] properties of actual cases of randomly distributed striae. The importance of this finding is that this equation can be used to generate computer assisted programs capable of studying the effects of such crucial variables as striae density, uniformity or non-uniformity, and randomness, with a speed and efficiency not possible by conventional direct visual comparisons and evaluation. No one, however, has pursued this line of research.

In a review of published efforts from 1990–1994 to make toolmark examinations more objective, Springer[16] concluded that, "the early 1990's shows much promise for the advancement of toolmark comparisons." He suggests that the advancements will be made by automated technology.

Research[17] performed under the direction of Biasotti and Murdock following their 1984 *"Criteria for Identification" or "State of the Art"* paper[18] was specifically directed at examining actual two and three-dimensional striated and impression toolmarks to determine in KNM comparisons: (1) for striated marks, the maximum percent match and the maximum number of consecutive matching striae; and (2) for impression marks, the maximum number of matching randomly distributed individual characteristics.

The striated toolmark samples studied during the CCI classes consisted of:

(1) six 9 mm. Luger metal jacketed test bullets, followed by six lead test bullets fired from ten previously unfired, consecutively rifled, gun

[14]Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

[15]"Run count" is a term used by Brackett to describe the number of consecutive matching striae. "Run distribution" is a term used by Brackett to describe the number of striae in any given toolmark or portion thereof.

[16]Springer, Toolmark Examinations—A Review of Its Development in the Literature, 40 J. Forensic Sci. 964 (1995).

[17]Biasotti and Murdock were principal instructors in six forty-hour courses that dealt exclusively with "Firearms and Toolmark Identification Criteria." These were offered by the California Department of Justice Criminalistic Institute (CCI) commencing 12/10/90, 4/29/91, 5/11/92, 2/1/93, 12/11/95 and 10/96. Each course averaged twelve students, ranging in experience from one to fifteen or more years, doing comparison microscope examinations of toolmarks generated both by firearms and a hand tool. The goal of these courses was to conduct practical exercises with actual toolmarks to allow students to develop their personal criteria for identification and to further develop and refine objective, quantitative criteria. John Murdock and Frederic Tulleners (Program Manager for CCI) conducted these classes annually from 1997 to 2004. Currently John Murdock and Bruce Moran teach these classes.

[18]Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

barrels. Plastic casts were made of each barrel before tests were fired. Microscopic examination of these casts revealed no subclass characteristics in either the lands or grooves in any of the ten barrels; and

(2) twelve duplicate sets of striated test marks made with the top and bottom working edges of a previously unused, three-fourths inch wide chisel having a stone-ground working edge.

For the bullet comparisons, the student examiners were directed to select and compare "out-of-phase"[19] land and groove marks (fired from the same barrel), or any of the five land and groove marks (fired from different barrels) where the striae appeared most similar in density, width, and contour. Similarly, for the chisel test marks, the examiners were directed to select any test from the same out-of-phase side, or any combination of opposite side tests. These examination procedures were intended to maximize the finding of the highest percent match and highest number of consecutively matching striae for KNM comparisons.

The most significant conclusions that can be drawn from more than a thousand specifically directed, striated KNM bullet and chisel mark comparisons are:

(1) not more than three consecutive corresponding three-dimensional striae (i.e., among the bullets) were found, and the few (less than 20) apparent "fours" found lacked exact qualitative agreement[20] in striae width, relative position, or contour;

(2) for striae lacking depth and therefore appearing two-dimensional (i.e., among the chisel marks), not more than five consecutive corresponding striae were found;[21]

(3) percent matching striae ranged from 15 to 30%, which is similar to values reported in previous studies,[22] thus confirming the limited value of percent match as a criterion for identification; and

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[19] *Out-of-Phase* refers to two possible situations: (1) two bullets which were fired from the same gun barrel are aligned on the comparison microscope so that the land and groove impressions on these bullets, which were produced by the same lands and grooves in the barrel, are *not* opposite each other. When the correct corresponding land and groove impressions are opposite one another, the bullets are said to be "in phase." This also is sometimes called *orienting* or *indexing*.

[20] *Qualitative Agreement* refers to the degree or extent of the agreement of striae width, relative position and contour. In practice, striae in one toolmark often will come close to matching striae in another toolmark with respect to these comparison parameters. Significant correspondence or agreement is achieved when there is *exact* agreement of these comparison parameters. Close does not count, and *very* closely agreeing striae may be ascribed greater significance than is justified, leading to incorrect identifications.

[21] Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

[22] Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984); Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets, 4 J. Forensic Sci. 34 (1959).

(4) the nearly identical range of quantitative values found in all known non-match comparisons for all types of rifled barrels, in addition to striated marks made by the ground working surface of a chisel, demonstrates that the probability for the matching microscopic agreement of randomly distributed striae is fundamentally the same, regardless of the tool used.

Analogous studies of impression type toolmarks, such as firearm breech face markings, or models of randomly distributed individual characteristics of the same or different shape revealed no more than four matching individual characteristics. Even this small degree of chance correspondence observed was possible only if one ignored the exact shape, size, and orientation that was present in each of these randomly distributed individual characteristics. In practice, the examiner would critically evaluate impression characteristics occupying the same relative position for the extent of agreement, and conclude that evidence and test impressions were made by the same surface only where the matching[23] features are sharply defined either wholly or in part.

All research to date supports the hypothesis that it is possible to individualize toolmarks because there are practical probability limits to: (1) the number of randomly distributed consecutive matching striae; and (2) the number of randomly distributed matching individual characteristics in impression toolmarks in known non-match positions. This research also demonstrates that quantitative objective criteria can be applied with a high degree of statistical confidence in determining that a toolmark is unique if the values from KNM comparisons are conservatively applied. The authors, in advocating the following conservative quantitative criteria for identification guidelines, have considered that: (1) there is a probability that a higher number of both single and multiple groups of consecutive matching striae than empirically observed to date could occur in KNM's; (2) the occurrence of multiple groups of consecutive matching striae appearing in the same relative position in any given known non-matching toolmark becomes less probable as the number of groups increases; and (3) there may be some variance between examiners in their subjective interpretation of the qualitative and quantitative agreement observed. With these considerations in mind, the authors' conservative quantitative criteria for identification are:

(1) in three-dimensional toolmarks when at least two different groups of at least three consecutive matching striae appear in the same relative position, or one group of six consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark; and

(2) in two-dimensional toolmarks when at least two groups of at least five consecutive matching striae appear in the same relative position, or one group of eight consecutive matching striae are in agreement in an

unchanged since 1997 1st edition – J Murdock 7/11/15

[23] See Biasotti & Murdock, "Criteria For Identification" or "State of the Art of Firearms and Toolmark Identification," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984).

evidence toolmark compared to a test toolmark.

For these criteria to apply, however, the possibility of subclass characteristics must be ruled out.

Research conducted thus far by the authors indicates that the practical probability limits in known non-matches for impression toolmarks are similar to those found for striated toolmarks. Some progress has been made in developing quantitative criteria for the identification of compression toolmarks. Following Stone's publication of a theoretical model for the mathematical evaluation of well defined types of impressed toolmarks,[24] Collins used and evaluated Stone's model while performing an empirical study of twenty worn hammer faces. His preliminary results show that combinations of even low numbers of simple impressed defects are, on a practical level, quite discriminating.[25] However, more research is needed involving very fine, high density, randomly distributed individual impression characteristics, viewed two dimensionally, before definitive practical probability limits can be stated confidently.

Since this chapter was first published in 1997, there have been a number of studies which have included an evaluation, using consecutive matching striae, of the numerical criteria for the identification of striated toolmarks proposed above by the authors.[26] No known non-matching (two- or three-dimensional) toolmarks were found in these studies which exhibited agree-

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[24]Stone, How Unique are Impressed Toolmarks?, 35 Ass'n Firearm & Toolmark Examiners J. 4 (2003). The comparison model developed by Stone offers a springboard upon which those interested in studying the occurrence of impressed contours and establishing the basis for a quantifiable identification criterion of impressed toolmarks may now do so. His work has inspired other researchers.

[25]Collins, How Unique are Impressed Toolmarks: An Empirical Study of 20 Worn Hammer Faces 37 Ass'n Firearm and Toolmark Examiners J. 252 (2005). Collins tested the validity of Stone's theories on the statistical uniqueness of impressed toolmarks through the empirical examination of the defects observed on the faces of twenty hammers that had been subjected to various degrees of wear and abuse through normal use. These examinations were carried out under controlled conditions that would simulate those used in practical casework. The results of this study led to a re-evaluation of Stone's work and a modification of related formulae. The revised formulae were used to calculate practical but conservative probabilities associated with impressed toolmarks using the data collected from the hammers in this study.

[26]Tulleners, Giusto & Hamiel, Striae Reproducibility on Sectional Cuts of One Thompson Contender Barrel, 30 Ass'n Firearm & Toolmark Examiners J. 62 (1998); Miller & McLean, Criteria for Identification of Toolmarks, Ass'n Firearm & Toolmark Examiners J. 15 (1998) (offering a sound description of the history of criteria for identification, the use of IBIS and the scientific method; the authors used IBIS to sort single land impressions of.38 special caliber bullets for comparison; the test firings used in their study were from firearms associated with forensic casework and thus were used firearms); Miller, Criteria for Identification of Toolmarks Part II—Single Land Impression Comparisons, 32 Ass'n Firearm & Toolmark Examiners J. 116 (2000) (extending his IBIS sorted study by examining single land impressions of. 25 auto, .380 auto and 9mm calibers; because he limited his studies (Part I and II) to single land impressions, he found that he excluded some known identifications because there was not enough agreement to

ment in excess of the proposed Biasotti-Murdock criteria.

There are indications that the concept of objective quantitative criteria for identification is gaining wider acceptance. In 1999 at the annual training seminar, approximately 300 members of the Association of Firearm and Toolmark Examiners (AFTE) voluntarily participated in a four-hour

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meet the Biasotti-Murdock criteria; no false identifications were made, however; the test firings used in this study were from firearms associated with forensic casework and thus were used firearms); Miller, An Examination of Two Consecutively Rifled Barrels and a Review of the Literature, 32 Ass'n Firearm & Toolmark Examiners J. 259 (2000) (after reviewing literature dealing with the examination of bullets fired from consecutively rifled barrels, Miller then compared test bullets pushed through two new consecutively rifled gun barrels; after determining that there was no subclass influence, he evaluated the test bullets by using the Biasotti-Murdock numerical criteria for identification described in this chapter; he found that no false identifications would be made using these criteria); Fred Tulleners, David Stoney & James Hamiel, An Analysis of Consecutive Striae on Random and Consecutive Chisels, Paper presented at the annual meeting of the American Academy of Forensics Sciences (Feb.1999). Tulleners et al. summarized a cumulative study comparing striae patterns left by six consecutively manufactured chisels and four chisels of the same size and brand, chosen randomly. The results were: "there were no consecutive runs of striae greater than 4X in known non-matching positions." They observed that "the absence of any 4X or higher occurrences in the mismatched positions, along with their routine and multiple occurrence in properly phased known matching toolmarks, provides the foundation for the hypothesis: chisel marks have an objective, measurable threshold, that can be set, above which one can be certain that a given correspondence results from a true association rather than at random." They further concluded, "these results strongly support the hypothesis that an objective threshold, based on consecutively matching striae, can be set such that there is a clear distinction between random and matching striae correspondence."

Miller, An Examination of the Application of the Conservative Criteria for Identification of Striated Toolmarks Using Bullets from Ten Consecutively Rifled Barrels, 33 Ass'n Firearm and Toolmark Examiners J. 2 (2001). Miller intercompared bullets test fired from ten consecutively broached gun barrels. He found that considering the results of the data for the two and three dimensional comparisons between known matches and non-matches, no erroneous identifications would be expected although some actual identifications would be excluded. He said that his study further validates the use of the conservative-numerical criteria (proposed by Biasotti and Murdock) insofar as critical evaluation of striated toolmark agreement will not result in a false identification.

Miller and Neel, Criteria for Identification of Toolmarks, Part III: Supporting the Conclusion, 36 Ass'n Firearm and Toolmark Examiners J. 1 (2004). In this study, students at the ATF National Firearm Examiners Academy evaluated two dimensional toolmarks produced with 60 grit sandpaper and recorded on 35 mm photographic film. Each kit contained known matching and non-matching toolmarks. In the three studies (12 students in each class) reported on in this research, the concept of using the Biasotti-Murdock conservative CMS criteria as a method for describing the difference between a known match and known non-match, as well as its use to support a conclusion in a striated toolmark examination, was tested. In all of the samples examined, no false identifications occurred. Missed identifications occurred only when the defined pattern area was limited, and these were rare. Although variations in counting striae and consecutive groups of striae were noted this had *no effect on* the conclusions reached by the student examiners.

workshop on the subject.[27] In addition, workshops of varying lengths up to 20 hours duration entitled "Scientifically Defensible Criteria for the Identification of Toolmarks" have been presented by John Murdock and Bruce Moran at the 2003 (8 hours), 2004 (12), 2005 (12 hours) and 2007 (15 hours) AFTE annual seminars. Approximately 120 AFTE members have attended. This same workshop was presented at the International Association of Forensic Science meeting in August 2005 in Hong Kong (13 hours, 25 students), to the Los Angeles, CA Police Department Firearms Unit in October 2005 (16 hours) and the European Network of Forensic Science Institutes, Bad Camberg, Germany, March 2009 (20 hours, 50 firearm/toolmark examiners from approximately 27 European countries).

On a more practical level, Bruce Moran has authored two papers which describe how he uses objective quantitative criteria in firearms and toolmark casework and how a typical question and answer session might be presented in court on the same subject.[28]

Ronald Nichols has authored two papers which have helped clarify the use of consecutive matching striae, summarized CMS validation studies,

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[27]Objective Criteria Workshop, presented by Torrey D. Johnson (of the Las Vegas Metro Police Department Forensic Laboratory) in Williamsburg, Virginia (July 18–23, 1999). Each participant performed a number of toolmark "photo comparisons" and were to conclude if the comparisons represented an identification, an elimination or were inconclusive of the AFTE glossary A, B or C type; see § 35:9. The hypothesis for this study was that, when toolmarks are compared, based on corresponding groups of striae, called consecutive matching striae, a level of correspondence exists which provides a satisfactory determination of identity between the marks. If it is possible to establish this level, it is possible to define quantitatively the degree of correspondence that divides inconclusive from identification. Unfortunately, the scope of this study proved too great for the time available, and no meaningful data were obtained.

[28]Moran, The Application of Numerical Criteria For Identification in Casework Involving (Ammunition) Magazine Marks and Rifling Impressions (on Bullets), 33 Ass'n Firearm & Toolmark Examiners J. 41 (2001) (including a well-illustrated discussion of subclass toolmarks on ammunition magazine lips); Moran, Firearms Examiner Expert Witness Testimony: The Forensic Firearms Identification Process Including Criteria for Identification and Distance Determination, 32 Ass'n Firearm & Toolmark Examiners J. 231 (2000) (providing helpful discussion concerning skillful and thorough presentation of this subject in court).

See also Hess and Moran, The Removal of Superficial Rust/Corrosion From the Working Surfaces of Firearms For the Purpose of Preserving Their Potentially Identifiable Signature and an Application of this Technique in a Firearms Identification, 38 Ass'n Firearm and Toolmark Examiners J. 112(2006). This two-part paper describes: (1) a method for removing superficial rust and corrosion from the working surfaces of firearms with the intent to restore any surviving identifiable signature of the firearm and (2) casework resulting in the successful identification of several bullets to a rusted firearm treated using the procedure. The latter discussion includes a series of photomicrographs illustrating tabulations of CMS supporting conclusions of an identification involving a limited amount of striae. It also describes the approach to the consideration of subclass influence present in the grooves of the barrel bore of the questioned firearm and provides photomicrographs of these features.

and described the validity of the AFTE Theory of Identification.[29] In addition to a well illustrated discussion of the presence of subclass characteristics which do not prevent the individuality of the working tool surfaces of ten consecutively manufactured extractors, this article collates the relevant studies, showing substantial support for the AFTE Theory of Identification, and suggesting that its scientific validity and reliability can be more than adequately defended.

Additionally, a recent paper sheds light on the astronomical probabilities, from a Bayesian point of view, of approaching KNM agreement equal to or greater than the minimum numerical criteria.[30]

§ 35:14 Future directions

It is anticipated that objective quantitative criteria for identification will eventually become widely accepted and used[1] because of: (1) research al-

[29]Nichols, Consecutive-Matching Striations (CMS): Its Definition, Study and Application in the Discipline of Firearms and Toolmark Identification, 35 Ass'n Firearm and Toolmark Examiners J. 3 (2003). A definition of CMS is presented that helps demonstrate that it is not in conflict with what has been referred to as the traditional pattern matching approach, but is simply a means of describing the observed pattern. This article also critically evaluates those articles that have questioned the conservative minimum criteria for identification approach. See also Nichols, Firearm and Toolmark Identification: The Scientific Reliability and Validity of the AFTE Theory of Identification Discussed Within the Framework of a Study of Ten Consecutively Manufactured Extractors, 36 Ass'n Firearm & Toolmark Examiners J. 1 (2004). This paper provides a summary of approximately 6,000 known non-matching striated toolmark comparisons that were conducted since publication of the conservative CMS criteria was first published in 1997. The conservative CMS criteria was not exceeded in any of these 2D and 3D comparisons.

[30]Buckleton et al., An Exploratory Bayesian Model for Firearm and Tool Mark Interpretation, 37 Ass'n Firearm and Toolmark Examiners J. 352 (2005).

[Section 35:14]

[1]A Survey of the Association of Firearm & Toolmark Examiners Concerning Quantitative Consecutive Matching Striae (CMS), Final Report (September 27, 2007). (For February 20, 2008 amendments, see CAC News, 3rd Quarter 2008, at 49). (JD Franz Research, Inc., Public Opinion and Marketing Research, Sacramento, CA).

The Report's findings derive from a survey of members of the Association of Firearm and Toolmark Examiners (AFTE) that was commissioned by California Association of Criminalists (CAC), Northern California Firearms Study Group.

The survey targeted all of the approximately 800 AFTE members and as many other qualified firearm or toolmark examiners as could be reached. Data were collected between October 2006 and April 2007.

The primary purposes of the survey were to determine the extent to which AFTE members use and believe in the scientific validity of the Quantitative Consecutive Matching Striae (CMS) method of firearm and toolmark identification. Specific areas of inquiry were as follows:

- Reading about the CMS method
- Receipt of training in CMS
- Familiarity with the theoretical aspects of the CMS method
- Familiarity with the CMS method in practice
- Knowledge about CMS and scientific validity
- Awareness of evidence that should prevent CMS from being used
- Use of pattern matching and CMS

ready conducted and published;[2] (2) training classes given,[3] and (3) a com-

- Determining whether to use CMS
- Reasons for using CMS
- Guidance from SOP or procedure manuals
- Court challenges and feedback on the use of CMS
- Characteristics of responding examiners.

From the results, it appears that the Quantitative Consecutive Matching Striae (CMS) method of firearm and toolmark identification remains controversial among professional examiners. A solid minority of examiners reject the scientific validity of the technique. Most examiners, however, accept the method as being valid. In addition, 43% use the technique as an extension of pattern matching in their own work. Relatively few are aware of any compelling evidence that should actually prevent CMS from being used in casework. Court challenges to the use of CMS have reportedly been rare. Feedback from the courts has also been predominantly positive.

In terms of the future of CMS, analysis of the survey data suggest that there is a relationship between familiarity with the technique and its acceptance as scientifically valid. It therefore seems reasonable to conclude that as more examiners read about the technique and receive training in it, its use will increase. Reinforcing this contention is the fact that among those who do not actually view the method as being valid, the largest group do not know whether they should accept or reject it. Presumably, as knowledge and understanding continue to spread, acceptance will grow as well.

The complete survey as well as Appendices are available at www.cacnews.org.

[2]Grzybowski, Miller, Moran, Murdock, Nichols, Thompson, Firearm/Toolmark Identification: Passing the Reliability Test Under Federal and State Evidentiary Standards, 35 Ass'n Firearm and Toolmark Examiners J. 2 (2003). (Appendix No. 2, at 234-240, provides a clear explanation of the steps in the scientific method and illustrates how both firearm and toolmark casework and research is conducted according to the scientific method). Ronald Nichols, The Scientic Foundations of Firearms and Tool Mark Identification—A Response to Recent Challenges, California Association of Criminalists—The CAC News, Second Quarter (2006), at 8.

Ronald Nichols, Defending the Scientific Foundations of the Firearms and Tool Mark Identification Discipline: Responding to Recent Challenges, 52 J. Forensic Sci. 586 (2007).

Neel & Wells, A Comprehensive Statistical Analysis of Striated Toolmark Examinations, Part I: Comparing Known Matches and Known Non-matches, 39 Ass'n Firearm and Toolmark Examiners J. 176 (2007) (errata at 39 AFTE J. 264 (2007)) (The purpose of this paper is to quantify the difference between known matches (KM) and known non-matches (KNM). In this research over 4000 striated toolmark comparisons were examined for consecutive matching striae (CMS). This research demonstrated that both two dimensional and 3 dimensional KM and KNM can be statistically distinguished from one another.).

D. Howitt, F. Tulleners, K. Cebra, and S. Chen, A Calculation of the Theoretical Significance of Matched Bullets, 53 J. Forensic Sciences 868 (2008). (concluding that it is possible to determine the probabilities of consecutively matched lines on a bullet and to demonstrate that they are extremely unlikely to occur randomly).

[3]Following the presentation of two CC1 "firearms and toolmark identication criteria" classes to a total of twenty eight examiners from Australia and New Zealand in November 2001 by John Murdock and Fred Tulleners, national agreed guidelines were developed regarding comparative microscopic examinations and the relevance of the conservative criteria for the identication of striated toolmarks. It was agreed that applying the criteria for Consecutively Matching Striae (CMS) was a valid tool when carrying out the comparative process and that CMS provides for a more objective approach. Firearm and Toolmark Scientific Working Group Report and Report on CMS Workshop (Australia and New Zealand), The Forensic Bulletin - National Institute of Forensic Sci-

mercially available system called the Integrated Ballistic Identification System (IBIS)[4] developed by Forensic Technology Industries of Montreal, Canada, for the comparison of fired bullets and cartridge cases. Barrett reported on the basic concept of the IBIS system in 1991, while Tontarski and Thompson have provided a description of the IBIS system as it was being used in 1998.[5] It has undergone several upgrades since.

The primary purpose of these automated comparison systems, as far as fired bullets are concerned, is to rapidly screen large populations of electronically stored images of fired bullets. From a comparison of the unique features of the stored images, these systems produce a list of bullet images ranked in order of striae agreement. An imaging comparison system called "Drugfire" was developed for cartridge cases by the Federal Bureau of Investigation.[6] Drugfire machines have been, however, phased out. They have been replaced across the United States by IBIS machines.

Automated systems do *not* make identifications, or replace the need for an expert examiner. The identification or exclusion of the images generated by these systems must be based on the informed judgement of an examiner comparing real or replica bullets or cartridge cases selected by these systems.

However, these systems will continue to make major contributions toward establishing objective quantitative criteria for identification. Objective criteria such as the number of consecutively matching striae, and the effect of variable qualitative dimensions of individual characteristics can be evaluated rapidly for large populations of known non-matches from a variety of different calibers, bullet and cartridge types and manufacturing methods. These automated measurements, which are inherently objective, can therefore be used to increase substantially the statistical confidence in the range of correspondence observed in direct manual known non-match comparisons.

Beyond this, it is up to individual examiners to become aware of the literature about criteria for identification and use it in their day-to-day casework. Perhaps then it will be possible to come close to the standard

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ence Australia (June 2002), at 2–3.

Also refer to a series of workshops presented by Moran and Murdock summarized in Section 35:12.

In addition, between 1990 and 2008 nineteen one week California Criminalistics Institute Courses No. CCI E201, Firearms and Toolmark Identification Criteria, have been presented to approximately 228 students.

[4]Technical and other information available from Forensic Technology WAI Inc.5757 Cavendish Blvd., Suite 200Côte St-Luc, QC H4W 2W8 Tel: 514-489-4247 Fax: 514-485-9336 Toll Free Number: 1-888-984-4247 E-mail: "mailto:info@contactft.com"info@contactft.com.

[5]Barrett, The Microchip and the Bullet: A Vision of the Future, 23 Ass'n Firearms & Toolmark Examiners J. 876 (1991); Tontarski & Thompson, Automated Ballistic Comparison: A Forensic Tool for Firearms Identification-An Update, 43 J. Forensic Sci. 641 (1998).

[6]Robert W. Sibert, Drugfire: Revolutionizing Forensic Firearms Identification and Providing the Foundation for a National Firearms Identification Network, 21 Crime Laboratory Dig. 63 (October 1994).

espoused by Paul Kirk in his syllabus to his University of California, Berkeley, Course number 151: "In criminalistic practice [forensic science], mistakes are not allowed."[7] In reality, mistakes do occur in forensic science, as in all other professions. All we can do is to try very, very hard to prevent them. It is our belief that the continued development and widespread acceptance of objective quantifiable criteria for identification will hold mistakes to a minimum, especially where limited striae are available for comparison.

The intercomparison of striated toolmarks by pattern recognition alone is a process of form perception where the goal of the examiner is to use his/her training and experience to locate sufficient matching agreement between questioned and known toolmarks to effect an identification between these toolmarks. This is a process that does *not* include a conscious tabulation of consecutive matching striae (CMS). Examiners using pattern recognition alone can describe the extent of matching striae in any given striated toolmark match position by saying that it exceeds any known non-match with which they are familiar.

Some examiners, who locate *potential* matching striated toolmark areas through pattern matching, have chosen to critically evaluate the extent of this striated pattern agreement by numerically tabulating the quantity of consecutively matching striae (CMS) in these areas and use these tabulations as a way to describe the extent of matching CMS in any given striated toolmark comparison. These numerical counts are then compared to the results of empirical research involving tabulations of CMS in both known matching and known non-matching toolmarks. Toolmark identifications are made when the tabulated CMS runs exceed the thresholds established by empirical research. The thresholds may be those proposed by Biasotti and Murdock in 1997, or lower or higher thresholds depending on examiner preference, based on their training and experience. If a numerical threshold lower than the Biasotti-Murdock conservative CMS criteria is used, it should be validated by competent researchers in the same way that their criteria have been validated over the past twelve years. A higher CMS criterion than that proposed by Biasotti and Murdock has, by virtue of the validation studies performed on their conservative CMS criteria over the last twelve years, already been validated.

It should, therefore, be clear that the application of quantitative CMS criteria is not a different method than pattern matching, but is merely a quantitative way to describe the extent of striated pattern matching agreement and is also a means of universally communicating the extent of this agreement. It is important to note that examiners using quantitative CMS criteria do not first identify a striated toolmark using pattern matching and then quantitate CMS. Pattern matching is used simply to locate stri-

[7]Paul L. Kirk, Outline of Laboratory Work in Criminology 151 (University of California, Berkeley, 1957, reprinted 1963), at 2.

ated toolmark areas worthy of CMS quantitation. One author, critical of CMS, has incorrectly stated that examiners use CMS after they have already reached an identification in their minds eye.[8]

With the assumption that firearm/toolmark examiners embrace the concept of quantitative criteria for identification of striated toolmarks using consecutive matching striae, Grzybowski and Murdock have summarized the view of many examiners by concluding that:

> The firearm/toolmark identification field has all the indicia of a science: (1) It is well grounded in scientific method; (2) it is well accepted in the relevant scientific community; (3) it has been subjected to many forms of peer review and publication; (4) it has participated in proficiency testing and published error rates; and (5) it provides objective quantitative criteria that guide the identification process.[9]

Grzybowski et al.[10] comprehensively cite and summarize work that they suggest provides an approach to explaining the firearm and toolmark identification process as a reliable science under the challenges of both *Daubert* and *Frye*.

There have been criticisms of firearm and toolmark identification from individuals outside the profession,[11] most notably by Adina Schwartz, who has written about the scientific shortcomings of forearm and toolmark analysis. Ronald Nichols has responded directly to Schwartz by pointing out what he argues are the deficiencies in her critique of the reliability of toolmark identification[12] and has responded generally to Schwartz and others who have also questioned the reliability of toolmark identification.[13]

Two recent reports issued under the auspices of the National Academies of Sciences are critical of firearm and toolmark identification.[14]

The National Research Council (NRC), one of the National Academies,

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[8]Schwartz, A., Challenging Firearms and Toolmark Identification, Part One, The Champion, November 2008, p 10 - 19 at p. 16.

[9]Grzybowski & Murdock, Firearms and Toolmark Identification—Meeting the *Daubert* Challenge, 30 Ass'n Firearm & Toolmark Examiners J. 3 (1998) (including a basic discussion of the scientific method as well as inductive and deductive reasoning).

[10]Grzybowski, Miller, Moran, Murdock, Nichols, Thompson, Firearm/Toolmark Identification: Passing the Reliability Test under Federal and State Evidentiary Standards, 35 Ass'n Firearm and Toolmark Examiners J. 2 (2003).

[11]Adina Schwartz, Toolmark and Firearm Identification, in Jane Campbell Moriarty, Psychological and Scientific Evidence in Criminal Trials, § 12:39, at 12–49 (2005).

[12]Ronald Nichols, The Scientific Foundations of Firearms and Tool Mark Identification—A Response to Recent Challenges, California Association of Criminalists—The CAC News, Second Quarter 2006, at 8.

[13]Ronald Nichols, Defending the Scientific Foundations of the Firearms and Tool Mark Identification Discipline: Responding to Recent Challenges, 52 J of Forensic Sciences, 586 (2007).

[14]Committee to Assess the Feasibility, Accuracy and Technical Capability of a National Ballistics Database, of the National Research Council, Ballistic Imaging (2008). Committee on Identifying the Needs of the Forensic Science Community of the National Research Council, Strengthening Forensic

working on a project sponsored by the National Institute of Justice (NIJ) undertook a lengthy study of the current ballistic imaging technology commonly known as IBIS and NIBIN as it might apply to a proposed national database of computerized images of bullets and/or cartridge cases from all new firearms sold in the United States. This mission is embodied in the NRC committee's title: "The Committee to Assess the Feasibility, Accuracy, and Technical Capability of a National Ballistics Database." The efforts of this committee covered the period from 2004 to the issuance of their report in March of 2008. The ultimate conclusion of this committee was given in a single sentence on page 4 of the Executive Summary: "A national reference ballistic image database of all new and imported guns is not advisable at this time."

The discipline of firearm and toolmark identification has come under increased scrutiny as a result of this NRC report. While there is much in the report that is accurate and with which practitioners within the discipline agree, there are concerns raised by the NRC Committee that, in the opinion of the Association of Firearm and Toolmark Examiners, appear without basis and indeed have been addressed on a number of occasions by well-respected practitioners within the field of firearm and toolmark identification in response to other critics of the discipline.[15] The reader is encouraged to review the AFTE response as well as the NRC Report in their entirety.[16]

In February 2009, the National Research Council (NRC) issued a report authored by its Committee on Identifying the Needs of the Forensic Science Community (herein referred to as the NRC Committee) entitled, "Strengthening Forensic Science in the United States: A Path Forward."

The aim of the NRC Committee, as stated on page P-1 of the prepublication report, was "to chart an agenda for progress in the forensic science community and its scientific disciplines," including firearm and toolmark identification. (The portion of the report addressed specifically to firearms and toolmark examination is provided in Appendix 34C.) Pursuant to this goal, the report offers 13 recommendations that represent the

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Science in the United States: A Path Forward (2009).

[15]Among the most current of these are: Ronald Nichols, Firearm and Tool Mark Identification: The Scientific Reliability and Validity of the AFTE Theory of Identification Discussed Within the Framework of a Study of Ten Consecutively Manufactured Extractors, 36 AFTE Journal 67 (2004); The Scientific Foundations of Firearms and Tool Mark Identification—A Response to Recent Challenges," CACNews 8 (2nd Quarter, 2006); and Defending the Scientific Foundations of the Firearms and Tool Mark Identification Discipline: Responding to Recent Challenges" 52 J. Forensic Sciences 586 (2007).

[16]AFTE Committee for the Advancement of the Science of Firearm and Toolmark Identification, A Response of the Association of Firearm and Toolmark Examiners to the National Academy of Sciences 2008 Report, Assessing the Feasibility, Accuracy, and Technical Capability of a National Ballistics Database, 40 AFTE Journal 234 (2008) (committee members include: John Murdock (Chair), Andy Smith, Brandon Giroux, Lucien Haag, James Hamby, and Pete Striupaitis).

Committee's studied opinion on how best to achieve its agenda.

To make its task feasible, the NRC Committee imposed limitations on how much depth it would go into about any one forensic science area. As expressed by the NRC Committee on page S-5:

> The committee decided early in its work that it would not be feasible to develop a detailed evaluation of each discipline in terms of its scientific underpinning, level of development, and ability to provide evidence to address the major types of questions raised in criminal prosecutions and civil litigation.

By approaching their stated task with this self-imposed limitation in mind, the NRC Committee, in effect, ignored extensive research supporting the scientific underpinnings of the identification of firearm and toolmark evidence. In spite of this limitation, the Association of Firearm and Tool Mark Examiners (AFTE) reviewed the thirteen recommendations made by the NRC Committee and found that six of them, numbers 2, 3, 6, 7, 8 and 9, directly relate to firearms and toolmark examination. The AFTE responded that activities conducted by AFTE and the Scientific Working Group for Firearms and Toolmarks (SWGGUN) already meet certain requirements or expectations of these six recommendations. These recommendations and the AFTE responses to them are included in the AFTE response to the NRC report. The reader is encouraged to review the AFTE response to the NRC report in its entirety.[17]

These debates will influence the future of the field of firearms and toolmark analysis and the evidence the field's examiners present in court.

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[17]AFTE Committee for the Advancement of the Science of Firearm and Toolmark Identification, The Response of the Association of Firearm and Tool Mark Examiners to the February 2009 National Academy of Science Report, "Strengthening Forensic Science in the United States: A Path Forward," ___ AFTE Journal ___ (2009) (committee members include: John Murdock (Chair), Andy Smith, Brandon Giroux, Lucien Haag, James Hamby, and Pete Striupaitis). The AFTE Committee's final draft, dated July 22, 2009, was accepted by the AFTE Board of Directors.

APPENDIX 35A

Glossary of Terms

Terms accompanied by an asterisk have been drawn from a list promulgated by the Association of Firearm and Toolmark Examiners

Accidental characteristic.* Term formerly used to mean individual characteristic. See individual characteristics.

Class characteristics.* Measurable features of a specimen which indicate a restricted group source. They result from design factors, and are therefore determined prior to manufacture.

Consecutive Striae. Parallel, side by side, contour variations within a striated toolmark.

Consecutive Matching Striae (CMS). Contour variations, within two different striated toolmarks, which, when compared microscopically, line up exactly with one another without a break or dissimilarity in-between.

Impression.* Contour variations on the surface of an object caused by a combination of force and motion where the motion is approximately perpendicular to the plane being marked. These marks can contain *class* and/or *individual characteristics*.

Individual characteristics.* Marks produced by the random imperfections or irregularities of tool surfaces. These random imperfections or irregularities are either produced incidental to manufacture or are caused by use, corrosion, or damage. They are unique to that tool and distinguish it from all other tools.

Known non-matching toolmarks. Toolmarks known to have been made by different tools, or made by the same tool but deliberately placed in a non-matching position.

Maximum Known Non-matching Agreement in Striated Toolmarks. (a) For pattern matching alone, the ability of an examiner to recall the best agreement either personally observed, or has been observed by others in the profession by rigorous studies, or (b) for examiners who quantitate CMS, this is a numerical way to describe the best known non-matching agreement that has either been personally observed, or has been observed by others in the profession by rigorous studies.

Pattern matching in toolmark comparison. The visual comparative examination of the topographical features (a configuration of a surface including its relief and the position of its man-made features) of two different toolmarks. These topographical features consist of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and the spatial relationship of these features are defined for one toolmark and are then compared to the corresponding topographical features in the other toolmark. The consecutiveness of striae is an important topographical comparative feature. The comparison process is a combination of art and science. The art portion is the ability of an examiner to recognize agreement between patterns. This depends on an examiners' cognitive ability. This ability is acquired as an examiner uses his or her training and experience viewing the relative correspondence of known matching and non-matching toolmarks to built up an awareness of uniqueness. Although an examiner that uses pattern matching alone is unlikely to be able to pinpoint a specific criteria of counted points of correspondence, he or she can recognize when the agreement present in any given comparison, whether it be striated or impressed, exceeds maximum known non-match agreement. When it does, a positive identification, to the practical exclusion of other tools, can be made. The scientific portion of the pattern match comparison is the validated premise that unique tool working surfaces leave toolmarks that can establish an identification.

Quantitative CMS. A numerical tabulation of CMS runs. Typically, the number of matching CMS is designated by a number, followed by the letter x. For example, 1x, 2x, 3x..., etc.

Quantitative CMS Identification Criteria. A numerical standard used when making a quantitative assessment of matching CMS in a comparison of a test striated toolmark with a questioned striated toolmark. The amount of matching CMS is compared to an empirically determined numerical threshold which is greater than the best known non-match quantitative CMS value. When the best KNM value is exceeded, a positive toolmark identification can be made with confidence.

Striations.* Contour variations, generally microscopic, on the surface of an object caused by a combination of force and motion where the motion is approximately parallel to the plane being marked. These marks can contain *class* and/or *individual characteristics*.

Subclass characteristics.* Discernible surface features of an object that are more restrictive than *class characteristics* in that they: (1) are produced incidental to manufacture; (2) relate to a smaller group source (a subset of the class to which they belong); and (3) can arise from a source which changes over time. Examples include: bunter marks (headstamps produced on cartridge cases) produced by bunters made from a common master, extrusion marks on pipe, etc.

Tool.* An object used to gain mechanical advantage. Also thought of as the harder of two objects which produces toolmarks when brought into contact with each other resulting in the softer one being marked.

Toolmark, impressed.* Marks produced when a tool is placed against another object and enough force is applied to the tool so that it leaves an impression. The class characteristics (shape) can indicate the type of tool used to produce the mark. These marks can contain *class* and/or *individual characteristics* of the tool producing the marks. Also called *compression marks*.

Toolmark, striated.* Marks produced when a tool is placed against another object and with pressure applied, the tool is moved across the object, producing a striated mark. *Friction marks, abrasion marks*, and *scratch marks* are terms commonly used when referring to striated marks. These marks can consist of either *class* or *individual characteristics*, or both.

APPENDIX 35B

Questions Designed to Test a Witness's Ability to Identify Striated Toolmarks

1. Have you had training in toolmark comparisons?

2. Please describe this training for us. I am especially interested in the specific training you have had that enables you to individualize striated toolmarks.

(Several types of training are possible: (1) formal classroom (this includes professional association workshops), (2) organized on-the-job training, and (3) structured self-directed type. All of these can focus on many areas worthy of study such as note taking, photography, tool manufacturing in general, but be unrelated to the individualization process.)

3. When you are comparing striated toolmarks made by tools capable of making unique toolmarks, how much agreement do you require before you can identify a specific tool as having made a specific evidence toolmark?

(An amount that exceeds the best known non-match agreement that I have ever seen, either in my experience or in the literature.)

4. How much agreement do other examiners require?

(This is generally unknown but the answer to #3 above is generally accepted.)

5. What is the standard amount of agreement that is required by the profession of firearm and toolmark examiners for an identification?

(there are no quantifiable standards recognized by the profession; but there are individual subjective "standard criteria" built up in the examiners' mind's-eye and based on their training and experience.) Some examiners have adopted the universal standard criteria for striated toolmark identification offered by Biasotti and Murdock in 1997. Refer to question #15.)

6. If there are no universally recognized quantifiable standards for the amount of agreement that is required to individualize striated toolmarks, how do you expect this court to evaluate the propriety of your conclusion(s)?

(There are subjective guidelines. There has been a *Theory of Identification* and *Range of Conclusions Possible when Comparing Toolmarks* (supra note 15) adopted by the Association of Firearm and Toolmark Examiners.)

7. Would you expect to find some agreement [matching striae] when comparing striated toolmarks known to have been made by different tools?

(The answer is yes.)

8. Isn't it true that there can be, on occasion, a considerable amount of agreement in comparisons of this sort, especially if the width of a shallow (for practical purposes, two-dimensional) mark being compared is quite small [say 2 millimeters or less]?

(The agreement referred to here should be enough agreement to pique an examiner's interest. The answer should be yes, but if no, you could refer the witness to a 1975 article on boltcutters, Butcher & Pugh, A Study of Marks Made by Bolt Cutters, 15 J. Forensic Sci. Soc'y 115 (1975), wherein apparent matching striae in known non-match positions are shown; and Murdock & Biasotti's "Criteria For Identication" or "State of the Art of Firearms and Toolmark Identication," 16 Ass'n Firearm & Toolmark Examiners J. 16 (1984), which also contains illustrations of known non-match agreement.)

9. The match or agreement in this case has been characterized as "________".

(The person asking the question can either quote from pretrial oral statements or written report(s) describing the nature of the toolmark agreement. The agreement may be described, depending on the examiner, as "significant," "best seen," "textbook," etc.)

10. Since you can get striae agreement in "known non-match" comparisons, how can you be sure that the agreement in this case is any better than remarkable "non-match" agreement. If the agreement in this case is no better than that, it doesn't mean anything does it?

(A witness who has never compared known "non-matches" is in a poor position with respect to this question. A witness who has studied known non-matches probably would say, in their opinion, that the extent of agreement exceeds known "non-match" agreement, if it does.)

11. Have you ever *deliberately* compared striated toolmarks that you knew were made by different tools?

(The answer should be yes. "Deliberately" is the key word here. When you do this, you are focusing on known non-match (KNM) agreement. When you find KNM agreement incidental to casework, you are probably not so focused and probably wouldn't take the time to record agreement in KNM positions; most examiners, however, gain some experience in KNM agreement while doing striae comparison casework.)

12. If so, how many of these comparisons have you made and what was the purpose of making comparisons of this sort?

(Approximately ________, for purposes of finding maximum striae agreement in any given KNM position.)

13. Wouldn't you agree that it is important, in order to properly evaluate and determine the significance of limited or less than textbook striae agreement, to know what the best agreement looks like in known non-match comparisons?

(The answer is yes. This knowledge is best gained by *deliberate* KNM comparisons, and not simply by what the examiner remembers having seen while comparing striae in casework, although some knowledge, as mentioned above in #11, is gained in this way.)

14. In order to make a positive identification of striated toolmarks, it seems to me that you have to have an amount of agreement that exceeds the best known non-match agreement. Do you agree?

(Yes. A witness who acknowledges having limited or no experience critically comparing known non-matching striated toolmarks, may not be in a very good position to properly evaluate the significance of the amount of agreement in cases where limited striae are present.)

15. How much agreement is this?

(Since it has been almost 13 years since the Biasotti-Murdock conservative CMS criteria were proposed, most examiners should be familiar with it and should be able to comment on how they personally satisfy the need to have a sufficient quantity of consecutive matching striae in toolmark identifications.)

APPENDIX 35C

National Research Council Comments*

TOOLMARK AND FIREARMS IDENTIFICATION

Toolmarks are generated when a hard object (tool) comes into contact with a relatively softer object. Such toolmarks may occur in the commission of a crime when an instrument such as a screwdriver, crowbar, or wire cutter is used or when the internal parts of a firearm make contact with the brass and lead that comprise ammunition. The marks left by an implement such as a screwdriver or a firearm's firing pin depend largely on the manufacturing processes—and manufacturing tools—used to create or shape it, although other surface features (e.g., chips, gouges) might be introduced through post-manufacturing wear. Manufacturing tools experience wear and abrasion as they cut, scrape, and otherwise shape metal, giving rise to the theory that any two manufactured products—even those produced consecutively with the same manufacturing tools—will bear microscopically different marks. Firearms and toolmark examiners believe that toolmarks may be traced to the physical heterogeneities of an individual tool—that is, that "individual characteristics" of toolmarks may be uniquely associated with a specific tool or firearm and are reproduced by the use of that tool and only that tool.

The manufacture and use of firearms produces an extensive set of specialized toolmarks. Gun barrels typically are rifled to improve accuracy, meaning that spiral grooves are cut into the barrel's interior. The process of cutting these grooves into the barrel leaves marks and scrapes on the relatively softer metal of the barrel.[1] In turn, these markings are transferred to the softer metal of a bullet as it exits the barrel. Over time, with repeated use (and metal-to-metal scraping), the marks on a barrel (and the corresponding "stria" imparted to bullets) may change as individual imperfections are formed or as cleanliness of the barrel changes. The brass exterior of cartridge cases receive analogous toolmarks during the process of gun firing: the firing pin dents the soft primer surface at the base of the cartridge to commence firing, the primer area is forced

*This Appendix contains an excerpt from Strengthening Forensic Science in the United States: A Path Forward, which has been reprinted with permission from the National Academies Press, Copyright 2009, National Academy of Sciences.

[1]Although the metal and initial rifling are very similar, the cutting of the individual barrels, the finishing machining, and the cleaning and polishing begin the process of differentiation of the two sequentially manufactured barrels.

backward by the buildup of gas pressure (so that the texture of the gun's breech face is impressed on the cartridge), and extractors and ejectors leave marks as they expel used cartridges and cycle in new ammunition.

Firearms examination is one of the more common functions of crime laboratories. Even small laboratories with limited services often perform firearms analysis. In addition to the analysis of marks on bullets and cartridges, firearms examination also includes the determination of the firing distance, the operability of a weapon, and sometimes the analysis of primer residue to determine whether someone recently handled a weapon. These broader aspects are not covered here.

Sample and Data Collection

When a tool is used in a crime, the object that contains the tool marks is recovered when possible. If a toolmark cannot be recovered, it can be photographed and cast. Test marks made by recovered tools can be made in a laboratory and compared with crime scene toolmarks.

In the early 1990s, the FBI and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) developed separate databases of images of bullet and cartridge case markings, which could be queried to suggest possible matches. In 1996, the National Institute of Standards and Technology (NIST) developed data exchange standards that permitted the integration of the FBI's DRUGFIRE database (cartridge case images) and the ATF's CEASEFIRE database (then limited to bullet images). The current National Integrated Ballistic Information Network (NIBIN) includes images from both cartridge cases and bullets that are associated with crime scenes and is maintained by the ATF.

Periodically—and particularly in the wake of the Washington, D.C. sniper attacks in 2002—the question has been raised of expanding the scope of databases like NIBIN to include images from test firings of newly manufactured firearms. In concept, this would permit downstream investigators who recover a cartridge case or bullet at a crime scene to identify the likely source firearm. Though two states (Maryland and New York) instituted such reference ballistic image databases for newly manufactured firearms, proposals to create such a database at the national level did not make substantial progress in Congress. A recent report of the National Academies, *Ballistic Imaging*, examined this option in great detail and concluded that "[a] national reference ballistic image database of all new and imported guns is not advisable at this time."[2]

Analyses

In both firearm and toolmark identification, it is useful to distinguish several types of characteristics that are considered by examiners. "Class characteristics" are distinctive features that are shared by many items of

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[2]National Research Council. 2008. *Ballistic Imaging*. Washington, D.C.: The National Academies Press, p. 5.

the same type. For example, the width of the head of a screwdriver or the pattern of serrations in the blade of a knife may be class characteristics that are common to all screwdrivers or knives of a particular manufacturer and/or model. Similarly, the number of grooves cut into the barrel of a firearm and the direction of "twist" in those grooves are class characteristics that can filter and restrict the range of firearms that match evidence found at a crime scene. "Individual characteristics" are the fine microscopic markings and textures that are said to be unique to an individual tool or firearm. Between these two extremes are "subclass characteristics" that may be common to a small group of firearms and that are produced by the manufacturing process, such as when a worn or dull tool is used to cut barrel rifling.

Bullets and cartridge cases are first examined to determine which class characteristics are present. If these differ from a comparison bullet or cartridge, further examination may be unnecessary. The microscopic markings on bullets and cartridge cases and on toolmarks are then examined under a comparison microscope (made from two compound microscopes joined by a comparison bridge that allows viewing of two objects at the same time). The unknown and known bullet or cartridge case or toolmark surfaces are compared visually by a firearms examiner, who can evaluate whether a match exists.

Scientific Interpretation

The task of the firearms and toolmark examiner is to identify the individual characteristics of microscopic toolmarks apart from class and subclass characteristics and then to assess the extent of agreement in individual characteristics in the two sets of toolmarks to permit the identification of an individual tool or firearm.

Guidance from the Association of Firearm and Tool Mark Examiners (AFTE)[3] indicates that an examiner may offer an opinion that a specific tool or firearm was the source of a specific set of toolmarks or a particular bullet striation pattern when "sufficient agreement" exists in the pattern of two sets of marks. The standards then define agreement as significant "when it exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent with the agreement demonstrated by tool marks known to have been produced by the same tool."[4]

Knowing the extent of agreement in marks made by different tools, and the extent of variation in marks made by the same tool, is a challenging task. AFTE standards acknowledge that these decisions involve subjective qualitative judgments by examiners and that the accuracy of examiners'

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[3]Theory of identification, range of striae comparison reports and modified glossary definitions—An AFTE Criteria for Identification Committee report. 1992. *Journal of the Association of Firearm and Tool Mark Examiners*. 24:336-340.

[4]Ibid., p. 336.

assessments is highly dependent on their skill and training. In earlier years, toolmark examiners relied on their past casework to provide a foundation for distinguishing between individual, class, and subclass characteristics. More recently, extensive training programs using known samples have expanded the knowledge base of examiners.

The emergence of ballistic imaging technology and databases such as NIBIN assist examiners in finding possible candidate matches between pieces of evidence, including crime scene exhibits held in other geographic locations. However, it is important to note that the final determination of a match is always done through direct physical comparison of the evidence by a firearms examiner, not the computer analysis of images. The growth of these databases also permits examiners to become more familiar with similarities in striation patterns made by different firearms. Newer imaging techniques assess toolmarks using three-dimensional surface measurement data, taking into account the depth of the marks. But even with more training and experience using newer techniques, the decision of the toolmark examiner remains a subjective decision based on unarticulated standards and no statistical foundation for estimation of error rates.[5] The National Academies report, *Ballistic Imaging*, while not claiming to be a definitive study on firearms identification, observed that, "The validity of the fundamental assumptions of uniqueness and reproducibility of firearms-related toolmarks has not yet been fully demonstrated." That study recognized the logic involved in trying to compare firearms-related toolmarks by noting that, "Although they are subject to numerous sources of variability, firearms-related toolmarks are not completely random and volatile; one can find similar marks on bullets and cartridge cases from the same gun," but it cautioned that, "A significant amount of research would be needed to scientifically determine the degree to which firearms-related toolmarks are unique or even to quantitatively characterize the probability

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[5]Recent research has attempted to develop a statistical foundation for assessing the likelihood that more than one tool could have made specific marks by assessing consecutive matching striae, but this approach is used in a minority of cases. See A.A. Biasotti. 1959. A statistical study of the individual characteristics of fired bullets. *Journal of Forensic Sciences* 4:34; A.A. Biasotti and J. Murdock. 1984. "Criteria for identification" or "state of the art" of firearms and tool marks identification. *Journal of the Association of Firearms and Tool Mark Examiners* 16(4):16; J. Miller and M.M. McLean. 1998. Criteria for identification of tool marks. *Journal of the Association of Firearms and Tool Mark Examiners* 30(1):15; J.J. Masson. 1997. Confidence level variations in firearms identification through computerized technology. *Journal of the Association of Firearms and Tool Mark Examiners* 29(1):42. For a critique of this area and a comparison of scientific issues involving toolmark evidence and DNA evidence, see A. Schwartz. 2004-2005. A systemic challenge to the reliability and admissibility of firearms and tool marks identification. *Columbia Science and Technology Law Review* 6:2. For a rebuttal to this critique, see R.G. Nichols. 2007. Defending the scientific foundations of the firearms and tool mark identification discipline: Responding to recent challenges. *Journal of Forensic Sciences* 52(3):586-594.

of uniqueness."[6]

Summary Assessment

Toolmark and firearms analysis suffers from the same limitations discussed above for impression evidence. Because not enough is known about the variabilities among individual tools and guns, we are not able to specify how many points of similarity are necessary for a given level of confidence in the result. Sufficient studies have not been done to understand the reliability and repeatability of the methods. The committee agrees that class characteristics are helpful in narrowing the pool of tools that may have left a distinctive mark. Individual patterns from manufacture or from wear might, in some cases, be distinctive enough to suggest one particular source, but additional studies should be performed to make the process of individualization more precise and repeatable.

A fundamental problem with toolmark and firearms analysis is the lack of a precisely defined process. As noted above, AFTE has adopted a theory of identification, but it does not provide a specific protocol. It says that an examiner may offer an opinion that a specific tool or firearm was the source of a specific set of toolmarks or a bullet striation pattern when "sufficient agreement" exists in the pattern of two sets of marks. It defines agreement as significant "when it exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent with the agreement demonstrated by tool marks known to have been produced by the same tool." The meaning of "exceeds the best agreement" and "consistent with" are not specified, and the examiner is expected to draw on his or her own experience. This AFTE document, which is the best guidance available for the field of toolmark identification, does not even consider, let alone address, questions regarding variability, reliability, repeatability, or the number of correlations needed to achieve a given degree of confidence.

Although some studies have been performed on the degree of similarity that can be found between marks made by different tools and the variability in marks made by an individual tool, the scientific knowledge base for toolmark and firearms analysis is fairly limited. For example, a report from Hamby, Brundage, and Thorpe[7]65 includes capsule summaries of 68 toolmark and firearms studies. But the capsule summaries suggest a heavy reliance on the subjective findings of examiners rather than on the rigorous quantification and analysis of sources of variability. Overall, the process for toolmark and firearms comparisons lacks the specificity of the

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[6]All quotes from National Research Council. 2008. *Ballistic Imaging*. Washington, D.C.: The National Academies Press, p. 3.

[7]J.E. Hamby, D.J. Brundage, and J.W. Thorpe. The identification of bullets fired from 10 consecutively rifled 9mm Ruger pistol barrels—A research project involving 468 participants from 19 countries. Available online at http://www.fti-ibis.com/DOWNLOADS/Publications/10%20Barrel%20Article-%20a.pdf.

protocols for, say, 13 STR DNA analysis. This is not to say that toolmark analysis needs to be as objective as DNA analysis in order to provide value. And, as was the case for friction ridge analysis and in contrast to the case for DNA analysis, the specific features to be examined and compared between toolmarks cannot be stipulated a priori. But the protocols for DNA analysis do represent a precisely specified, and scientifically justified, series of steps that lead to results with well-characterized confidence limits, and that is the goal for all the methods of forensic science.

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EDUCATION

1956 Wheaton Community High School, Wheaton, Illinois - Graduated

1964 A.A. Degree, Vallejo Junior College, Vallejo, California (now Solano Community College)

1967 B.S. Degree (with honors), University of California, Berkeley, California

1977 M.C. (Master of Criminology), University of California, Berkeley, California, School of Criminology

Elected to membership in the California Alpha chapter of the Phi Beta Kappa honor society in June 1967. From 1967 to 1970, earned 60 units of Criminology Graduate School credit, and was proceeding as directed by the faculty of the School of Criminology toward the Doctor of Criminology degree. On June 6, 1970, successfully completed the qualifying oral examination for the Doctor of Criminology degree.

Due to the demands from teaching part-time and the nature of my research topic, did not complete the dissertation for the degree. Prior to the expiration of my Graduate Student status, completed a Master's Thesis and was awarded a Master of Criminology degree as indicated above.

OTHER TRAINING

1971

Jan. 4 "Elements of Supervision"
A Contra Costa County Home Study Course

2.

RELEVANT TEACHING, TRAINING, AND EXPERIENCE (continued)

14. California Department of Justice, California Criminalistics Institute (CCI) 40 hour course CCI-E-201 "Firearms and Toolmark Identification Criteria" – Average number of students per class is 12.

- Team taught the following E-201 classes with Al Biasotti and the CCI staff at Sacramento, CA:
  1. December 1990
  2. April 1991
  3. May 1992
  4. February 1993
  5. December 1995
  6. October 1996
- Team taught the following E-201 classes with CCI staff at Sacramento, CA:
  7. 1997
  8. March 1998
  9. March 1999
  10. October 2000
  11. February 2003
- Team taught the following E-201 classes with Fred Tulleners:
  12. November 12-16, 2001- Sydney, NSW, Australia
  13. November 19-23, 2001- Perth, South Australia
  14. April 2003- Ammendale, MD for ATF FA/TM Examiners.
  15. March 2004- Miami, FL for the Miami- Dade Police Department FA/TM Examiners.
- Team taught the following E-201 classes with Bruce Moran:
  16. April 2005- Sacramento, CA
  17. March 2007- Sacramento, CA
  18. October 2009- Sacramento, CA
  19. November 3-8, 2008- Sydney, NSW, Australia
  20. November 2009- Miami, FL for the Miami –Dade Police Department.

Summary of CCI- E-201 Classes from 1990 through 2009:
21 classes with average of 12 students per class equals about 252 students.

15. Lectured on Firearms and Toolmark Evidence - part of a one-day course at the ATF crime laboratory in Walnut Creek, CA to three groups of ATF Special Agents from April. 4-29, 1994.

16. Lectured at the California Criminalistics Institute "Overview of Firearm and Toolmark Identification" course on General approach to casework and case documentation/note taking, Nov. 5, 1993, Oct. 1994, Dec. 6, 1995, Oct. 23, 1996, and Mar. 4, 1998.

RELEVANT TEACHING, TRAINING, AND EXPERIENCE (continued)

36. Team taught (with Bruce Moran) – "Scientifically Defensible Criteria for Identification of Toolmarks Workshop":
    1) at Annual AFTE training seminar – May 2003 – Philadelphia, PA (8 hours);
    2) at Annual AFTE training seminar - May 2004 – Vancouver, BC (12 hours). 25 students;
    3) at Annual AFTE training seminar - June 2005 – Indianapolis, IN (12 hours and 40 students);
    4) at the International Association of Forensic Sciences tri-annual meeting in Hong Kong, China - 13 hours – 25 students, August 25-26, 2005;
    5) at the Los Angeles Police Department for all LAPD FA/TM Examiners, 16 hours, Oct 15-16, 2005;
    6) at the Annual AFTE training seminar in San Francisco, CA, June 7, 2007, 15 hours, 33 students;
    7) in Bad Camberg, Germany for 50 students from over 20 European Countries, 20 hours- March, 2009;
    8) in Albany, NY for the New York State Division of Criminal Justice Services,18 students, 20 hours;
    9) at Contra Costa County Crime Lab for all FA/TM Examiners- 5 hours, April 15, 2010;
    10) in Sacramento, CA for California Dept. of Justice, California Criminalistics Institute (CCI), -Nov 16- 18, 2010- 20 hours- 25 students;
    11) In Los Angeles, CA for California Dept. of Justice, California Criminalistics Institute (CCI), April 2011, 12 students- 20 hours;
    12) at Annual AFTE training seminar in Chicago, IL- 8 hours- 30 students;
    13) for the Los Angeles, CA Police Dept., Sept 27-29, 2011- 25 students;
    14) Through 21) in Capetown, Durban, Port Elizabeth and Pretoria, South Africa for the South African Police Services (SAPS), Oct 10-Nov 10, 2012, presented eight 16 hour workshops to all SA FA Examiners (approximately 200 students):

    Summary- From 2003 to 2012: twenty one workshops with approximately 528 students.

37. Lectured on "Ethics and Forensic Science" at the ATF National Firearms Examiners Academy, Ammendale, MD 2004 and March, 2006.

38. Lectured (1 hour) on "The Ethics of Forensic Science" at the annual meeting of the California State Division of the International Association for Identification, San Jose, CA, May 23, 2005.

RCF14-2 Attachment 16 - P. 1/7

Contra Costa County Office of the Sheriff FORENSIC SERVICES DIVISION Comparative Evidence Technical Unit Manual	REVISION DATE: 09/09/13	NUMBER: CE.04
	RELATED ORDERS:	
APPROVED BY: Chris Coleman	ASCLD-LAB:	
CHAPTER: Comparative Evidence	SUBJECT: Case Records, Test Reports, and Conclusions	

I. POLICY The Comparative Evidence Unit adheres to the polices of the Division Manual in regards to Case Records and Test Reports with the following additions and clarifications:

A. Case Records. A case record in the Comparative Evidence Unit shall be comprised of the following types of administrative, technical, and examination records, if applicable to a particular case:

1. Assignment Notification Sheet

2. Laboratory Examination Request Form(s)

3. Case notes, including evidence inventory

4. Forms and Worksheets

a. Due to the repetitive nature of firearms evidence, forms can be used to simplify documentation. The following forms are approved for casework documentation:

i. Firearms Worksheet

ii. Bullet Worksheets

iii. Cartridge Case Worksheets

iv. Evidence Inventory

v. Comparison Worksheet

vi. Digital Image Worksheets

vii. IBIS Worksheet

viii. Serial Number Worksheets

ix. Distance Determination Worksheets

2.

x. Suppressor Worksheets

xi. Subclass Characteristic Worksheets

xii. Other forms may be used as dictated by casework or existing ones can be altered with Supervisor approval.

5. Diagrams

a. The Comparative Evidence Unit adheres to policy FSD.42.01 , "Diagrams, Photographs, and Digital Images".

6. Photographs and Digital Images

a. The Comparative Evidence Unit adheres to policy FSD.42.01 , "Diagrams, Photographs, and Digital Images".

7. Printouts

8. Communication Log of relevant correspondence

9. Any addition documentation that supports the analyst's conclusions, as appropriate.

B. Test Reports

1. The following information does not appear in Test Reports issued by the Comparative Evidence Unit but is documented as indicated:

a. The location where the tests were carried out, if different from the address of the laboratory, will be documented by the analyst in the case notes.

b. The name of the test method(s) used will be indicated by the analyst in the examination documentation relevant to the method(s). Procedures used in the examination(s), if different than those documented in the Technical Unit Manual, will be recorded by the analyst in the case notes. Any deviations from or additions to the test method or the specific test will also be noted.

c. The address of the customer agency is documented in LIMS.

d. The date(s) when the evidence was received will be recorded by the analyst in the case notes; the date or date range when the examinations were performed will be recorded at the top of the note page(s) pertaining to the examination(s).

e. Any additional information which may be required by specific methods or customers will be documented on the appropriate pages of the case record.

2. When relevant, a statement of compliance/non-compliance with requirements or specifications will be included in the test report.

C. General Conclusions. The Comparative Evidence Unit adheres to the AFTE (Association of Firearms and Toolmark Examiners) Range of Conclusions and Theory of Identification as related to comparisons with the addition of quantitative consecutive matching striae (CMS) and photographs for documentation. 3.

1. AFTE Range of Conclusions

   a. IDENTIFICATIONS - Agreement of a combination of individual characteristics and all discernible class characteristics where the extent of agreement exceeds that which can occur in the comparison of toolmarks made by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.

   b. INCONCLUSIVE -

      i. Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification.

      ii. Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.

      iii. Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an exclusion.

   c. ELIMINATION - Significant disagreement of discernible class characteristics and/or individual characteristics.

   d. UNSUITABLE - Unsuitable for microscopic examination.

2. AFTE Theory of Identification

   a. The theory of identification as it pertains to the comparison of toolmarks enables opinions of common origin to be made when the unique surface contours of two toolmarks are in "sufficient agreement."

   b. This "sufficient agreement" is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours. Agreement is significant when the agreement in individual characteristics exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool. The statement that "sufficient agreement" exists between two toolmarks means that the agreement of individual characteristics is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility. 4.

c. Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

d. The Comparative Evidence Unit uses both the traditional pattern matching approach along with quantitative CMS to document comparisons. Casework will also be documented with representative digital images of the comparisons being conducted. The examiner should report the objective observations that support the findings of the toolmark examinations and should be conservative when reporting the significance of these observations. This allows the examiner to explain their reasoning for reaching the conclusions they have. These conclusions are based on a specific comparison of individual characteristics, having eliminated any possibility of subclass influence.

3. Terminology

a. Pattern matching in toolmark comparison: The visual comparative examination of the topographical features (a configuration of a surface including its relief and the position of its man-made features) of two different toolmarks. These topographical features consist of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and the spatial relationship of these features are defined for one toolmark and are then compared to the corresponding topographical features in the other toolmark. The consecutiveness of striae is an important topographical comparative feature. The comparison process is a combination of applied skill and science. The applied skill portion is the ability of an examiner to recognize agreement between patterns. This depends on an examiners' cognitive ability. This ability is acquired as an examiner uses his or her training and experience viewing the relative correspondence of known matching and non-matching toolmarks to build up an awareness of uniqueness. Although an examiner that uses pattern matching alone is unlikely to be able to pinpoint a specific criteria of counted points of correspondence, he or she can recognize when the agreement present in any given comparison, whether it be striated or impressed, exceeds maximum known non-match agreement. When it does, a positive identification, to the practical exclusion of other tools, can be made. The scientific portion of the pattern match comparison is the validated premise that unique tool working surfaces leave toolmarks that can establish an identification.

b. Consecutive Striae: Parallel, side by side, contour variations within a striated toolmark.

c. Consecutive Matching Striae (CMS): Contour variations, within two different striated toolmarks, which, when compared microscopically, line up exactly with one another without a break or dissimilarity in-between.

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d. Quantitative CMS: A numerical tabulation of CMS runs. Typically, the number of matching CMS is designated by a number, followed by the letter x (e.g. 2x, 3x, 4x, etc…). Examiners in this laboratory, who locate potential matching striated toolmark areas through pattern matching, have chosen to numerically tabulate the quantity of CMS in these areas and use these tabulations as a way to describe the extent of matching CMS in any given striated toolmark comparison. These numerical counts are then compared to the results of empirical research involving tabulations of CMS in both known matching and known non-matching toolmarks. Toolmark identifications are made when the tabulated CMS runs exceed the thresholds established by empirical research. The application of quantitative CMS criteria is not a different method than pattern matching, but is merely a quantitative way to describe the extent of striated pattern matching agreement. The use of quantitative CMS criteria is simply an extension of traditional pattern matching.

e. Quantitative CMS Identification Criteria: A numerical standard used when making a quantitative assessment of matching CMS in a comparison of a test striated toolmark with a questioned striated toolmark. The amount of matching CMS is compared to an empirically determined numerical threshold, which is greater than the best know non-match quantitative CMS value. When the best KNM value is exceeded, a positive toolmark identification can be made with confidence.

f. Known non-matching toolmarks: Toolmarks know to have been made by different tools, or made by the same tool but deliberately placed in a non-matching position.

g. Maximum Known Non-matching Agreement in Striate Toolmarks: (a) For pattern matching alone, the ability of an examiner to recall the best agreement either personally observed, or that has been observed by others in the profession by rigorous studies, or (b) for examiners who quantitate CMS, this is a numerical way to describe the best known non-matching agreement that has either been personally observed, or has been observed by other in the profession by rigorous studies.

h. Quantitative CMS Criteria. The following is the definition of conservative quantitative criteria for identification using Consecutive Matching Striae (CMS). This criteria or higher will be acceptable for confirming identifications.

i. In three dimensional toolmarks when at least two different groups of at least three consecutive matching striae appear in the same relative position, or one group of six consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark.

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ii. In two dimensional toolmarks when at least two groups of at least five consecutive matching striae appear in the same relative position, or one group of eight consecutive matching striae are in agreement in an evidence toolmark compared to a test toolmark.

iii. To apply CMS criteria, the influence of sub-class characteristics must be eliminated.

i. The Comparative Evidence Unit adheres to the definitions of specific firearms terms as listed in the AFTE (Association of Firearms and Toolmark Examiners) Glossary.

4. Certainty of Opinions

a. The positive identification of a *toolmark* is made to the practical, not absolute, exclusion of all other *toolmarks.* The reason why the identification is not (or identifications are not) absolute is because it will never be possible to examine all firearms or tools in the world, a prerequisite to making an absolute determination. The conclusion that "sufficient agreement" exists between two toolmarks (test and questioned) for identification means that the likelihood another tool could have made the questioned toolmark(s) in this case is so remote as to be considered a practical impossibility.

b. The phrase "practical impossibility", which currently cannot be expressed in mathematical terms, describes an event that has an extremely small probability of occurring in theory, but which empirical testing and experience has shown will not occur. In the context of firearm and toolmark identification, "practical impossibility" means that based on 1) extensive empirical research and validation studies, and 2) the cumulative results of training and casework examinations that have either been performed, peer reviewed, or published in peer-reviewed forensic journals, no firearms or tools other than those identified in any particular case will be found that produce marks exhibiting sufficient agreement for identification.

i. If something is impossible, it is thought to be incapable of being done, attained, fulfilled, or occurring. The opposite is true for things that are thought to be possible.

ii. If some course of action or result is practical, it means that is is not theoretical, and that it has been shown to occur through practical experience.

iii. A practical impossibility means that through empirical research, validation studies, and practical experience, it has been shown that some course of action or result is thought to be incapable of occurring.

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iv. While some courses of action or results may be thought to be theoretically possible, empirical research, validation studies, and practical experience combined has the ability to conclusively demonstrate that these courses of action or results are not possible, from a practical point of view.

c. Reports issued by the Comparative Evidence Unit can simply state that the identifications were made to the practical, not absolute, exclusion of other firearms or tools.

5. Documentation of Comparisons. The following items should be used for documentation of comparisons to support any conclusions:

a. Record the class and individual characteristics used to reach the conclusion.

b. If Quantitative CMS is used, note representative CMS runs that meet or exceed the threshold for identification for the comparison in question and record the conclusion and whether it meets 3D or 2D CMS criteria.

c. Any photographs taken to document and support the conclusion should be referenced. Clearly identify the items depicted in each photograph.

d. The Comparison Worksheet should be used for this documentation.

e. Conclusions should be based on complete understanding of the criteria for identification and focus on the quality and quantity of individual agreement.

f. It is up to the examiner's discretion as to the amount of documentation needed to support any conclusions of highly repetitive examinations of large numbers of similar evidence items.

6. Evidence used for test-firing.

a. It may be necessary to test-fire submitted ammunition for comparison purposes. The notes will indicate that evidence was used for test-firing and comparison and was then returned (with the original evidence submission).

7. Abbreviations. Notes can freely use abbreviations if they are commonly used and included in the list. Abbreviations can be used in notes and reports if the un-abbreviated form of the word is used first to define the abbreviation. Example: Integrated Ballistics Identification System (IBIS). See the Abbreviation List CE.05 for approved abbreviations.

END OF DOCUMENT

PCF 14-2 - attachment #17 - p:1/1

CASE SUMMARY WORKSHEET

Case # 09P01160

Case Start Date: 08/17/2011 **Case Completion Date: 03/13/2012**

Examinations Requested:

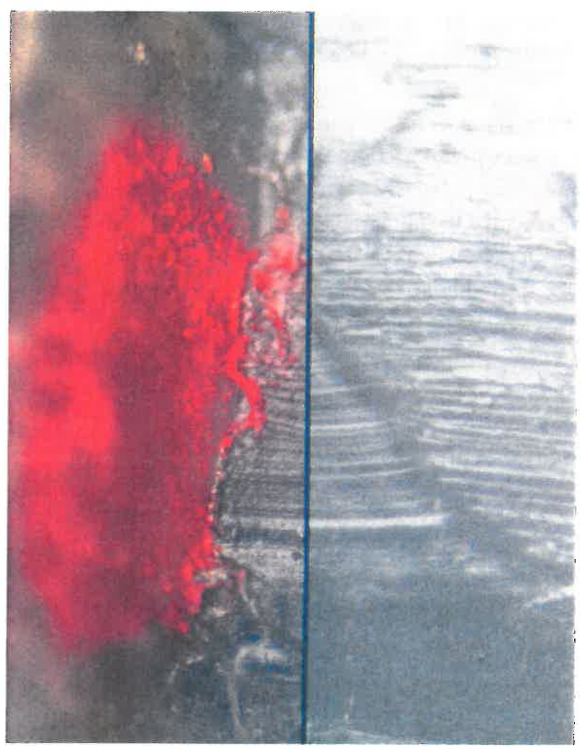
- Determine if the LIMS item 3-1 revolver fired the plastic wads listed in LIMS items 2-1, 2-2, and 2-4

Conclusions:

- LIMS items 2-1, 2-2, and 2-4 (plastic wads) were identified as having been fired by the same firearm
- LIMS items 2-1, 2-2, and 2-4 (plastic wads) could not be identified or eliminated to test fires from the LIMS item 3-1 revolver
- Shot pellets included in LIMS items 2-1, 2-2, and 2-4 were not examined at this time
- LIMS items 2-3 and 2-5 were not examined at this time
- LIMS items 3-1, 5-1, 6-1, and 7-1 are mechanically functional firearms as received in the laboratory
- Due to the manufacture date of LIMS items 5-1, 6-1, and 7-1 succeeding the offense date, TF wads were not compared to LIMS items 2-1, 2-2, and 2-4 (plastic wads)
- TF wads and silicone bbl casts of LIMS items 5-1, 6-1, and 7-1 were compared to each other for the presence of carry-over toolmarks but none were found

Comparisons Verified By: LF REC ALS

Photos of Representative Identifications Made:



LIMS item 2-1 to LIMS item 2-4
orange phase

Examiner's Initials/Date: HRT 03/13/2012

PCF 14-2 attachment #18- p.1/4

MICROSCOPIC COMPARISON MATRIX - 1 - **Case# 09P01160**

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-1TF1	LIMS 3-1TF2	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF1	LIMS 3-1TF4	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF1	LIMS 3-1TF5	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF1	LIMS 3-1TF6	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF1	LIMS 3-1TF7	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF1	LIMS 3-1TF8	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF1	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF2	LIMS 3-1TF4	wad to wad	.410	ID-Bl,Bk	NO	N/A
LIMS 3-1TF2	LIMS 3-1TF5	wad to wad	.410	ID-Bl,Bk,G	NO	N/A
LIMS 3-1TF2	LIMS 3-1TF6	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF2	LIMS 3-1TF7	wad to wad	.410	ID-Bl,Bk,G	NO	N/A
LIMS 3-1TF2	LIMS 3-1TF8	wad to wad	.410	ID-S,Bl	NO	N/A
LIMS 3-1TF2	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF4	LIMS 3-1TF5	wad to wad	.410	ID-S,Bl	NO	N/A
LIMS 3-1TF4	LIMS 3-1TF6	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF4	LIMS 3-1TF7	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF4	LIMS 3-1TF8	wad to wad	.410	ID-S,Bl	NO	N/A
LIMS 3-1TF4	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,Bk	NO	N/A
LIMS 3-1TF5	LIMS 3-1TF6	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF5	LIMS 3-1TF7	wad to wad	.410	ID-S,Bl	NO	N/A
LIMS 3-1TF5	LIMS 3-1TF8	wad to wad	.410	ID-S,Bl,G	NO	N/A
LIMS 3-1TF5	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,G	NO	N/A
LIMS 3-1TF6	LIMS 3-1TF7	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 3-1TF8	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 3-1TF9	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 3-1TF8	wad to wad	.410	ID-S,Bk,G	NO	N/A
LIMS 3-1TF7	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A
LIMS 3-1TF8	LIMS 3-1TF9	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A

LIMS 3-1TF3 wad was lost on the range during test firing.

LIMS 3-1TF6 wad is not a suitable test to use for comparisons as it could not be ID or ELIM to any of the other test fired wads.

Test fired cartridge cases and shotshells were not compared for reproducibility to each other at this time.

Comparison Microscope(s) Used:

☐ **Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186**

☒ **Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724**

☐ **Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661**

☐ **Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none**

Revised 10/06/2011 **Examiner/Date: HRT 08/22/2011 – 03/13/2012**

MICROSCOPIC COMPARISON MATRIX - 2 - **Case# 09P01160**

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF1	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF2	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF4	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF5	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF6	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF7	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF8	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF9	slug to wad	.410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-2 (Legacy 69TF1)	slug to bullet	.410 to 45	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-2 (Legacy 69TF2)	slug to bullet	.410 to 45	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF2)	LIMS 3-2 (Legacy 69TF1)	bullet to bullet	45	ID*	NO	NO
LIMS 3-1TF1	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF1	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF1	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF2	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF4	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF5	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF5	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC**	N/A	N/A

* *69TF1 and 69TF2 are 45 caliber bullets. They exhibit profound gas cutting and though they are id to each other, are not suitable for comparisons to the plastic wads.*

** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (red phase area)*

LIMS 3-1TF6 wad is not a suitable test to use for comparisons as it could not be ID or ELIM to any of the other test fired wads.

Comparison Microscope(s) Used:

☐ **Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186**

☒ **Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724**

☐ **Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661**

☐ **Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none**

Revised 10/06/2011

Examiner/Date: HRT 08/22/2011 – 03/13/2012

MICROSCOPIC COMPARISON MATRIX - 3 -

Case# 09P01160

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-1TF5	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC**	N/A	N/A
LIMS 3-1TF6	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF6	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF7	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF8	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF8	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF8	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 3-1TF9	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC***	N/A	N/A
LIMS 2-1 (Legacy 3-1)	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	ID-orange,red,pink	NO	N/A
LIMS 2-2 (Legacy 4-1)	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	ID-orange,red,pink	YES-orange, red, pink	22X
LIMS 3-2 (Legacy 69TF3)	LIMS 2-1 (Legacy 3-1)	slug to wad	.410	INC****	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 2-2 (Legacy 4-1)	slug to wad	.410	INC****	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 2-4 (Legacy 6-1)	slug to wad	.410	INC****	N/A	N/A
LIMS 3-1TF10	LIMS 3-1TF7	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A
LIMS 3-1TF10	LIMS 3-1TF11	wad to wad	.410	ID-S,Bl,Bk,G	NO	N/A
LIMS 3-1TF10	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF10	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A

** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (red phase area)*

*** *Striae in various areas around the circumference of the wads line up okay, but sometimes sporadically with respect to where the shoulders of the signatures are. (silver and blue phase areas)*

**** *Striae in the red phase (as before) still look good, but not great, and it's not enough to make a definitive conclusion…especially considering all the tests of appropriate material (plastic wad to plastic wad) that have now been examined and compared microscopically.*

LIMS 3-1TF6 wad is not a suitable test to use for comparisons as it could not be ID or ELIM to any of the other test fired wads.

Comparison Microscope(s) Used:

☐ **Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186**

☒ **Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724**

☐ **Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661**

☐ **Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none**

Examiner/Date: HRT 08/22/2011 – 03/13/2012

MICROSCOPIC COMPARISON MATRIX - 4 - Case# 09P01160

Comparison		S = silver; Bl = blue; Bk = black; G = green				
Item #	Item #	Type	Caliber	Results (phase color)	Photo (phase color)	Microscope Magnification
LIMS 3-1TF10	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF11	LIMS 2-1 (Legacy 3-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF11	LIMS 2-2 (Legacy 4-1)	wad to wad	.410	INC	N/A	N/A
LIMS 3-1TF11	LIMS 2-4 (Legacy 6-1)	wad to wad	.410	INC	N/A	N/A
LIMS 5-1TF6	LIMS 5-1TF7	wad to wad	.410	INC*****	N/A	N/A
LIMS 5-1TF6	LIMS 5-1TF8	wad to wad	.410	INC*****	N/A	N/A
LIMS 5-1TF7	LIMS 5-1TF8	wad to wad	.410	INC*****	N/A	N/A
LIMS 6-1TF5	LIMS 6-1TF6	wad to wad	.410	INC*****	N/A	N/A
LIMS 6-1TF5	LIMS 6-1TF7	wad to wad	.410	INC*****	N/A	N/A
LIMS 6-1TF6	LIMS 6-1TF7	wad to wad	.410	INC*****	N/A	N/A
LIMS 7-1TF6	LIMS 7-1TF7	wad to wad	.410	INC*****	N/A	N/A
LIMS 7-1TF6	LIMS 7-1TF8	wad to wad	.410	INC*****	N/A	N/A
LIMS 7-1TF7	LIMS 7-1TF8	wad to wad	.410	INC*****	N/A	N/A
LIMS 5-1TF8	LIMS 6-1TF7	wad to wad	.410	INC	N/A	N/A
LIMS 5-1TF8	LIMS 7-1TF8	wad to wad	.410	INC	N/A	N/A
LIMS 6-1TF7	LIMS 7-1TF8	wad to wad	.410	INC	N/A	N/A
LIMS 5-1 BBL CAST1	LIMS 5-1 BBL CAST2	cast to cast	45	ID	NO	N/A
LIMS 6-1 BBL CAST1	LIMS 6-1 BBL CAST2	cast to cast	45	ID	NO	N/A
LIMS 7-1 BBL CAST1	LIMS 7-1 BBL CAST2	cast to cast	45	ID	NO	N/A
LIMS 5-1 BBL CAST1	LIMS 6-1 BBL CAST2	cast to cast	45	N/A~	NO	N/A
LIMS 5-1 BBL CAST1	LIMS 6-1 BBL CAST2	cast to cast	45	N/A~	NO	N/A
LIMS 6-1 BBL CAST2	LIMS 7-1 BBL CAST2	cast to cast	45	N/A~	NO	N/A
LIMS 3-1TF12	LIMS 3-1TF13	slug to slug	410	ID	NO	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF12	slug to slug	410	INC	N/A	N/A
LIMS 3-2 (Legacy 69TF3)	LIMS 3-1TF13	slug to slug	410	INC	N/A	N/A

***** *These test fires were punctured through the shotshell into the wad with the point of a scribe for orientation reference in the chambers prior to test firing. Although there were similarities among the test fired wads of a specific gun, there were not sufficient individual characteristics for identification for each group. Additionally, the test fired wads from 5-1, 6-1, and 7-1 were not compared among each other for carry-over observation because of the insufficient detail in the individual characteristic within each gun group.*

~ *These casts were compared to each other to identify the presence of carry-over toolmarks from one bbl to the next. While few similar marks were noted, these marks were not of sufficient quality to be mis-construed as "carry-over" toolmarks.*

Comparison Microscope(s) Used:

- ☐ **Leeds, model LCF SZX12, serial #449991, IFS 0992, Dallas County #95186**
- ☒ **Leeds, model LCF SZX16, serial #465513, IFS 1057, Dallas County # 95724**
- ☐ **Leica, model FSM, serial #20613, IFS 1056, Dallas County # 95661**
- ☐ **Leica, model UFM4/K2700, serial #369-8, IFS 0250, Dallas County # none**

Examiner/Date: HRT 08/22/2011 – 03/13/2012

PCF 142 attachment 19 – p. 1/4

THE SCIENTIFIC APPROACH

Basic Principles of the Scientific Method

by

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of symmetry but also of asymmetry. This means that classes may be designated not only as equivalents to other classes; but also as nonequivalents. Thus, for example, a given ordinal scale may designate that class X is greater than class Y, and therefore that class Y is smaller or less than class X. Transitivity, of course, still operates in an ordinal scale; for if class X is greater or higher than class Z, then any specific X is greater or higher than any specific Z.

VII.41 If it is desired to indicate *how much* one class of a scale differs from another (e.g., how much greater or higher X is than Y), then an *interval scale* is required. Measurement, in the common sense of the term, normally begins at this level of designation. The new element added to this stage is the *unit* of measurement (feet, years, degrees Fahrenheit, etc.). The units so employed, however, should be *constant* and *replicable*—i.e., they should give consistent readings under equivalent measurements.

VII.42 In order to permit such equivalent designations, such units must be located with reference to an absolute or arbitrary zero point. When so located, the scale is now referred to as a "ratio" scale; and has become the most useful type of all measurements. An illustration of both the interval and the ratio types will perhaps help to point out their relative merits. Suppose, for example, that in our test of political conservatism, one person is designated as "ten degrees" conservative, and another as "twenty degrees" conservative. In an interval scale, there is no implication that the first person is in behavioral (i.e., operational) fact only half as conservative as is the second, nor that the second is twice as conservative as is the first; but only that the first is ten degrees—whatever that may mean!—less conservative than the second, and vice versa. Manipulating units in an interval scale by normal mathematical procedures is a wholly indefensible operation common to naive methodologists.

VII.43 If, however (to pursue our illustration), we were able to establish an absolute or nonarbitrary zero point of political conservatism—equivalent in this case to, let us say, a zero amount of money in the bank—then such a scale would move from an interval to a ratio type; and would permit all the usual mathematical and statistical calculations necessary to achieve exacting specification and prediction. It would be possible, for example, to indicate that a person who scores four hundred on a ratio scale of political conservatism is (i.e., predictably, behaviorally speaking) eight times as conservative as one who scores only fifty. Such designations—it should be pointed out, in spite of our illustration—are not possible at this stage of development in the behavioral sciences, though of course they are quite basic and common to the physical sciences.

VII.44 It should be obvious, then, why measurement is so critical a feature of all scientific endeavor. The twin questions of what to measure and how to measure comprise a central problem of all scientific methods. Not only do these twin questions involve logical and semantic problems, but also mensural problems (i.e., what types of mathematical procedures to use) as well as technical problems of instrumentation. Furthermore, decisions regarding measurement significantly influence the type of analytic design that can be employed, as well as the cogency of the verification offered as proof of any test. For these and many other reasons, the heart of the scientific approach beats as strongly or as weakly as the sophistication of its measurements permits. In the chapters to follow all these various facets of the scientific approach will be related to the most critical aspect of the entire scientific enterprise, to wit: the test of hypothetical propositions by the use of an analytic design.

E. *Recording and Presentation*

VII.45 Since the whole purpose of scientific research is to add to man's store of verified knowledge, communication among scientists is a vital link in the whole chain of research effort. Science is now an international enterprise, and the communication of knowledge has become a highly complex process. Such communication is effected through personal correspondence, through published articles in scientific journals, monographs and books, and during meetings of the various professional societies. The nature of that communication, therefore, is a substantial part of the process of verification of one's findings. (This latter process will be discussed in the final chapter.)

VII.46 The proper recording of scientific data is influenced by the type of study: the quantity and quality of the material involved, the methods employed, and the interests and skills of the researcher. Though miniscule studies can be reported on a school boy's tablet, large-scale projects require huge electronic data-processing machines, whole buildings full of file cabinets, vast indexing systems, and a whole host of equipment and services necessary to a complete portrayal of the study. Furthermore, some studies are brief and discreet—e.g., an analysis of traffic patterns at a particular intersection, the verbal responses of a group of voters, the reaction of particular patients to particular drugs, or the expansion coefficient of particular metals. Other studies, however, may be quite continuous—e.g., Census studies, stock-market patterns, long-term analyses of basic organic processes, or the reactions of large groups of persons to new social conditions (i.e., prison, army life, resettlement, divorce, etc.). Certain general processes, however, are common to all types and sizes of studies, and certain general principles of effective communication apply to all mature scientific research.

VII.47 The arrangement and classification of data should follow the study design. Whether the study is basically descriptive or analytic, the data can be collected and arranged in a number of ways. Some workers prefer a cross-indexed card system, others prefer log books, while still others utilize work sheets. The only essential feature of any system is utility—i.e., the data should be arranged in such ways that they are clear and easily available. Competent researchers tend to develop neat and orderly systems of data arrangement, systematized in such ways that others would have no difficulty in studying the material if desired.

VII.48 Verbal data generally consist of written records or reports such as books, manuscripts, letters, diaries, documents, etc. Where utilized directly as primary sources, they should be available to other investigators either in libraries or in the possession of the researcher. Reference to original sources should clearly indicate, according to standardized methods of reference,

the exact portions of the work being utilized. When written records are translated, the original must also be available to possible critics of the translation. When excerpts from a book, letter, diary or document are being utilized, the researcher must be careful not to interpret portions out of context—i.e., in such ways as to violate the intrinsic meaning of the whole. The data also should be collected according to some logical plan. Random collection of masses of facts in the hope that something unforeseen later might prove to be useful generally results only in confusion; and while being collected, the data should be arranged according to a well-thought-out system which permits clear and functional presentation. In cases where only one copy of an original source exists (e.g., diaries, letters), the cautious procedure suggests that the document be reproduced (e.g., by photostat or microfilming) as a safeguard against any possible loss of the original.

VII.49 Whenever feasible nonwritten verbal data should be recorded, preferably on tape; and even if the tapes have been transcribed, they should remain available to anyone skeptical of the transcription. Whether tapes or discs are used for recording, prudence sometimes suggests that they be duplicated even though they may later be transcribed. When editing of recordings seems desirable in order to eliminate irrelevant or extraneous material, it is especially imperative that copies of the original be kept somewhere on file for possible later perusal. In presentation, recorded data may be arranged either in transcribed form if only the content is pertinent, or *in toto* if inflections, timing, auxiliary sounds, etc., are deemed pertinent to the presentation.

VII.50 Visual data may be interpreted verbally, of course, especially when they are of a simple and indisputable type (e.g., the number of persons crossing a street, the size of dresses most frequently sold, or the color of packages most often selected). But when the quality of the data or their arrangement or interpretation are pertinent to their employment in the hypothesis, then the data should be recorded by appropriate instruments (cameras, photomicrography, macrophotography, X-ray, etc.). In some cases, sound movies (perhaps in color and perhaps even in stereo) are necessary; in other cases, color photographs or slides may prove desirable. Timed-sequence photographs, aerial views, stereoscopic slides, underwater photographs, telescopic photographs—the whole range of photographically recordable data should be exploited in a manner most pertinent to the needs of the study.

VII.51 In many instances visual data are transcribed into appropriate graphic presentations. Charts, graphs, maps, drawings, sketches, profiles, sociograms, etc., are often employed to permit visualization of concrete data. An elementary skill in methods of graphic presentation is essential to any competent researcher; and attractive as well as functional graphic presentations are a common feature of most well-done studies. In all cases where facts are presented graphically, however, the original data being depicted should be available in the files for possible inspection. Where the data are quantitative, the criterion of communicability should determine whether they might better be presented graphically or in tabular form; generally speaking, charts, graphs and maps are easier to comprehend than are tables.

VII.52 The particular advantages of charts and graphs over tables bear serious consideration. First of all, well-designed charts are generally much more effective in creating interest and visual appeal than are other types of presentations. Secondly, visual, spatial or relative data are more easily portrayed by charts or graphs than by any other method. Thirdly, charts and graphs permit an overall view of related data. Finally, charts and graphs can designate relationships probably better than can any other form of presentation. If there is any doubt about the advisability of depicting data in graphic rather than in tabular or textual form, the criterion of communicability should be employed by testing samples of the various forms of presentation to persons not familiar with the study at hand.

VII.53 Though quantitative data may be depicted in graphic form, in most instances tables are required if the data are relatively complex or detailed. Like the construction of graphs, charts, maps, etc., the construction of meaningful and clear tables is a basic skill required of all researchers who deal with quanti-

tative data. Whether tables should be incorporated into the body of the text or grouped in an appendix will depend mainly upon whether or not they are absolutely necessary in order to understand the text. In most cases tables are relegated to an appendix, and only their interpretation is included in the body of the text.

VII.54 Physical data sometimes are basic to the study design, but are usually reproduced photographically. In some few cases, however, specimens, samples, prototypes, models, etc., may exhibit features lost in visual or mechanical reproduction, and in such cases the original data are appended to the study in the form of exhibits. These exhibits should be clearly indexed, neatly arranged and properly labeled so that any competent student of the subject can understand them and their relation to the study. Where original tools or instruments—e.g., scales, questionnaires, stimuli cards, measuring devices—have been devised and utilized, copies or samples of them also should be included in the exhibit. In determining which kinds and amounts of data should be included in a study, the scientist bears in mind the basic fact that scientific method demands exactness and clarity; and thus he includes in his presentation all those elements which a competent student of the subject might require in order to be able to understand and possibly criticize both the methods and the conclusions.

applies to forensic case work.

VII.55 Like any human being who might become emotionally involved in his field of interest, the scientist is at times apt to distort or exaggerate (by maximizing or by minimizing) his data in the direction of his predilections or prejudices. But the basic fact that scientific method is self-critical means that the possible distortions of an investigator can always be checked by the duplication or replication of a study by other investigators. For all practical purposes, then, no data or interpretations are acceptable as valid until corroborated by other investigators working independently. This means in effect that dishonesty cannot be practiced for any length of time; and therefore, that the presentation of a study should always make clear exactly how the study was done.

PCF 14-2 – attachment 20 – p. 1/2

Standardization of Comparison Documentation (Revised: June 13, 2005)

Abstract

The June 13, 2005 revision of the Standardization of Comparison Documentation was discussed and adopted at the business meeting of the 2005 AFTE Training Seminar in Indianapolis, IN. This information was made available to the membership via the AFTE News and is presented here to further distribute the information.

JUSTIFICATION

WHEREAS: The work performed by a forensic scientist can potentially impact an entire scientific community. All cases; even those that appear routine or mundane have the potential to be subjected to rulings in appellate or supreme courts, which may broadly impact the practice of that science.

WHEREAS: It is a fundamental truth that all practitioners within a responsible and thoughtful scientific community are united by a common set of guidelines or standards. Science is based upon the contributions of past and present peers whose work has been evaluated against those standards.

WHEREAS: The proper comparison of toolmarks and the subsequent reporting of reliable conclusions are often the single-most critical responsibilities of a firearm and toolmark examiner.

WHEREAS: The existence of multiple approaches in achieving compliance with a professional standard does not weaken the value of that standard to the relevant scientific community nor those served by the work.

WHEREAS: The criminal justice system has demonstrated an increased demand for reliable scientific results that are supported by reviewable and interpretable documentation.

WHEREAS: Case records are often released to appropriate legal entities for consideration and review. Observations and scientific evaluations are made in the due course of laboratory business and are a work product for which the laboratory and its quality system may be held accountable. This accountability extends to the analysis of the evidence, the creation of records, and the retention thereof.

WHEREAS: A conference of committee chairs was convened at the direction of the AFTE President to discuss and recommend a course of action that will protect the long-term interests of the science of Firearm and Toolmark Identification, AFTE, and the community they serve.

THEREFORE: The following standard has been created for approval by the membership of the Association of Firearm & Tool Mark Examiners.

STANDARDIZATION OF COMPARISON DOCUMENTATION

PURPOSE: The purpose of this document is to set forth a scientifically acceptable standard for documenting, in a case record, the observations that serve as the basis for a reported conclusion.

SCOPE: This standard applies to all conclusions that are based upon the observed agreement or disagreement of individual (unique) and/or class (family) characteristics.

STANDARD: The case record must contain documentation of the observations that serve as the basis for a reported conclusion. Laboratories are afforded latitude in establishing how this should be accomplished. At a minimum, the documentation must include interpretable depictions or descriptions of the agreement or disagreement of individual and/or class characteristics to the extent that another qualified firearm and toolmark examiner, without the benefit of the evidence itself, can

STANDARD cont:

review the case record, understand what was compared, and evaluate why the examiner arrived at the reported conclusion. It is acceptable for the supporting documentation of one comparison to be used for a subsequent comparison as long as the agreement described or depicted is representative of the subsequent comparison. It must be clear in the case record what items are being depicted and/or described in the comparison documentation. The case record must clearly describe or label what items are depicted.

DISCUSSION

The work of a forensic scientist is of value to the courts to the extent that the reported conclusions assist the trier of fact in adjudicating a criminal or civil matter. Experts are often called to testify to their findings. The court has a reasonable expectation that the expert will recall, to some extent, the observations that preceded the conclusion, and will be able to answer questions pertaining to these observations. In the absence of adequate documentation, the expert will be unable to satisfy this expectation unless an additional comparison is made, or the examiner happens to recall the examination. Therefore, compliance with this standard has the benefit of allowing the original examiner to recall the basis for his or her conclusions even after the passage of time.

It is acknowledged that this standard does not require any one approach for compliance. While photography is the preferred method of documentation, narrative descriptions, sketches, diagrams, charts, worksheets, and other methods, or a combination of multiple methods may serve to satisfy the requirements of this standard. Third-party verifications, while encouraged, are not a form of documentation because they do not record observations. Examiners who are compliant with this standard, when evaluating the completeness of their documentation, will be able to answer "yes" to each of the following questions:

1. Will my notes help me to recall, at some point in the future, what I observed?

2. Would another examiner reviewing my notes be able to interpret what I observed?

3. If the evidence was unavailable for review, could I defend my conclusion?

4. Are my notes legible and clear?

Contra Costa County Office of the Sheriff FORENSIC SERVICES DIVISION Comparative Evidence Technical Unit Manual	REVISION DATE: 06/04/13	NUMBER: CE.11
	RELATED ORDERS:	
APPROVED BY: Chris Coleman	ASCLD-LAB:	
CHAPTER: Comparative Evidence	SUBJECT: Firearms Identification Examinations	

I. **POLICY Firearms Identification is the scientific process of determining whether or not a firearm was used to fire evidence bullets or cartridge cases. It can also be used to link different shooting incidents together when no firearm is available.**

A. Initial Documentation. The firearm, if one is submitted, and the fired bullets and cartridge cases that are to be compared, should be described in the notes and be subjected to examinations detailed previously in this manual prior to comparison. All this information can be noted on individual worksheets.

B. Evaluation of Ammunition and Firearm.

1. Determine the type of ammunition for test-firing. For comparison purposes the same ammunition as that in question, or as close as can be obtained, should be used in test firing.

a. This will usually require test firing the ammunition that was submitted with the firearm.

b. If no ammunition is submitted with the firearm, laboratory-supplied ammunition that is as close as possible to the submitted evidence ammunition components will be used.

c. At least three test-fires of the ammunition in question should be obtained. If three cartridges of a specific type are not available, then two test fires may suffice, but three test-fires of one type of ammunition should be collected (such as ammunition used for entry into the NIBIN system) to assess reproducibility.

2. The firearm in question should be examined to evaluate the bearing surfaces for subclass characteristics and individual characteristics. Intentional alterations should also be noted. This procedure allows an evaluation of the tool working surface to determine if microscopic defects are present and gives an indication as to the individualization potential as well as any subclass influence of these surfaces.

2.

a. Examine the bore of the barrel with a borescope.

   i. Determine how the rifling was produced (broach, button, hammer forging, etc…) if possible. Any subclass influence in barrels can be dependent on how the barrel was rifled.

   ii. Look for any damage, corrosion, or areas of obvious wear which may eliminate subclass influence.

   iii. Subclass marks are typically coarse marks that run parallel to the rifling and run almost the entire length of the barrel without change or disruption.

   iv. Typically, the lands have no subclass influence, but the grooves in a broached or cut rifled barrel can. Button and hammer forged barrels usually do not have any subclass characteristics.

   v. Be aware of heavy fouling, including powder residues, metal fouling from copper jackets, and the leading from lead bullets. This can cover up machining marks and cause differences in the individual characteristics observed on fired components.

b. Examine the breechface, firing pin, extractor, ejector, and other areas that bullets or cartridge cases could contact. A borescope or stereomicroscope can assist with the examination.

   i. Breechfaces and firing pins formed by end mills can have concentric rings that need to be evaluated since they can be subclass. Defects between and on the rings can help to eliminate subclass influence from the comparison.

c. Make casts of the barrel, breechface, or other areas with Forensic Sil or Mikrosil to help evaluate the working surfaces of these tools, if needed.

   i. Use a solvent soaked patch or cotton tipped swab to clean the area being cast.

   ii. Label the non-silicone side of a piece of siliconized paper (backing of label paper) with appropriate case information.

   iii. Apply Forensic-Sil or Mikrosil to the area being cast.

   iv. Place label paper (silicone side) against the exposed casting material.

   v. Once the cast has set, carefully remove the cast from the firearm.

   vi. The casts should be retained with the test fires, but they can be packaged separately if used for training or reference.

d. Subclass evaluation worksheets can be used to document the microscopic defects that were used to support the identification.

3. Initial Examination of Evidence Bullets and Cartridge cases.

   a. The evidence items in question should be examined and grouped according to similar class characteristics.

   b. Once it has been determined that all class characteristics are similar for a group of evidence (caliber, number of lands and grooves, direction of twist, widths of lands and grooves for bullets; and firing pin shape, breechface marks, ejector and extractor orientation for cartridge cases), and that an exclusion based on differences in class characteristics is not possible, the evidence bullets and cartridge cases can be microscopically compared.

   c. A stereomicroscope should be used to help with this evaluation.

C. Microscopic Comparison of Bullets.

1. The test-fired bullets should be compared in a systematic manner. This is done in order to 1) assess them for individual characteristics and 2) to evaluate the reproducibility of the individual characteristics observed.

   a. Place test-fired bullet #1 on one stage of a comparison microscope and test-fired bullet #2 on the other stage making sure they are pointing the same way and properly illuminated (oblique lighting to get good definition of the striations). Note, test-fired bullets #1, #2, & #3 are used for ease of explanation, but any of the test-fires could be used.

      i. Bullets with a right-hand twist should point towards the right; bullets with a left-hand twist should point toward the left. This alignment helps illuminate the driving edge more evenly and reduces shadows. You may find with some comparisons that switching this orientation is beneficial.

      ii. Center the land or groove impressions being compared at top dead center (12 o'clock position). This decreases any distortion due to curvature of the surface.

   b. Begin the examination at low magnification and start with the index mark placed on the bullets prior to test-firing. Examine the area on one bullet looking for a landmark area, a thick striation or easily distinguished group of striae or distinguishing contour. Keep that bullet in place and rotate the other bullet looking for similar marks. Once corresponding marks have been located, index the bullet by aligning these marks on the two bullets. Once satisfied that the marks are in agreement, the bullets are considered to be in "phase".

   c. Phase can be checked by rotating bullets together to other areas and looking for agreement. If other areas of agreement are found, the bullets are confirmed as being in phase. It is good at this point to place an indexing mark in ink or by scribing on both bullets so they can quickly be aligned

4.

back into phase.

d. Once indexing marks are placed on the bullets, the land impressions should be numbered consecutively around the bullets beginning with land impression #1. This helps locate and document the land impressions with the best potential for identification. Ink can be used to number the land impressions. Groove impressions can also be used for comparison if subclass influence has been eliminated from consideration, but land impressions are the primary area of interest in bullet comparisons.

e. Rotate bullets together in phase and evaluate the quality and quantity of individual characteristic agreement. Move to higher magnification and line up areas of individual characteristic agreement. Find the best area(s) of agreement and count consecutive matching striae (CMS) runs. The representative areas of CMS used to establish the identification should be documented on the Comparison Worksheet.

f. Once the entire bullet has been examined, and a conclusion as to the quality and quantity of individual characteristic agreement has been established, representative photographs must be taken for documentation. Typically these will be of the areas where CMS runs were documented.

   i. The number of photographs taken to document agreement is at the discretion of the examiner, based on the quality and quantity of the agreement observed.

   ii. It is recommended that some low power photographs be taken for orientation, as well as close-up photographs taken at whatever magnification is needed to show detail well.

g. Remove test-fired bullet #2 and replace it with test-fired bullet #3. Repeat the above comparison with #1 against #3. Once the bullets have been placed into phase, number the land impressions of test-fire #3 to correspond with the land impressions of test-fire #1. Evaluate and document the observed agreement.

h. Remove test-fired bullet #1 and replace it with test-fired bullet #2. Repeat the above comparison with #2 against #3. Evaluate and document the observed agreement.

i. The test fires have now been compared and evaluated. The quality and quantity of the agreement and reproducibility of the test-fired bullets should be documented in the notes. One of the test-fires should be chosen as the representative test-fire to be used for comparison to the evidence bullets. Any and all of the test-fires can be used for comparison to the evidence if needed.

   i. It is possible to have test fires with very poor reproducibility of individual characteristics. Some of the factors that cause this are detailed in section 2. f. below.

5

2. The evidence bullets can now be compared systematically to the test-fired bullets.

   a. Place a test-fired bullet on one stage of a comparison microscope and an evidence bullet on the other stage, making sure they are pointing the same way and properly illuminated.

   b. Begin the examination on low magnification and compare the land and groove impression widths. If they are similar, conduct the rest of the examination the same as for the test-fires above, beginning with finding the landmark used above to phase the test-fired bullets.

      i. Be careful to use the land impression and groove impression edges and not artifacts caused by gas cutting or slippage.

      ii. If the land and groove impression widths are not the same between the two bullets, determine if deformation and distortion from bullet damage is the cause.

      iii. If one of the bullets is deformed, try to use a land or groove impression that is the least affected. Caution must be exercised in eliminating bullets when deformation is present.

      iv. If no deformation is present, and the differences in the widths is determined to be significant, the bullets can be eliminated based on differences in class characteristics.

   c. Once the entire bullet has been examined and a conclusion as to the quality and quantity of individual characteristic agreement has been made and representative CMS runs noted, representative photographs must be taken of those specific areas to document the agreement in those areas used to make the conclusion.

      i. The number of photographs taken to document agreement is at the discretion of the examiner, based on the quality and quantity of the agreement observed. Multiple photographs of different areas of agreement on a bullet may be needed.

      ii. If no agreement is found, or disagreement is observed, photographs demonstrating the differences between the bullets are appropriate. The non-agreement or disagreement will also be documented in the notes to support a result of inconclusive or exclusion.

   d. The final conclusion as to the comparison will be documented in the notes. Refer to Firearms Manual section 1.04, Case Documentation and Conclusions, for details.

   e. The above procedure can be repeated with other evidence bullets.

   f. The following factors can influence the appearance of the rifling impressions left on fired bullets and, consequently, the comparison results. 6.

i. Damage or wear of the firearm.

ii. Bullet composition and velocity.

iii. Chamber to barrel alignment (especially in revolvers).

iv. Leading and fouling of the barrel.

v. Damage to the bullet causing deformation, distortion, or elimination of individual characteristics.

vi. Lack of obturation of the bullet in the barrel resulting in loose fit and random bullet to barrel contact resulting in irregular rifling impressions on the bullet.

vii. Poor manufacturing of the barrel.

viii. Corrosion.

g. In cases where no agreement or disagreement is observed, investigating the circumstances that might cause this to occur need to be considered. The following reasons can account for this:

i. Any of the factors in 2. f. 1-8 above.

ii. Significant changes to the firearm from the time the evidence was fired to the time the firearm was recovered.

iii. The bullets were fired from different guns.

3. Comparing Evidence bullets without a suspected firearm.

a. On occasion, evidence from the same scene or multiple scenes will be submitted without a firearm to determine if the evidence was all fired from the same gun.

b. This comparison is performed the same as the comparisons above except no test-fires are present.

c. Conclusions can reflect whether or not all the bullets were fired from the same gun, even though no gun was submitted for comparison. Caution must be exercised in eliminating the possibility of subclass influences when a gun is not available for examination.

D. Microscopic Comparison of Cartridge Cases.

1. The test-fired cartridge cases should be compared in a systematic manner. This is done in order to 1) assess them for individual characteristics and 2) to evaluate the reproducibility of the individual characteristics observed.

a. Place test-fired cartridge case #1 on one stage of a comparison microscope and test-fired cartridge case #2 on the other stage making sure they are properly oriented (both aligned with marks in same positions) and illuminated (oblique lighting to get good definition of the markings). 7.

i. Cartridge cases present many potential areas with identifying marks, including: the head, the rim, and the case body, so position the cases accordingly. All areas should be evaluated for individual characteristics.

b. Examine the marks resulting from firing of the cartridge, such as the firing pin impression, breechface marks, chamber marks, and firing pin aperture marks. The ejector mark, extractor mark, any cutout marks, chambering marks, and magazine marks can also be examined; however they may not be the result of firing, but from being cycled through the action of a firearm. These are called action marks. Use the appropriate magnification required for the area being examined.

c. Evaluate the quality and quantity of the detail present in each mark to determine if there is sufficient individual characteristic agreement for identification. These should be documented on a Comparison Worksheet. Class characteristics can help sort groups of cartridge cases fired from multiple guns into distinct groups for comparison. The following marks may be present:

i. Firing pin impressions can have pits, nicks or broken portions of the firing pin surface which may leave individual marks. There may also be a firing pin drag mark. It may be necessary to cast the impressions with Forensic Sil or Mikrosil.

ii. Breechface marks can come from a number of sources. The marks on the breech face left by machining processes or finishing processes are what are commonly referred to as breech face marks. These marks are impressed onto the head of the cartridge case and onto the primer when fired. This type of mark is typically a compression mark, but can be a striated mark.

iii. Chamber marks can be a good source of identifiable marks. They are caused by imperfections in the chamber of the weapon that cause striated marks when the expanded, fired cartridge case is extracted from the chamber.

iv. Firing pin aperture marks are caused from the area around the firing pin hole. When a cartridge is discharged, the primer is forced against the aperture or back into the firing pin hole, making a compression mark of this area on the breechface. If the barrel moves during firing then the primer metal can be sheared off, creating striated marks.

v. Ejector marks may or may not be present. If present, compare orientation, size, shape and impressed and/or striated detail.

8.

vi. Extractor marks are commonly found on the edge and under the rim of the cartridge case and can include compression and striated detail.

vii. Cutout marks are caused from the cutouts in the breechface for extractors and ejectors; and like the firing pin hole, they can be pressed onto the head of cartridge cases.

viii. Action or chambering marks are marks caused by the cartridge case moving through the action of the gun. They can be override marks and ejection port marks. A rotating bolt can create striated marks on the base and edge of the rim of the cartridge case.

ix. Magazine marks occur when cartridges are pushed out of the magazine during chambering and are striated by the magazine lips.

x. Anvil marks occur in rimfire guns. The firing pin often peens out a section of chamber wall, causing a raised portion on the lip of the chamber to be formed. This bump on the chamber then causes chamber marks on the fired cases. The marks are located in line with the firing pin impression on the opposite side of the rim.

d. Once the entire cartridge case has been examined, and a conclusion of the quality and quantity of individual characteristic agreement has been established, and representative CMS runs noted if applicable, representative photographs must be taken for documentation.

i. The number of photographs taken to document agreement is at the discretion of the examiner, based on the quality and quantity of the agreement observed.

e. Remove test-fired cartridge case #2 and replace it with test-fired cartridge case #3. Repeat the above comparison with #1 against #3. Evaluate and document the observed agreement.

f. Remove test-fired cartridge case #1 and replace it with test-fired cartridge case #2. Repeat the above comparison with #2 against #3. Evaluate and document the observed agreement.

g. The test fires have now been compared and evaluated. The quality and quantity of the agreement and reproducibility of the test-fired cartridge cases should be documented in the notes. One of the test-fires should be chosen as the representative test-fire to be used for comparison to the evidence cartridge cases. Any and all of the test-fires can be used for comparison to the evidence if needed.

i. It is possible to have test-fires with very poor reproducibility of individual characteristics. Some of the factors that cause this are detailed in section 2. g. below.

9.

2. The Evidence cartridge cases can now be compared systematically to the test-fired cartridge cases.

   a. Place a test-fired cartridge case on one stage of a comparison microscope and an evidence cartridge case on the other stage, making sure they are both aligned with marks in the same positions and properly illuminated (oblique lighting to get good definition of the striations).

   b. Compare the test-fired cartridge case and evidence cartridge case using the same procedure as above.

   c. Once the cartridge case has been examined and a conclusion as to the quality and quantity of individual characteristic agreement has been made, and representative CMS runs noted if applicable, representative photographs must be taken for documentation.

      i. The number of photographs taken to document agreement is at the discretion of the examiner, based on the quality and quantity of the agreement observed. Multiple photographs of different areas of agreement may be needed in some difficult comparisons. Similar areas on repetitive evidence (ie. Glock type breechface marks) only require one photograph to document. There is no need to photograph the same area on every item submitted.

      ii. If no agreement is found, or disagreement is observed, photographs demonstrating the differences between the cartridge cases are appropriate. The lack of agreement or disagreement will also be documented in the notes to support a result of inconclusive or exclusion.

   d. The conclusion as to the comparison will now be documented in the notes. Refer to Firearms Manual section CE.04, Case Documentation and Conclusions for details.

   e. Repeat the above procedure for other evidence cartridge cases.

   f. The following marks may reproduce but may consist mostly of toolmarks that are not unique. Look closely for any defects among the parallel and circular striae to help individualize these marks.

      i. Circular marks on firing pins due to lathing or milling.

      ii. Parallel breechface marks due to broaching.

      iii. Circular breechface marks due to milling.

      iv. Dimpled surface marks due to bead blasting.

   g. The following factors can influence the marks left on cartridge cases and consequently the comparison results:

10.

i. Hardness of the cartridge case or primer material.

ii. Differences in pressure when fired.

iii. Alteration of the weapon due to wear, corrosion, and damage.

iv. Operating condition of firearm.

v. Cleanliness of firearm and fouling build up.

vi. Poor manufacturing of the firearm.

vii. The orientation the firearm is held in when fired.

h. In cases where no agreement or disagreement is observed, the circumstances that might cause this to occur need to be taken into account. Some of the factors to consider are:

i. Any of the factors in 2. g. 1-7 above.

ii. Significant changes to the firearm from the time the evidence was fired to the time the firearm was examined.

iii. The cartridge cases were fired from different guns.

3. Comparing evidence cartridge cases without a suspected firearm.

a. Evidence from the same scene or multiple scenes may be submitted without a firearm to determine if the evidence was fired from the same gun.

b. This comparison is performed the same as the comparisons above except no test-fires are present. Index and identification marks should be placed on the evidence cartridge cases. Ink or scribing can be for this purpose.

c. Conclusions can reflect whether or not all cartridge cases were fired from the same gun, even though no gun was submitted for comparison. Caution must be exercised in eliminating the possibility of subclass influences when a gun is not available for examination.

4. Comparing unfired evidence ammunition to other unfired ammunition or to test fires or evidence cartridge cases.

a. It is possible to compare the action marks present on an unfired cartridge that has been cycled through the action of a firearm to other unfired ammunition or to test-fired or evidence cartridge cases.

b. The comparison would be conducted as above except that only those marks left during the cycling of a cartridge through the action without firing it would be compared. (magazine marks, chambering marks, ejector marks, extractor marks, ejection port marks).

c. Keep in mind that many of these action marks can be faint. The action of cycling a cartridge through the gun will usually leave marks, but those marks are not necessarily as distinct as those created from being fired in the same gun. This is due to the higher energy of the action during firing.

E. Verification of Comparisons

1. All cases with comparison conclusions will be verified by another qualified examiner except as noted in 2 below. This verification process does not mean the second examiner will examine each comparison made by the original examiner in a particular case; the second examiner may verify representative comparisons as determined by the original examiner (e.g. if the same conclusion is rendered by the original examiner regarding multiple items based on the same type of toolmark with good reproducibility). Verifiers will initial and date the photographs they used or that represent those areas directly viewed to arrive at their conclusion. The verifier should perform the Technical Review of the report and notes when finished.

   a. Verification should be done at the time the original examiner is performing their examination. Observing the evidence on the microscope is the preferred method, but viewing digital images on the computer monitor is also approved.

   b. Depending on the quality and quantity of the individual agreement, photographs may be used by the verifier to form their opinion without examining the evidence itself.

   c. The verifier should not be told of the original examiner's conclusion. The original examiner should only describe contextual information (e.g. test fire on the left stage, evidence on the right).

   d. The verifier must reach the same conclusion as the examiner. Any differences in opinion should try to be resolved by the examiner and verifier. The Comparative Evidence Supervisor can arbitrate situations where agreement can't be reached. The supervisor can decide in favor of either conclusion or send the evidence to another laboratory for arbitration if needed.

2. Exclusions based on difference in class characteristics will be technically peer reviewed, but do not need to be verified. Exclusions based on differences in individual characteristics as well as all Identifications and Inconclusive results will be subjected to the verification process.

END OF DOCUMENT

PCF 14-2 attachment 22 - p 1/4

Contra Costa County Office of the Sheriff **FORENSIC SERVICES DIVISION** Comparative Evidence Technical Unit Manual	**REVISION DATE:** 05/15/2014	**NUMBER:** CE.17
	RELATED ORDERS:	
APPROVED BY: Chris Coleman & Debbie McKillop	**ASCLD-LAB:**	
CHAPTER: Comparative Evidence	**SUBJECT:** Toolmark Comparisons	

I. **POLICY Tools and items with toolmarks may be submitted to the laboratory to determine if a specific tool was responsible for creating the toolmarks.**

A. Toolmark Comparisons.

1. General Information.

a. Evidence will usually consist of an object with a toolmark or a cast of a toolmark and a suspected tool. All trace evidence collection and latent fingerprint processing should be completed prior to toolmark examination.

b. Note: Never place a tool in contact with a toolmark as this may permanently change the tool and toolmark.

c. Firearms comparisons are a subset of toolmark comparisons and the overall procedures are similar.

d. Limitations.

i. Suspected tools should be obtained as soon as possible after the evidence toolmark was made. The working surfaces of the tools change through use or alteration and thus the toolmarks made with that tool will change.

ii. Tools and toolmarks can be damaged by rust or corrosion. Therefore, evidence should be collected as soon as possible and stored properly to minimize rust or corrosion.

2. Comparison procedure.

a. Document the condition of the evidence as received. Record the presence or absence of trace evidence using notes, sketches and/or photographs. Collect and package any trace evidence that is present either on the evidence toolmarks or the submitted tools.

b. Mark the evidence or proximal container with permanent identification. Do not deface evidence and do not alter the toolmarks or the working surfaces of the tools. 2.

c. Examine the evidence toolmarks and determine:

i. If there is sufficient individual detail present for comparison and possible identification purposes.

ii. The class characteristics of tools that may have been used including:

1. Single bladed, opposed jaws, impact, etc.

2. Length and width of blades

3. Number and shape of teeth

iii. Are the toolmarks the result of compression, motion producing striations, or both?

iv. Document details of the toolmark using notes, sketches and/or photographs.

d. Examine the submitted tool and determine the following (Record your findings using notes, sketches and/or photographs):

i. The class characteristics of the tool.

ii. The presence or absence of subclass characteristics.

iii. If the tool produces unique toolmarks.

iv. If there is evidence as to how the tool was used.

v. If the tool has any damage to the working edges.

vi. If there is any evidence of which surface on the tool was the working surface.

vii. If there are physical limitations that require the tools to be used in a certain manner, thus eliminating some tools or restricting which part of the tool could make the marks.

viii. How the tool was used can help with reconstruction. For example, from what side was the fence cut?

ix. How was the tool manufactured? Manufacturing processes determine possibilities of uniqueness. Cast tools made from the same mold may make similar toolmarks unless the working surface has enough damage to make it unique. Hand finishing of the working surface may make tools unique. Grinding, filing, sanding of the working surface may make tools unique.

e. Make testmarks.

i. If the class characteristics of the tool and the toolmark agree, make testmarks in a soft material like lead. 3,

ii. The goal is to prepare a representative testmark without changing the features of the tool. The test material may eventually need to be as hard as the questioned material in order to produce a representative toolmark. In these cases, the hardness of the test material should be gradually increased until satisfactory testmarks are obtained. Retain all test marks made with hard material since testing with this material may alter the tool working surface. Keep a record of the sequence of the test marks made (T-1, T-2, etc) and document how each test series was prepared. Place adequate identification marks on all test marks.

iii. Forensic Sil or Mikrosil casts of the toolmark and testmarks may be used for comparison when necessary. Conditions that could lead to this are:

1. The object with the working surface or toolmark is too big to fit on the stage of the microscope or too big to collect.

2. The working surface or toolmark is in a place that cannot be examined easily.

3. More detail can be seen in the cast than the working surface or tool mark.

    1. Mark the casts to match the series of test marks they replicate (T-1, T-2, etc.) and place adequate identification marks on each cast.

iv. Use precautions when creating testmarks. Tools can be heavy and have sharp edges. Follow safety procedures when producing test marks.

f. Compare the toolmarks.

i. Compare the testmarks to each other to determine if the toolmarks are reproducible. Note which part of the tool was the working surface used, the orientation of the tool to the working surface, and the direction of force used on the tool.

ii. Compare the testmarks with the evidence marks.

iii. Consider making a sketch of the orientation of the questioned and test marks or cast made of them, on the tables of the comparison microscope. This helps keep track of which comparisons have been made.

iv. Take low and high power photographs of any matching detail.

v. Count consecutive matching striae (CMS) runs, if applicable, and record these in the notes. 4.

vi. Record whether the toolmarks appear to be two or three dimensional.

3. Conclusions.

a. Conclusions should follow the same convention already discussed in Section CE.04 Case Documentation and Conclusions.

ACF 142 - attachment 23 - P. 1/1

Institute of Forensic Sciences
Peer/Technical Review

Date:	September 05, 2012
Laboratory #:	09P01160
Request #:	0011
Service:	Firearms Analysis
Analyst:	Heather R Thomas

By signing this request as Technical Reviewer, I certify that I have performed a review of this request, its final report and other reports, and its supporting documentation for technical and administrative correctness in accordance with relevant laboratory policies and procedures. I further certify that the report and supporting documentation satisfy the following specific elements where applicable:

1. The requested examinations have been addressed.
2. The results are clearly communicated to the reader.
3. The report is editorially and typographically correct.
4. The general format of the report is consistent with laboratory practice.
5. The evidence is adequately described.
6. The case number appears on each page of each file related to the request. The analyst's initials [and page number] appear on each page of each file related to the request, or review of each page by the analyst is electronically documented. — The total number of pages is indicated on the first and last pages.
7. Graphs, charts, [photographs] etc. are available to support the examinations conducted.
8. The chain of custody is adequately documented.
9. All needed standards and/or controls were used and are adequately documented.
10. The tests performed conform to accepted techniques.
11. The conclusions drawn are fully supported by the data.
12. The conclusions are reasonable and within the range of acceptable opinions of peers within this discipline.

☑ I so certify

Raymond E. Cooper

Raymond Cooper, M.S.
Firearms Supervisor
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Email: Raymond.Cooper@dallascounty.org

PCF 14-2 - attachment #24 - p. 1/3

Summary of the Verification and Technical Review Process for 2010 Testing – 09P1160

The Southwestern Institute of Forensic Sciences (SWIFS) Firearm and Toolmark Procedures Manual, Version 2.3, was in effect from May 27, 2009 to January 25, 2011. The verification of the comparisons done for the October 19, 2010 report fell under this version of the procedure manual. Version 2.3, in reference to microscopic comparisons, states, "A second examiner, if available, must verify all identifications." A second examiner is always available.

In firearm and toolmark cases where identifications are made based on microscopic comparisons, a second trained examiner verifies all identifications by direct observation prior to completion of the case. The verifying analyst is selected by the primary analyst. Upon completion of all microscopic comparisons by the primary analyst, the primary analyst verbally communicates to the verifying analyst that identifications have been made in the case and require verification, and more specifically, what identifications have been made so that the verifying analyst knows what comparisons to verify. For the October 19, 2010 report, the identifications to be verified were the autopsy wads to one another and one of the autopsy wads to a test fired slug. When the verifying analyst begins their comparisons, two identified items of evidence would be on the comparison microscope in phase and ready for verification. If additional identifications need to be verified (as in this case), the verifying analyst performs those verifications as well. Once verification is complete, the verifying analyst verbally communicates their results of comparison to the primary analyst. If the results of comparison are the same for the primary and verifying analyst (as they were in this case), the verifications are documented on the case summary worksheet. If the results of comparison differ between the primary and verifying analyst, those analysts will discuss the differences and attempt to reach a consensus. If a consensus cannot be reached, the supervisor and/or chief of physical evidence will be consulted to determine the course of action (results of comparison between the primary and verifying analysts did not differ in this case). The case summary worksheet documents a summary of the requested examinations, all identifications made in the case, and includes representative photographs of those identifications made in the case. The case summary worksheet also serves to document that the identifications in the case have been verified by the verifying analyst. This is documented by the placement of the verifying analyst's initials on the case summary sheet. This is how the verification process was conducted in this case.

Following verification, a case report is generated by the primary analyst. The case report and all supporting documentation are given to the technical reviewer for peer/technical review. In general, the verifying analyst and the peer/technical reviewer are the same person.

The SWIFS Quality Management Program Quality Manual, Version 2.5, was in effect from November 20, 2009 to November 22, 2010. The technical review of the initial portion of this case fell under this version of the quality manual. Section 17.3 (Technical/Peer Review of Case Records) of the Quality Manual states the following in reference to the technical/peer review of case records:

1. *Peer/technical review is a review of the analytical report and supporting documentation package for technical correctness by an individual - other than the primary analyst - who has expertise in a specific functional area gained through documented training and expertise.*
    a. *The technical reviewer may be either an individual appropriately qualified as a casework analyst in the discipline/subdiscipline under review, or an individual qualified by appropriate training and expertise but who does not perform casework analysis in the discipline/subdiscipline under review.*
2. *Peer/technical review provides a second evaluation of bench notes, data, and other documents which form the basis for the scientific conclusion described in the report.*
3. *Technical/peer review must be conducted on a minimum of 20% or six (whichever is fewer) completed cases per examiner per month.*

The firearm and toolmark unit of SWIFS performs peer/technical review of 100% of completed cases. The verifying analyst typically also performs the peer/technical review for a particular case. Mr. Raymond Cooper was the verifying analyst and technical reviewer for this particular case.

Section 17.3 of the Quality Manual (Version 2.5) also states the following in reference to the technical/peer review of case records:

1. *For each case that receives peer/technical review, the reviewer will determine if the following elements have been satisfied:*
    a. *The requested examinations are addressed, and the results are clearly communicated to the reader.*
    b. *The format of the report is consist with laboratory practice, and the report is editorially and typographically correct.*
    c. *The report adequately describes the evidence.*
    d. *The case number and signing analyst's (or analysts') initials appear on all pages of the report's supporting documentation package.*
    e. *The chains of custody for evidence items examined (including internal transfers) are current and adequately documented.*
    f. *The examination results are supported by applicable analytical documentation (graphs, charts, etc.).*
    g. *The tests performed conform to accepted techniques, and appropriate standards and/or control samples were used and adequately documented.*

h. The conclusions drawn are fully supported by the date, and are reasonable within the range of acceptable opinions of peers within the discipline.

The peer/technical review for this case was documented on the Institute of Forensic Sciences Peer/Technical Review form signed and dated on October 19, 2010 and is included with the report packet.

AFrancis ______________________ 01/14/2015 ______________

Firearms Examiner — Date

April Kendrick ______________________ 1/14/2015 ______________

Firearms Supervisor — Date

AFTE Journal - Vol 11 #2, April 1979

PCF14-2 attachment #25 P. 1/4

THE VALIDITY OF FIREARMS EVIDENCE

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(This article was originally published in the July/August 1978 issue of FORUM, the bi-monthly journal of California Attorneys for Criminal Justice, 6430 Sunset Boulevard, Suite 521, Los Angeles, California 90028.)

An article by Donald Belveal published in this journal (March/April 1977) raised the question of the validity of firearms evidence and the nature of the processes employed by firearms examiners in forming their conclusions. Although Mr. Belveal makes several points which are indeed valid, I disagree with several of his conclusions and believe that certain of his comments deserve a response.

The greatest danger as I see it is that an attorney reading Mr. Belveal's article may be left with an impression which is not in consonance with reality. As a defense attorney, Mr. Belveal is, quite correctly, an advocate of a particular point of view. But just as the comments made by an attorney during trial are themselves not evidence, neither are the comments written by that attorney after the trial. Mr. Belveal presents not evidence but an argument. It is, in my mind, a good argument in some respects, and a poor argument in others, but it is still an argument.

Mr. Belveal asserts that there are two basic areas of weakness in the comparison of bullets, i.e., the comparison under a microscope of a questioned bullet with another bullet test-fired from a weapon in question. These areas, according to Mr. Belveal, are (1) a "lack of any such thing as real expertise in matching bullets," and (2) the "lack of objective standards to establish whether two bullets actually came from the same gun." Presumably the former emerges from the latter.

These assertions are sufficiently grave in nature to warrant a careful and detailed consideration of the matter. The area is susceptible of certain complexities, some of which are semantic, and some of which are not.

I am in accord with Mr. Belveal's assertion that there is a lack of objective standards in the interpretation of bullet matches, in the sense that there is virtually nothing published that represents a systematic and comprehensive attempt to codify standards for a minimum bullet match. It is true that firearms examiners have had half a century to develop objective standards and promulgate them, and have failed to do so. It is not to be supposed, however, that firearms examiners are insensitive or indifferent to this criticism. It is an area of concern to many firearms examiners, and if Mr. Belveal's article prompts them to be more reflective, then he has performed a great service to the firearms examination profession. But it is necessary to put this in proper perspective. The failure of firearms examiners to develop objective standards cannot be attributed to professional lassitude. It reflects instead the nature of firearms evidence and the uniqueness of each weapon. The markings on the surface of a bullet are unique because the barrel of the weapon is unique. The very notion of uniqueness thwarts attempts to categorize and generalize, processes which are necessary prolegomena to the development of objective standards. 2,

The problem is not that there are no objective criteria to be applied to the interpretation of bullet matches, but that the criteria which do exist are so diffuse. The information that the firearms examiner uses to establish that a bullet was fired from a particular weapon is in large part based on experience that does not, and cannot, come out of books. Consequently, it is difficult to transfer one examiner's ability to interpret the microscopic images to another person. Each examiner has to build up his or her own backround of experience. A standard of proficiency and a level of expertise may indeed be achieved, but it is admittedly difficult to effectively test the examiner as to the quality and sufficiency or his or her experience. It is not impossible. And just because the criteria for the interpretation of bullet striations exist largely as constructs of the mind does not mean that they will remain so forever. I will return to this point later in this discussion; my real quarrel is not with Mr. Belveal's assertion that objective do not exist, but rather with his conclusion as to the significance of this fact if it were unequivocally so.

Mr. Belveal suggests that a lack of objective standards means that this form of physical evidence is bankrupt of validity. This conclusion warrants scrutiny. First of all, we must be aware of the semantic pitfalls which cluster around the words "objective" and "subjective." They are tricky words at times, depending upon the level of abstraction at which they are used. In general usage "subjective" has come to mean "as we perceive something," while "objective" has come to mean "how that something actually is." In a more casual usage, and in progressively greater vogue, there is a tendency to correlate "objective" with "valid." This was not the original meaning of the word, and may well be the result of the influence of the cliche "a lack of objectivity," which has come to denote bias. Where, then, does firearms examination enter this semantic picture?

Certain aspects of firearms examination are unquestionably objective in nature. Mr. Belveal has, in a sweeping generalization, ignored these elements. The weight of a bullet, its diameter, the width of the land and groove impressions on its circumference, are all examples of objective features. So are the fine striations on the surface of the bullet which reflect the uniqueness of the gun barrel. Ten different firearms examiners looking through a comparison microscope will see the same configuration of striations. They may be recorded photographically or by micro-contour analysis. Ten laymen, given a few minutes of instruction on what to look for, will also see the same striations. Either the striations exist or they do not, and we must conclude that they do, and that they are real. 3,

Up to this point, the examination is objective, or as objective as anything else in our experience. But now, with striations on two bullets matching under the comparison microscope, the question becomes one of whether the extent of matching of striations justifies a conclusion that both projectiles were fired from the same weapon. This step does indeed involve a subjective opinion, but (and this point has eluded Mr. Belveal) the opinion is not made in a vacuum. The matching of striations on bullets is a form of pattern recognition, and like many other examples of patternrecognition it is harded to describe the process than it is to perform. But the successful matching of bullet striations is actually the product, not the process. The process begins with the examination of a number of consecutively fired bullets from a single weapon, noting the agreement in striations on the surfaces of the bullets, and noting the dissimilarities as well. Some dissimilarities are to be expected, and the extent of both accord and discord must be determined. The next step is to examine bullets fired from other weapons of the same manufacture and model. Profound dissimilarities are to be expected in this situation, and again the nature of these must be determined and quantified. Any attack on the validity of firearms evidence would have to deny the accord in the former instance and the lack of it in the latter; such an attempt would be folly and would surely fly in the face of reason.

This process of examination of known weapons and projectiles may, in the case of the new firearms examiner, be repeated for scores of cycles before the examiner begins to forge a notion of uniqueness in the smithy of his own consciousness. The process is subjective in the sense that each examiner must make up his or her own mind, but criteria for identification of bullets do exist as the projection of a gestalt of past experience. They may be difficult to describe, still more difficult to measure, but the criteria are there nevertheless. I would submit that training of this type is more systematic in its application than any course of instruction Mr. Belveal has received on, for example, how to distinguish his own house from others on the street.

Mr. Belveal suggests that firearms evidence be rejected altogether because of its lack of reliability arising from the paucity of objective criteria employed in the interpretational aspects of firearms evidence. I would agree that the subjective aspects of firearms identification diminish its reliability by virtue of the difficulty with which these aspects can be tested and related to the opinion being given in court, but I profoundly diaagree that they diminish it to the point where firearms evidence would be untrustworthy. The limitation to the objective reality of anything has been recognized as a valid doctrine in philosophy and logic since the writings of the Danish philosopher Soren Kierkegaard over a century ago. Secondly, our legal system has always acknowledged the subjective facets of human endeavor. The term "reasonable doubt" and "a prudent man" cry out for subjective consideration. If "objective" is held as an ideal, then we would use a dispassionate and totally objective computer to determine guilt, or to select judges. Thirdly, we commonly use very subjective criteria in our everyday life. What objective criteria do we use to recognize our own toothbrush? What objective criteria does a physician use to distinguish a common cold from influenza? What objective criteria do we use to recognize a friend in a crowded airport? What objective criteria does a lay person use when asked on the witness stand to identify his or her own signature? It is, after all, possible to tell a good egg from a bad one without having laid one.

One final point. Mr. Belveal states in his conclusion that an opinion on a bullet match is similar to the opinions of individuals upon the "merits" of art work. I find this analogy to be wide of the mark. It would be more correct and more relevant to say that an opinion concerning a bullet match is similar to the opinions of individuals as to the attribution of works of art. Many people with little or no formal training can recognize a Rembrandt or a Van Gogh. They do so subjectively, for the most part. Skilled art critics, again relying heavily on subjective factors, can distinguish an authentic Van Gogh from a fake; the possibility that the art critic would confuse a Rembrandt with a Van Gogh is nil. A firearms examiner faces something of a similar scenario. Two bullets fired from two different weapons will be as different as the Van Gogh and the Rembrandt, while bullets from a single weapon will be as similar as a Rembrandt with another Rembrandt.

JOHN I. THORNTON

(The author would like to express appreciation to Mr. John Davis, formerly of the Oakland Police Department Crime Laboratory, for helpful discussion on this topic. JIT)

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ASSOCIATION OF FIREARM & TOOL MARK EXAMINERS

GLOSSARY
6th Edition

Version 6.101613

About the Glossary

GLOSSARY OF
THE ASSOCIATION OF FIREARM AND TOOL MARK EXAMINERS

Edited by
the AFTE Training and Standardization Committee

Version 6.101613

Sixth Edition - 2013
Fifth Edition – 2007
Fourth Edition - 2001

Library of Congress Catalog Card Number
79-56452
First Edition – 1980 Second Edition - 1985 Third Edition – 1994

Post Sight

A front sight with flat sides and top.

Powder

Gunpowder; a commonly used term for the propellant in a cartridge or shotshell. Refer to the **Gunshot Residue and Gunpowder Section** for various types of gunpowder.

Powder Charge

The amount of gunpowder by weight in a cartridge or shotshell.

Powder Scale

A balance or weighing instrument for accurately weighing powder charges or other ammunition components.

Power Actuated Tool

A tool/ammunition system for fastening devices used in construction. The ammunition for these systems are known as power device cartridges and industrial cartridges. Abbreviated PAT.

Practical Impossibility

A phrase, which currently cannot be expressed in mathematical terms, that describes an event that has an extremely small probability of occurring in theory, but which empirical testing and experience has shown will not occur. In the context of firearm and toolmark identification, "practical impossibility" means that based on 1) extensive empirical research and validation studies, and 2) the cumulative results of training and casework examinations that have either been performed, peer reviewed, or published in peer-reviewed forensic journals, no firearms or tools other than those identified in any particular case will be found that produce marks exhibiting sufficient agreement for identification.

Precision Casting

Refer to **Investment Casting**.

Premature Firing

Refer to **Out of Battery Discharge**.

Prescribed Load

Refer to **Load – Prescribed Load**.

Pressure

The force developed in a firearm by the expanding gases generated by the combustion of the propellant. The following are various types of pressure associated with the discharge of a firearm:

Average Pressure – The arithmetic mean of a number of cartridges tested for pressure.

Chamber Pressure - The pressure in a firearm generated by the expanding propellant gases after ignition. Normally measured by means of piezoelectric transducers or crusher gauges. Also known as breech pressure or barrel pressure.

Peak Pressure – The highest value that the chamber pressure reaches during the burning of propellant.

Residual Pressure – The pressure level that remains in the cartridge case or shotshell within the firearm's chamber and in the bore immediately after the projectile leaves the muzzle of the firearm.

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Practical Solutions to Cognitive and Human Factor Challenges in Forensic Science

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ABSTRACT The growing understanding of the central role of human factors and cognition in forensic science has paved the way to develop and implement practical solutions to enhance work in forensic laboratories. Cognitive insights provide relatively simply practical solutions to minimize bias by increasing examiners' independence of mind. These derive from understanding the spectrum of biases–not only those that can arise from knowing irrelevant case information, but also biases that emerge from base rate regularities, working 'backwards' from the suspect to the evidence, and from the working environment itself. Cognitive science's contribution to forensic work goes beyond fighting bias, it suggests ways to enhance examiners' work with technology (distributed cognition), as well as how best to select candidates during recruitment. Taking human cognition into account, such as with a triage approach and case managers, can enhance the quality and effectiveness of the work carried out by forensic examiners. This paper details practical solutions that emerge from a cognitive perspective that understand human expertise and performance. Such cognitively informed approaches should be integrated within forensic work on an ongoing basis.

KEYWORDS Confirmation bias, decision making, cognitive contamination, base-rate, technology, contextual influences, cognitive forensics, case managers, triage

The recent progression in forensic science to understand and acknowledge that the human examiner is the main instrument of analysis in many forensic domains has raised a whole set of new and exciting challenges. A critical point in this development was the National Academy of Sciences report on strengthening forensic science (NAS 2009), stating that:

> A body of research is required to establish the limits and measures of performance and to address the impact of sources of variability and potential bias. Such research is sorely needed, but it seems to be lacking in most of the forensic disciplines that rely on subjective assessments of matching characteristics. These disciplines need to develop rigorous protocols to guide these subjective interpretations and pursue equally rigorous research and evaluation programs. The development of such research programs can benefit significantly from other areas, notably from the large body of research on the evaluation of observer performance in diagnostic medicine and from the findings of cognitive psychology on the potential for bias and error in human observers (p. 8).

There are a few misconceptions of what bias is and how best to address and minimize it (Pronin 2006). For example, often the issues of cognitive bias and

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contextual influence are incorrectly seen as ethical issues. Cognitive bias is a result of computational trade-offs carried out in the brain, not an intentional act that one consciously takes (or can 'switch off' at will) (e.g., McClelland and Rumelhart 1981; Wilson and Brekke 1994).

Since the NAS report (2009), much has been written about the potential of bias in conducting forensic work, including in document analysis (Found and Ganas 2013), fire investigation (Bieber 2012), odontology (Page et al. 2012; Osborne et al. 2014), forensic anthropology (Nakhaeizadeh, et al. 2013), and even forensic domains such as fingerprinting (Dror and Rosenthal 2008) and DNA (Dror and Hampikian 2011).

However, the growing cognitive understanding of these issues has not been systematically translated into practical solutions and ways to minimize the effect of cognitive bias. Indeed, the NAS (2009) inquiry makes a specific recommendation in this regard (Recommendation no. 5):

> The National Institute of Forensic Science (NIFS) should encourage research programs on human observer bias and sources of human error in forensic examinations. Such programs might include studies to determine the effects of contextual bias in forensic practice (e.g., studies to determine whether and to what extent the results of forensic analyses are influenced by knowledge regarding the background of the suspect and the investigator's theory of the case). In addition, research on sources of human error should be closely linked with research conducted to quantify and characterize the amount of error. Based on the results of these studies, and in consultation with its advisory board, NIFS should develop standard operating procedures (that will lay the foundation for model protocols) to minimize, to the greatest extent reasonably possible, potential bias and sources of human error in forensic practice. These standard operating procedures should apply to all forensic analyses that may be used in litigation (p. 24).

NAS (2009) has made a very important contribution in highlighting the need to address the human cognitive issues in forensic science. However, similar to the Office of the Inspector General's review of the FBI's handling of the Brandon Mayfield case (OIG 2006), they limit their conceptualization of cognitive issues and focus mainly on confirmation bias ("whether and to what extent the results of forensic analyses are influenced by knowledge regarding the background of the suspect and the investigator's theory of the case," NAS recommendation 5).

Cognitive contamination of forensic examiners emerges from a whole spectrum of sources, and it is not limited to the impact of knowing irrelevant case information. In order to effectively combat biases and cognitive contamination, one needs to understand the multitude of factors that affect forensic examiners' ability to conduct their work impartially and unbiased. These factors go well beyond the examiners' exposure to irrelevant case information (such as what the detective thinks, whether the suspect confessed to the crime, and whether s/he was identified by witnesses and other case evidence, etc.).

Cognitive biases, for example, also emerge from working "backwards" from the suspect to the evidence; such circular reasoning, working to a 'target,' introduces examiners' biases in how evidence is perceived and evaluated. Further biases are introduced by base-rate regularities (such as verifications of positive matches and finding AFIS hits at the top of the candidate list), which cause expectations before the actual examination takes place, thus introducing a variety of cognitive affects on the examiners' work. If we limited our conceptualization of cognitive bias to case information, then we are not taking into account a variety of other sources for bias and cognitive contamination, and may not take the appropriate steps to deal with them.

Research has examined the expertise of forensic examiners and has demonstrated their high-level capabilities (e.g., Ulery, Hicklin, Buscaglia, and Roberts 2011). However, to reach such high performance levels one has to enable forensic examiners to work to their abilities, without influence and cognitive contamination that can bias their judgment and decision making. Indeed the studies of 'error rates' most often do not include biasing information, and hence to enable such performance we need to assure that the work in casework is also "bias free."

Cognitive biases (whether it is confirmation bias or other types of biases) are only one aspect of cognitive and human factors issues that the forensic community must address. There are a whole set of issues around "cognitive forensics." Cognitive forensics includes a whole array of cognitive issues on how human cognition relates to forensic science and how cognitive knowledge can guide and enhance forensic work. These issues relate from how to optimize the way forensic examiners work with technology (i.e., distributed cognition), to how best to identify applicants during recruitment who are the most talented for the job.

In this paper cognitively informed practical solutions are suggested. These are not limited to dealing with and minimizing cognitive bias, per se, but the wider perspective that emerges from the understanding of human cognition and its central role in forensic work. The solutions suggested take into account the work and financial realities of forensic laboratories (Charlton 2013), and hence attempt to suggest actions that require relatively minimal effort and resources. The paper focuses on the practical solutions with minimal reference and elaboration to the underlying science (the readers who are interested in more information about the scientific foundations of cognitive bias are referred to the relevant literature, e.g., Nickerson 1998).

BASE RATE

People, and experts in particular, learn from experience–this is one of the important cornerstones of intelligence and expertise. Given that our brain and cognitive capacity have limited resources, we optimize cognitive processing, which takes into account our past experiences. This is a very effective cognitive mechanism. However, this can be a problem (see an illustration in Figure 1). Take, for example, security X-ray screeners at the airport. Every day they look for weapons and bombs on the X-ray monitor, but almost never find any. Similarly, in the medical domain in intensive care units (ICU), medical monitors go off all the time, but in the vast majority of cases it is a false alarm (Alameddine et al. 2009; Donchin 2002). The human brain picks up on these base rate regularities, and adjusts cognitive attention and processing accordingly. A conscious and sincere effort to ignore base rate regularities, by itself, is doomed for failure.

Are such base rate regularities a problem in forensic science? Yes, in many ways. For example, in many laboratories verification is mainly performed on positive identifications (or the verifier knows what the first examiner has decided). In the vast majority of verifications of a positive identification, the second examiner verifies the work of the first examiner. This is a textbook example of a base rate regularity. Over time the verifier develops an expectation to agree with the positive identification of the first examiner. Regardless of how much effort and attention they try to put into the verification, the base rate regularities modify their cognitive processing.

What solutions can be used to combat and counter this base rate problem? One solution is to have blind verification (so the verifier does not know what the first

Count how many 'F's are in the following box (try it):

FINISHED FILES ARE THE RE

SULT OF YEARS OF SCIENTI

FIC STUDY COMBINED WITH

THE EXPERIENCE OF YEARS...

FIGURE 1 **How many 'F's do you see in the above box (try it)? Most people see 3 or 4, some 5, but rarely people see all of the 'F's, there are actually 6 of them. The reason many people miss some of the 'F's is because we are experts in reading. Our base rate experience tells us (our unconscious brain) that words such as 'of,' 'the,' and 'a' do not carry much meaning and weight, and therefore, based on our expectation, we tend to automatically ignore them.**

examiner did and concluded) and to verify all forensic decisions, thereby not enabling the verifier to know what decision they are verifying. In such blind verification, the verifier focuses their entire work on the evidence and comparisons without being cognitively contaminated by the work and conclusion of the initial examiner. Although such procedures are in place in some forensic laboratories, they require more effort and work.

Another solution, much simpler than to implement blind verification across all decisions, is to combat the base rate problem by countering the cognitive expectation of the verifier. This approach has been adopted and implemented in airport X-ray security. It entails including in the work stream dummy cases that counter the base rate. In the X-ray security setting it means including fake bombs in suitcases (Schwaninger 2006; see also the Threat Image Projection (TIP) program on the Transportation Security Administration (TSA) website).

In the forensic setting it means including nonmatches 'look-alike' within the stream of verifying identifications (they must be look-alike, so they are not easily detected). Introducing these fake/dummy cases can be done in a variety of ways, depending on the specific operations of the laboratory. For example, it can be a real case whereby the supervisor changes the evidence (e.g., marks, when it goes to the verifier; that is, changing a 'real match' with marks that are very similar but are not a match). Alternatively, the supervisor can give for verification a whole file that is fabricated. What is important is that the verifier receives a case which they think is real, which they think was concluded as an identification match, when in reality the evidence looks very similar, but is not actually a match.

There is no need to include many such fake/dummy cases, just a few can be very effective in countering the base rate and making the verification process more cognitively engaging and effective. Furthermore, such a solution is a very good quality control measure. If the fake/dummy look-alike cases are indeed found in the verification stage, then there is data to show that the verification process is indeed working (similarly to the X-ray security screener who finds the fake bomb). Of course, if the second forensic examiner verifies as an identification the fake/dummy look-alike case, then that is an indication that the verification process requires attention (similarly to an X-ray security screener who fails to detect the fake bomb).

TECHNOLOGY AND DISTRIBUTED COGNITION

The introduction of technology has greatly enhanced forensic work and capabilities, and we can expect this trend to continue, if not to increase even further. However, as these technologies get more and more complex, as they intertwine and collaborate more and more with the human examiner (i.e., distributed cognition), they also present challenges from a cognitive perspective.

First, following on from the base-rate issue, technology often creates such regularities. For example, automated fingerprint identification systems (AFIS) present a list of candidates to the human examiner. However, in the vast majority of cases a positive hit is most likely to be at the top of the list. Over time this technology-induced base rate regularity causes examiners to adapt to this expectation. Indeed, examiners spend less time examining candidates as they go down the list (i.e., even when the same exact candidate is presented, they spend less time on the comparison when the candidate is presented lower on the list–see Dror et al. 2012). As a consequence of the base rate expectation examiners do not only spend more time on the candidates on the top of the list, but they are more likely to make a false positive decision (wrong identification) on an item that is presented on the top of the list where they expect to find a hit, and to make more false negative decision (miss an identification) lower on the list where they do not expect to find a hit.

Solutions to this problem can entail randomizing the order of candidates on the list, causing forensic examiners over time to find hits in different positions on the list, and hence eliminating the base rate regularity. Removing such meta-data is a simple thing to do and can be done by the technology provider. Another solution is to provide reward and motivation to examine the entire list (training and procedures that state you must carefully go over the entire list is not cognitively sufficient or effective to counter the effects of base rate). Such reward and motivation may entail a significant prize for each correct identification made on a candidate that is further down the list.

However, although such solutions are effective, they will cause examiners to work more slowly, as now they will actually and carefully check those candidates that are lower down on the list. A simpler solution, which takes into account workflow and time, would entail shortening the lists and randomizing their positions. Currently many forensic laboratories have lists with 15 candidates, some even with 50. How long should a list be? Well, that can be determined empirically by data and the objective of each forensic laboratory: Once an objective has been determined, e.g., 95%, then the laboratory should check their past hits and see how long a list should be to reach their criteria. Hence, each laboratory can easily determine, based on data, how much to shorten their list, but still maintain the hit rate they want to reach. Of course, this relates to high volume crimes, but not to special cases (to be determined by the laboratory, e.g., homicide, terrorism, armed robbery), where longer lists should be produced and randomized (see the 'Triage' approach below).

A second example of issues with technology and distributed cognition is that in many forensic domains the human examiner needs to determine 'relative similarity' to decide if a mark from a crime scene and a known come from the same source. However, with technology the ability to find a known that is very similar to the evidence from the crime scene but is not from the same source is very high. Such incidental similarities are now much more likely to occur than before technology was involved (where suspects were few and were selected because of different reasons–e.g., had a criminal record, found near the crime scene, etc.). With technology, the known is selected based on their actual similarity to the mark from the crime scene, and the selection is a result of a huge search on a database–hence the increased chance of finding incidental similarities (Dror and Mnookin 2010; see Busey et al. 2014 for a discussion of this issue and optimizing the size of databases).

Therefore, the introduction of technology has introduced a profound change in the working environment in forensic laboratories. The criteria for making an identification based on relative similarity, the point of 'sufficient similarity' to determine that both come from the same source, i.e., an identification, must be changed and modified to take into account the increased chance of finding such levels of similarity due to the powerful ability of the technology to search huge databases and find such similarities. Managers of forensic laboratories that rely on sophisticated technology must consider the cognitive implications of incorporating such technology in the work. Technologies offer great opportunities, but their use in forensic work must take into account their effects on the work of the human examiners.

INDEPENDENCE OF MIND

A critical element of forensic work is that it is as objective, impartial, and free from pressure as much as possible. Such independence of mind is paramount so as to enable the forensic examiners to make their decisions based on the evidence at hand without cognitive contamination. This is not easy to achieve as influences on the forensic examiner come from a variety of sources. Hence, we can only strive to achieve independence of mind. However, just as the forensic examiners are aware and go out of their way to take steps to minimize physical contamination of the evidence, they also need to be aware and take steps to minimize possible cognitive contamination.

First, examiners must be trained so they are aware of the dangers and influences of cognitive contamination. If examiners do not believe they exist, or that they are immune to such influences, or that it is an ethical issue, and that they can 'block it out' by mere willpower, then it is impossible to implement solutions to minimize contextual bias and increase independence of mind. Therefore, the first step in adopting solutions to these issues is that forensic examiners get training about cognitive factors in making forensic comparisons. Such training has been recommended by the NIST/NIJ (2012) expert group on human factors (Recommendation 8.5) and is in line with the NAS report (2009).

Indeed, many laboratories now provide such cognitive training to their examiners. For example, in the United States, examiners in Los Angeles (LASD and LAPD), New York State (NYPD and other forensic laboratories in the state), and the FBI have received such cognitive training; as well as examiners in other countries (e.g., in the U.K., the London Metropolitan Police and many other police forces; and a variety of other police forces and agencies in the Netherlands, Finland, and Australia). This has been an important step forward. However, although training is necessary, it is not sufficient. Other solutions are required in tandem.

Second, in addition to training about cognitive factors in making forensic comparisons, examiners should be 'freed' from information that is totally irrelevant to their work but may influence them, and hence impede their independence of mind. The challenge in this solution is that there are many different sources of such contaminating influences. The simple and obvious one, as pointed out in the NAS report (2009), is contextual influences about the case (e.g., "influenced by knowledge regarding the background of the suspect and the investigator's theory of the case" see NAS recommendation 5). Such information can easily be masked, and therefore not bias the human examiner. It enables them to focus and concentrate on the evidence itself, producing more objective and impartial findings–and saves time too, as they focus on the work, rather than wasting time engaging with irrelevant information.

Clearly, if information is irrelevant and not needed for the forensic work, but can potentially influence the forensic examiner, then it should not be presented to the examiner. However, even information that is relevant to the forensic work should be given with caution and consideration of its potentially biasing effects. Such consideration may suggest giving it to the examiner nevertheless, but only when they need it, to delay it as much as possible; one approach that adopts this solution is sequential unmasking (Krane et al. 2008). Other approaches suggest to conduct a cost-benefit analysis, or to use methods that reveal and show the effect (if any) of the biasing information (Dror 2012).

Other sources of influences and contamination is when forensic examiners work from the suspect to the evidence, rather than from the evidence to the suspect. Forensic work should work linearly, first examining the evidence, in isolation from a "target" comparison. Only after the evidence has been examined, analyzed, and characterized should the human examiner be exposed to the target for comparison. This guarantees that the evidence was not evaluated in light of the target, with

6,

the target comparison affecting and influencing cognitive processing (Dror 2009). The FBI has modified its procedures to promote such linear examination: Their new standard operating procedures (SOPs) now "include some steps to avoid bias: examiners must complete and document analysis of the latent fingerprint before looking at any known fingerprint" (OIG 2011, p. 27). A similar approach has been adopted by the NIST/NIJ (2012) expert group, recommendation 3.2, states, "Modifications to the results of any stage of latent print analysis (e.g., feature selection, utility assessment, discrepancy interpretation) after seeing a known exemplar should be viewed with caution. Such modifications should be specifically documented as having occurred after comparison had begun." (For details about this idea, see Dror 2009).

The effects on the human examiner are not limited to base rate and contextual information; examiners are often under direct and indirect pressures from their working environment. These may include the effects of being a police officer (many forensic examiners are sworn police officers), communicating with the investigating detective, or even just working within the police. Indeed, the NAS report (2009) recognized such influences, and recommended that forensic laboratories should not be part of the police (Recommendation 4: "removing all public forensic laboratories and facilities from the administrative control of law enforcement agencies or prosecutors' offices." See also the call for independent crime laboratories by Giannelli 1997). Indeed, Washington D.C. has recently removed the forensic laboratories from the police and established the District of Columbia Consolidated Forensic Laboratories, an entity that is formally separate from the police.

There is no question that the mere presence of the forensic laboratory within, and as part of, the police has a whole range of effects and influences. One possible effect is lack of impartiality and bias as a result of mere affiliation and allegiance (Murrie et al. 2013). However, one must also consider the importance of communication between the police and forensic laboratory, and what such a separation means. Furthermore, if and when forensic laboratories are separate from the police, they will be within another setting, within other constraints and influences. What is important is to maximize the independence of the forensic work, and that it is as isolated as possible from pressures and influences. Such precautions and steps to ensure maximum independence need to be taken regardless of whether the forensic laboratory is within the police or not (Dror 2009).

TRIAGE

One of the most important suggestions is to set up the forensic laboratories to work cognitively effective. In this respect it is recommended to adopt a triage approach. Not all cases can (and should) be treated in the same way. Imagine in a medical setting that whether a patient comes in with a complex and acute condition or with a simple scratch on their finger, both would be dealt with in the same way. That does not seem to make sense. Similarly, it does not make sense, from a cognitive perspective, to consider and use procedures (for example, in combating bias) in the same way in each case. It seems that sometimes the procedures are an "overkill," whereas in other cases they are not sufficient. The danger of bias is dependent on the complexity of the case (as the decision is more difficult, nearer to the threshold, bias is more likely to effect the decision outcome), and the level and type of contextual bias is also very important (some cases have minimal biasing context, and other cases are full of potential biasing contextual information). Hence, more susceptible to bias are difficult decisions made within biasing contextual information, the 'danger zone'.

Given that it is quite simple to classify cases into different levels of difficulty and vulnerability to bias, it is suggested that a triage approach can stream cases into different procedures. If a forensic laboratory has the resources and time to do blind verifications in all cases, across all decisions, that's wonderful; however, many laboratories are not able to implement such procedures across the board. Why not use such procedures (and others) selectively, as and when needed. At the beginning of the paper, when discussing base rate and how to balance the need to randomize the positions of candidates against the increase that entails in work time to go over the list, such a triage approach was already suggested: In normal high-volume crime, it's important to cut the length of the randomized AFIS list so it is much shorter; however, in special cases, longer randomized lists are warranted.

It is up to the forensic laboratory to determine the criteria of what constitutes a special case, and how to implement the triage. The point is that it is not very cognitively efficient or wise not to adjust and to use the most appropriate procedures that best fit the case at hand. "For forensic science to successfully take on the issue of contextual bias, it is important that one correctly considers the risks, that measures are taken when needed, and that they are proportionate and appropriate" (Dror 2012). This is not limited to issues of bias, but to base rate and other challenges facing forensic laboratories. A one-size-fits-all approach–currently in use in most forensic laboratories–does not make sense. The triage approach enables laboratories to put the right resources and efforts when and where they are needed, allowing them to conduct high-quality forensic work in an effective way.

CASE MANAGERS, INTERPRETATION, AND CONTEXT MANAGEMENT

In order to implement the triage approach (see above), as well as to determine if and what information is relevant to the forensic examiner, it is necessary for someone to see and evaluate the potentially biasing information. Furthermore, forensic work often requires interpretation of the evidence within the entirety of the case, as well as working closely with detectives and prosecutors (e.g., Evett 2009; Jackson, Aitken, and Roberts 2013). These are all potentially highly biasing contexts, but are paramount for conducting forensic work. Furthermore, to determine if and which forensic tests are needed, one must be exposed to a whole range of information.

The simple and practical solution to this quandary is to divide this work among examiners. One examiner sees all the case information and context, determines what tests are needed, etc., and then gives the actual examination and comparison work to another examiner who was not exposed to the biasing information. Similarly, the examiner working with the detectives provides the materials to another examiner to do the actual forensic comparison work.

The crucial point here is that the examiner who is doing the actual comparison work, carrying out the forensic analysis, is isolated from the contextual and interpretative issues: They conduct the forensic work blind, in isolation from the contexts that are not relevant to the actual forensic work, so they can work independently and are as impartial as possible.

Such case managers can be permanent roles within the forensic laboratory, or can be rotating roles on a continuous basis. When it is a rotating role, in some cases an examiner acts in the role of a case manager, whereas in other cases they are the forensic examiner carrying out the actual forensic comparison work.

Similarly, in smaller jurisdictions often the crime scene investigator who collects the evidence (and is thus exposed to a variety of information and context) is the same person who then goes and conducts the actual laboratory comparison work. To avoid the cognitive biases we have discussed, all that is needed is to manage the context. This can be easily achieved by swapping over the roles: While examiner A collects evidence from scene X, and examiner B from crime scene Y, they switch, so examiner A does the laboratory comparison work from crime scene Y, and examiner B does the laboratory work from crime scene X. Thus, they conduct the laboratory forensic comparison on "context-free" evidence, and are able to minimize bias by managing the contextual and irrelevant information.

This solution is very similar to the use of case managers, and to other solutions suggested, they all work towards enabling forensic work to take place, but making sure context and potentially biasing information is isolated and managed in a way that minimizes cognitive contamination. This way forensic examiners are impartial and objective as much as possible.

COGNITIVE PROFILES AND RECRUITMENT

The cognitive issues in forensic science and the ways cognitive science can contribute to this domain are many and not limited to bias. An example of such a contribution is in understanding the cognitive building blocks of this profession–the talent that underpins being a forensic examiner, what is termed "cognitive profile." Cognitive profiles specify the abilities needed to perform the job. Such endeavors have been taken in many professional domains, as cognitive profiles allow us to characterize the people who can best do the work (e.g., medical experts, Caminiti 2000; Fernandez et al. 2011; U.S. Air Force pilots, Dror, Kosslyn, and Waag 1993).

The logic behind such cognitive profiles is that: "Different professions require different abilities. This is obvious when one considers what distinguishes accountants from interior decorators, but the observation applies to all specialized professions ... special abilities enable people to excel in occupations that depend critically on specific mental processes" (Dror, Kosslyn, and Waag 1993, p. 763). And forensic work is no exception;

8,

on the contrary, in much of this domain the human examiners are the main instrument of analysis, and hence play a critical role.

Once such cognitive profiles are established, then they provide a benchmark, an objective, for developing tests that specifically measure and quantify those abilities. This is critical in allowing us to select the best people for the job. Forensic science enjoys popularity and hence is in a "buyer's market" with many applicants for each position. Such tests allow us to take advantage of the available pool of candidates wanting to be forensic examiners.

Tests for recruitment must:

1. Be scientifically developed and validated. The vast majority of tests currently used in the forensic domain have not been scientifically developed or validated. There is a whole domain and expertise in developing such tests and for their validation (Borman 1997).
2. Be relevant to the abilities needed to do the job. For example, the Form Blindness test widely used in the fingerprint domain includes abilities that relate to right angle corners, which is not relevant or needed in examination of fingerprints. That is why it is important to have cognitive profiles that explicate the exact abilities needed for a job. Some forensic laboratories do use well-designed and validated tests, but these tests are ready-made and off-the-shelf tests are not specific for the abilities needed for the forensic examination at hand. Even validated and well-designed tests are no good if they measure irrelevant abilities.
3. Examine the underlying abilities, the raw talent that underpins being an expert. Hence, recruitment tests should not use actual forensic evidence, but the cognitive building blocks. In fingerprinting, for example, such abilities include relevant attention allocation, visual mental imagery, dealing with and filtering noise, visual search, and perceiving and comparing curvatures and orientation.

By selecting the best people for the job, the forensic laboratory will not only have examiners that perform better and faster, but there are also clear implications to training. By selecting the right people, training needs and time are reduced (Zamvar 2004). Furthermore, beyond the laboratory perspective, it is also fairer on a personal level for the people involved if we recruit those who can do the job well.

SUMMARY

Forensic science greatly relies on the human examiners–they are often the main instruments of analysis. This has been recognized by the NAS report (2009) and now is a major challenge in enhancing forensic work. Cognitive bias is now a recognized issue, but often misconceptualized and limited to confirmation bias. Bias has many forms and many origins, one of which is contextual information. Others include base rate regularities, working from the suspect to the evidence, allegiances, and working environment. There are many factors that shape examiners' perception and decision making. It is important for forensic examiners to be as impartial and objective as possible, and work toward their independence of mind.

The relevance of human cognition to forensic science is not limited to cognitive bias, but covers a whole range of issues, from use of technology and distributed cognition to developing cognitive profiles and tests that enable to recruit the best people for the job.

All these different aspects of forensic work (and there are more than those explicated in the paper) are intimately connected to human cognition. Cognitive science can provide practical solutions to enhance forensic work and make critical contributions to forensic science.

FUNDING

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EXHIBIT B

TEXAS FORENSIC
SCIENCE COMMISSION
Justice Through Science
1700 North Congress Ave., Suite 445
Austin, Texas 78701

TEXAS FORENSIC SCIENCE COMMISSION
COMPLAINT FORM

Please complete this form and return to:

Texas Forensic Science Commission
1700 North Congress Avenue, Suite 445
Austin, Texas 78701
Email: info@fsc.texas.gov
[P] 1.888.296.4232
[F] 1.888.305.2432

The Texas Forensic Science Commission ("FSC") investigates complaints alleging professional negligence or misconduct that would substantially affect the integrity of the results of a forensic analysis conducted by an accredited crime laboratory. The Commission also has jurisdiction to investigate non-accredited forensic disciplines and non-accredited entities under more limited circumstances, such as to make observations regarding best practices or for educational purposes. (For a comprehensive review of the Commission's jurisdiction, please refer to Tex. Code Crim. Proc. 38.01 as amended by Tex. S.B. 1238, 83rd Leg., R.S. (2013)).

Please be aware that the FSC investigates allegations involving "forensic analysis." This term includes any medical, chemical, toxicological, ballistic, or other expert examination or test performed on physical evidence, including DNA evidence, for the purpose of determining the connection of the evidence to a criminal action.

However, the term "forensic analysis" does not include the portion of an autopsy conducted by a medical examiner or other forensic pathologist who is a licensed physician. **Please be advised that if you submit a complaint regarding the results of an autopsy, it is highly likely your complaint will be dismissed.** (Note: the forensic testing done in connection with an autopsy, such as toxicology, is included within the Commission's jurisdiction even though the autopsy itself is not.)

The FSC will examine the details of your complaint to determine what level of investigation to perform, if any. All complaints are taken seriously. Because of the complex nature and number of complaints received by the FSC, we cannot give you any specific date by which that review may be completed.

If the criteria for an investigation are met, the FSC will send a letter to the laboratory/facility and/or individual(s) named in the complaint indicating that the FSC has received the complaint. The FSC will then request a response from the entity and/or individual who is the subject of the complaint. We may also need to obtain additional information from you.

If the criteria for an investigation are not met or the FSC declines to investigate further, you will receive a letter from the FSC.

The Commission's statute allows it to withhold from disclosure information submitted regarding a complaint until the final investigative report is issued. **However, after a report is issued, all information and complaints are subject to public disclosure under the Texas Public Information Act (Texas Government Code Chapter 552).**

You may submit a complaint without disclosing your identity. However, the FSC cannot guarantee your anonymity. Also, please note that filing a complaint without disclosing your identity may impede the investigation process, especially if our ability to contact you is limited.

Your cooperation, patience and understanding are appreciated.

1. PERSON COMPLETING THIS FORM

Name: Frank Blazek
Address: 1414 11th St.
City: Huntsville
State: Texas Zip Code: 77340
Home Phone:
Work Phone: 936-295-2624
Email Address *(if any)*: frankblazek@smithermartin.com

2. SUBJECT OF COMPLAINT

List the full name, address of the laboratory, facility or individual that is the subject of this disclosure:

Individual/Laboratory: Southwestern Institute of Forensic Sciences in Dallas, Texas
Address: 2355 North Stemmons Freeway
City: Dallas
State: Texas Zip Code: 75207
Date of Examination, Analysis, or Report: October 19, 2010
Type of forensic analysis: firearm examination
Laboratory Case Number *(if known)*: 09P1160

Is the forensic analysis associated with any law enforcement investigation, prosecution or criminal litigation?
Yes ☐ No ☐

★ If you answered "Yes" above, provide the following information *(if possible)*:

★ Name of Defendant: Joshua Ragston

★ Case Number/Cause Number: No. 17,187
(if unknown, leave blank)

★ Nature of Case: Capital Murder
(e.g burglary, murder, etc.)

★ The county where case was investigated, prosecuted or filed: Grimes County

★ The Court: 506th District

★ The Outcome of Case:

Plead guilty to offense of Murder, 30 years sentence

★ Names of attorneys in case on both sides *(if known)*:

Frank Blazek and Bill Bennett for the Defense Tuck McLain for the State

Your relationship with the defendant:

Self ☐ Family Member ☐
Parent ☐ Friend Attorney ☒
None ☐ Other *(please specify)*:

If you are not the defendant, please provide us with the following information regarding the defendant:

Name: Joshua Ragston
Address *(if known)*: Grimes County Jail awaiting transfer to TDCJ-ID
Home Phone: none
Work Phone: none

3. WITNESSES

Provide the following about any person with factual knowledge or expertise regarding the facts of the disclosure. Attach separate sheet(s), if necessary.

First Witness *(if any)*:
Name:
Address:
Daytime Phone:
Evening Phone:
Fax:
Email Address:

Second Witness *(if any)*:
Name:
Address:
Daytime Phone:
Evening Phone:
Fax:
Email Address:

Third Witness *(if any)*:
Name:
Address:
Daytime Phone:
Evening Phone:
Fax:
Email Address:

4. DESCRIPTION OF COMPLAINT

Please write a brief statement of the event(s), acts or omissions that are the subject of the disclosure.

Ragston was charged with Capital Murder. The deceased was shot several times with .410 shotgun ammunition causing his death. The deceased was known to carry a .410/.45 caliber pistol. No weapon was found at the crime scene. The State theorized that the perpetrators took the pistol from the deceased and shot him with it and then left with the weapon.

A few months after the crime, a .410 pistol similar to that owned by the deceased was recovered on a roadside in a nearby County. It was sent to the lab along with the wadding taken from the body of the deceased for comparison. The lab identified the found weapon as having fired the projectiles recovered from the deceased.

the investigation revealed that the recovered weapon did not belong to deceased but to a party unrelated to the investigation. The DA's investigation developed two suspects who were indicted. The State's theory continued to be that the Defendants Joshua Ragston and Christopher Boulding took the weapon away from the deceased and caused his death. If the lab report in 2010 is correct, then both defendants were not guilty, because they had no access to the recovered weapon.

The DA resubmitted the weapon and recovered projectiles to the same lab, along with 3 exemplar weapons of the same make and model. On this Occasion the analyst concluded that she could no longer confirm that the weapon was the murder weapon.

In a telephone conference the analyst indicated that the first report was scientifically valid but she did not know if the weapon actually fired the fatal rounds.

I have attempted to upload the two reports, but I cannot tell if that was accomplished. Feel free to contact me and I will provide copies.

5. EXHIBITS AND ATTACHMENT(S)

Whenever possible, disclosures should be accompanied by readable copies **(NO ORIGINALS)** of any laboratory reports, relevant witness testimony, affidavits of experts about the forensic analysis, or other documents related to your disclosure. Please list and attach any documents that might assist the Commission in evaluating the complaint. Documents provided will **NOT** be returned. List of attachments:

6. YOUR SIGNATURE AND VERIFICATION

By signing below, I certify that the statements made by me in this disclosure are true. I also certify that any documents or exhibits attached are true and correct copies, to the best of my knowledge.

Signature:

Date Signed: April 24, 2014 - 10:25am

SOUTHWESTERN

INSTITUTE OF FORENSIC SCIENCES

AT DALLAS

Firearm & Toolmark Unit

5230 Medical Center Drive
Dallas, Texas 75235

RECEIVED NOV 08 2010 DISTRICT ATTORNEY

FILED NOV 04 2010

October 19, 2010

Investigating Agency:	Det. Travis Higginbotham Grimes County District Attorney P.O. Box 599 Anderson, Texas 77830	Laboratory #:	09P1160
		Agency #:	09-0717-01DA
		DCME #:	2324-09
		Complainant:	Don Stolz
		Offense:	Homicide

COPY

EVIDENCE:

Submitted by J. Barnard, M.D. on July 20, 2009:

3(1 – 12). One fired plastic combination shotshell wad and eleven lead pellets
4(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
5(1 – 11). Eleven lead pellets
6(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
7(1 – 13). Thirteen lead pellets

Submitted by T. Higginbotham via FedEx# 257685100000523 on February 9, 2010:

69. One Taurus 45 Colt caliber / 410 "gauge" revolver, model The Judge, serial number BX715042
70 – 72. Three unfired 410 Winchester brand shotshells
73 – 74. Two unfired 45 Colt caliber Hornady brand shotshells

RESULTS:

The item 69 revolver is a mechanically functional firearm as received in the laboratory. It has conventional style rifling consisting of six lands and grooves with a right twist. The trigger pull force was measured to be approximately 4 to 5 pounds in single action and 10 to 11 pounds in double action. Item 69 was test fired using ammunition selected from laboratory stock. The test shots were labeled as items 69TF1 through 69TF6.

Items 3(1), 4(1), and 6(1) are three fired plastic shotshell combination wads. They were compared microscopically to each other and to item 69 test shots. Items 3(1), 4(1), and 6(1) were all identified as having been fired by the item 69 Taurus revolver.

Examiner's Initials ___

Items 3(2 – 12), 4(2 – 11), 5(1 – 11), 6(2 – 11) and 7(1 – 13) are lead pellets that are consistent with No. 6 shot. These items are not suitable for comparative examinations.

Item 70 is an unfired 2 ½ inch shotshell loaded with buck shot of undetermined size. Items 71 and 72 are unfired 2 ½ inch shotshells loaded with "bird" shot of undetermined size. Items 70 through 72 are suitable for firing in the item 69 revolver but were not used for test firing purposes.

Items 73 and 74 are unfired cartridges. These items are suitable for firing in the item 69 revolver but were not used for test firing purposes.

DISPOSITION OF EVIDENCE:

The listed item(s) of evidence and any test standards will be released to the investigating agency.

Heather R. Thomas
Firearm and Toolmark Examiner
Direct Line: 214-920-5895
E-mail: hthomas@dallascounty.org

cc: DCME# 2324-09 (JJB)

SOUTHWESTERN
INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

2355 North Stemmons Freeway
Dallas, Texas 75207

Telephone: 214-920-5900
Fax: 214-920-5813

Report Date:	September 05, 2012
Laboratory #:	09P01160-0011
Agency #:	09-0717-01DA - Grimes County District Attorney
Requested by:	Grimes District Attorney Grimes County District Attorney P.O. Box 599 Anderson, TX 77830-0599
Offense:	Homicide
Complainant(s):	Don Stolz

Evidence Submitted:

The following evidence was received by the laboratory from Grimes County District Attorney:

002-001: One fired plastic wad and eleven lead pellets recovered from autopsy - Legacy item 3(1-12)
002-002: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 4(1 - 11)
002-003: Eleven lead pellets consistent recovered from autopsy - Legacy item 5(1 - 11)
002-004: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 6(1 - 11)
002-005: Thirteen lead pellets consistent recovered from autposy - Legacy item 7(1 - 13)
003-001: Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite, serial number BX715042 - Legacy item 69
003-002: Test standards - Legacy items 69TF1 through 69TF6
003-003-001: One unfired Winchester brand 410 shotshell loaded with buckshot - Legacy item 70
003-003-002: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 71
003-003-003: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 72
003-004: Two unfired Hornady brand 45 Colt caliber cartridges - Legacy items 73 and 74
003-005: One disassembled reference 410 shotshell
004-001-001: Twelve unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-002: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-003: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-004: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-005: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
005-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275155
006-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275141
007-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275138

Description of Analysis:

This is a supplemental report addressing additional examinations performed using previously submitted items and newly submitted items.

PREVIOUS ANALYSIS

The item 003-001 revolver (Legacy item 69) was received by the laboratory in 2010 for mechanical evaluation testing and for comparison to items recovered during autopsy. In 2010, the item 003-001 revolver (Legacy item 69) was test fired using ammunition chosen from laboratory stock based on projectile type and availability.

A total of six test standards were fired during the 2010 examination and labeled as items 69TF1 through 69TF6,

(item 003-002). During the 2010 examination, the item 69TF3 rifled slug (originally, a Federal brand 410 shotshell containing a rifled slug and plastic wad) was determined to be the best representation of the barrel. As such, it was chosen as the test standard for comparative examinations with the fired plastic wads recovered from autopsy [Legacy items 3(1), 4(1), and 6(1)]. Based on those comparisons, the wads from autopsy were determined to have been fired by item the 003-001 revolver (Legacy item 69).

NEW ANALYSIS

A request was made by Travis Higginbotham, Grimes County District Attorney's Office, for the reanalysis of item 003-001 revolver (Legacy item 69) for comparison to the autopsy wads using ammunition provided by the District Attorney's Office. The ammunition was obtained from the owner of the item 003-001 revolver (Legacy item 69).

Additionally, Mr. Higginbotham requested analysis to determine if identification of the three autopsy wads to the item 003-001 revolver (Legacy item 69) was based on individual characteristics or subclass characteristics of this particular model of Taurus revolvers. Therefore, the District Attorney's Office submitted three newly purchased Taurus revolvers of a similar model to the item 003-001 revolver (Legacy item 69).

Results & Conclusions:

REANALYSIS OF ITEM 003-001 REVOLVER (LEGACY ITEM 69)

The item 003-001 revolver (Legacy item 69) was re-evaluated and determined to be functional as received in the laboratory. The trigger pull force was measured to be approximately 4.373 to 5.474 pounds in single action and 9.823 to 10.661 pounds in double action. These values are consistent with trigger pull values obtained during the previously reported testing period.

The item 003-001 revolver (Legacy item 69) was test fired a total of thirteen times using a combination of submitted and laboratory stock ammunition for test standards. Items 003-003-002 (Legacy item 71) and 003-003-003 (Legacy item 72) were used to create test standards 003-001 TF1 and 003-001 TF2, respectively. Item 004-001-002 includes two shotshells used to create test standards 003-001 TF3 and 003-001 TF4. The ammunition chosen from laboratory stock includes nine Winchester brand 410 shotshells used to create test standards 003-001 TF5 through 003-001 TF13. Each of the shotshells contained a plastic wad in addition to either lead shot or a rifled slug. All of the test standard wads were recovered except the wad from 003-001 TF3 which was lost in the range's backstop media. Test standard slugs from items 003-001 TF12 and 003-001 TF13 were recovered.

The recovered test standard wads and slugs were microscopically compared to each other for the purpose of determining whether the rifling toolmarks in the barrel of item 003-001 revolver (Legacy item 69) were reproducing adequately for identification purposes. The test standard wad 003-001 TF6 could not be identified or eliminated to any of the other test standards listed; however, all of the other test standards were identified to each other, thereby adequately establishing reproducibility of the rifling toolmarks within the barrel of the item 003-001 revolver (Legacy item 69).

To verify that the original test standard chosen as the best representation of the barrel in 2010 still displayed the now-established reproducibility of the rifling toolmarks within the barrel, item 003-002 (Legacy item 69TF3 rifled slug) was microscopically compared to test standard wads 003-001 TF1, 003-001 TF2, 003-001 TF4 through 003-001 TF13 and to test standard slugs 003-001 TF12 and 003-001 TF13. Item 003-002 (Legacy item 69TF3 test standard slug) could not be identified or eliminated to any of the newly produced test standards. One possible explanation for the inability to identify the previously produced test standard (item 003-002 - Legacy item 69TF3) to the newly produced test standards is that there could have been a slight change in the microscopic characteristics within the barrel due to (1) the cleaning of the barrel; (2) multiple firings of the firearm during the

initial examination; and/or (3) multiple firings of the firearm during the most recent examination.

The fired plastic wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) were microscopically compared test standard wads 003-001 TF1, 003-001 TF2, and 003-001 TF4 through 003-001 TF11. While there are areas of similarity, the correspondence of the individual characteristics between the wads recovered from autopsy and the test standards is not sufficient to identify or eliminate the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) as having been fired by the item 003-001 revolver (Legacy item 69).

The original reported conclusion identifying the wads recovered from autopsy to the item 003-001 revolver (Legacy item 69) cannot be confirmed. However, the previously reported conclusion identifying the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) to each other was confirmed with the caveat that the specific firearm from which they were fired is not known.

The wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) are consistent with having been fired by a 45 caliber/.410 bore firearm having a conventional styling rifling configuration consisting of six lands and grooves. The direction of twist and the measurements of the rifling impressions on the autopsy wads could not be determined.

As previously reported, the lead shot in items 002-001 (Legacy item 3(2 - 12)), 002-002 (Legacy item 4(2 - 11)), 002-003 (Legacy item 5(1 - 11)), 002-004 (Legacy item 6(2 - 11)), and 002-005 (Legacy item 7(1 - 13)) are consistent with No. 6 shot size.

INDIVIDUAL vs SUBCLASS CHARACTERISTICS ANALYSIS

Inasmuch as the Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite is no longer produced, three Taurus 45 Colt/.410 bore revolvers, model The Judge (item 005-001, item 006-001, and item 007-001) were submitted to the laboratory to determine if Taurus revolvers produced subclass characteristics.

Items 005-001 revolver , 006-001 revolver, and 007-001 revolver are mechanically functional firearms as received in the laboratory. They are designed to fire a 45 Colt caliber cartridge or a 2 1/2 inch 410 shotshell. The barrels of each of these firearms have a conventional style rifling configuration consisting of six lands and grooves with a right twist. The trigger pull force for item 005-001 was measured to be approximately 4.102 to 4.545 pounds in single action and 11.114 to 13.195 pounds in double action. The trigger pull force for item 006-001 was measured to be approximately 5.487 to 5.681 pounds in single action and 10.369 to 10.646 pounds in double action. The trigger pull force for item 007-001 was measured to be approximately 4.418 to 6.420 pounds in single action and 10.595 to 11.983 pounds in double action.

Silicone casts of the interior portion of the barrels of items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) were made for the purposes of identifying the presence of microscopic carryover toolmarks from one barrel to the next. The silicone casts were compared microscopically to each other but subclass carryover toolmarks were not viewed on the casts.

Items 005-001 (revolver) and 007-001 (revolver) were each test fired eight times and the item 006-001 (revolver) was test fired seven times, all using a combination of submitted and laboratory stock ammunition. Submitted ammunition in items 004-001-005, 004-001-004, and 004-001-003 were used to create test standards 005-001 TF1 through 005-001 TF3, 006-001 TF1 and 006-001 TF2, and 007-001 TF1 through 007-001 TF3, respectively. The ammunition chosen from laboratory stock included fourteen Winchester brand 410 shotshells loaded with No. 6 shot that were used to create test standards 005-001 TF4 through 005-001 TF8, 006-001 TF3 through 006-001 TF7, and 007-001 TF4 through 007-001 TF8.

Each of the shotshells used for test standards by the items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) contained a plastic wad. All of the test standard wads were recovered except the wad from 005-001 TF1, 005-001 TF2 and 007-001 TF1, which were lost in the range's back stop media. None of the shot from the test standards were recovered as the firearms were fired into the range's backstop media.

The test standards and silicone casts of the items were microscopically compared. While a few similar toolmarks were noted, these toolmarks were not considered to be characteristic of subclass toolmarks, or marks that were carried over among the barrels of the items 005-001, 006-001, and 007-001 Taurus revolvers.

Conclusions:

Based on new analyses using previously submitted and newly submitted items of evidence and microscopic comparisons with newly produced test standards, the original reported conclusion identifying the wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) as having been fired by the item 003-001 revolver cannot be confirmed. Additionally, there were no subclass carryover toolmarks observed among the newly purchased firearms.

Disposition of Evidence:

The listed items of evidence and all recovered test standards will be returned to the investigation agency.

In the event that additional analysis is required, please contact the laboratory.

Heather Thomas
Firearms Examiner
Phone: 214-920-5895
Email: Heather.Thomas@dallascounty.org

EXHIBIT C

SOUTHWESTERN

INSTITUTE OF FORENSIC SCIENCES

AT DALLAS

Firearm & Toolmark Unit

5230 Medical Center Drive
Dallas, Texas 75235

RECEIVED NOV 08 2010 DISTRICT ATTORNEY

FILED NOV 04 2010

October 19, 2010

Investigating Agency:	Det. Travis Higginbotham Grimes County District Attorney P.O. Box 599 Anderson, Texas 77830	Laboratory #:	09P1160
		Agency #:	09-0717-01DA
		DCME #:	2324-09
		Complainant:	Don Stolz
		Offense:	Homicide

COPY

EVIDENCE:

Submitted by J. Barnard, M.D. on July 20, 2009:

3(1 – 12). One fired plastic combination shotshell wad and eleven lead pellets
4(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
5(1 – 11). Eleven lead pellets
6(1 – 11). One fired plastic combination shotshell wad and ten lead pellets
7(1 – 13). Thirteen lead pellets

Submitted by T. Higginbotham via FedEx# 257685100000523 on February 9, 2010:

69. One Taurus 45 Colt caliber / 410 "gauge" revolver, model The Judge, serial number BX715042
70 – 72. Three unfired 410 Winchester brand shotshells
73 – 74. Two unfired 45 Colt caliber Hornady brand shotshells

RESULTS:

The item 69 revolver is a mechanically functional firearm as received in the laboratory. It has conventional style rifling consisting of six lands and grooves with a right twist. The trigger pull force was measured to be approximately 4 to 5 pounds in single action and 10 to 11 pounds in double action. Item 69 was test fired using ammunition selected from laboratory stock. The test shots were labeled as items 69TF1 through 69TF6.

Items 3(1), 4(1), and 6(1) are three fired plastic shotshell combination wads. They were compared microscopically to each other and to item 69 test shots. Items 3(1), 4(1), and 6(1) were all identified as having been fired by the item 69 Taurus revolver.

Examiner's Initials ______

Items 3(2 – 12), 4(2 – 11), 5(1 – 11), 6(2 – 11) and 7(1 – 13) are lead pellets that are consistent with No. 6 shot. These items are not suitable for comparative examinations.

Item 70 is an unfired 2 ½ inch shotshell loaded with buck shot of undetermined size. Items 71 and 72 are unfired 2 ½ inch shotshells loaded with "bird" shot of undetermined size. Items 70 through 72 are suitable for firing in the item 69 revolver but were not used for test firing purposes.

Items 73 and 74 are unfired cartridges. These items are suitable for firing in the item 69 revolver but were not used for test firing purposes.

DISPOSITION OF EVIDENCE:

The listed item(s) of evidence and any test standards will be released to the investigating agency.

Heather R. Thomas
Firearm and Toolmark Examiner
Direct Line: 214-920-5895
E-mail: hthomas@dallascounty.org

cc: DCME# 2324-09 (JJB)

Examiner's Initials

SOUTHWESTERN
INSTITUTE OF FORENSIC SCIENCES
AT DALLAS

2355 North Stemmons Freeway
Dallas, Texas 75207

Telephone: 214-920-5900
Fax: 214-920-5813

Report Date:	September 05, 2012
Laboratory #:	09P01160-0011
Agency #:	09-0717-01DA - Grimes County District Attorney
Requested by:	Grimes District Attorney Grimes County District Attorney P.O. Box 599 Anderson, TX 77830-0599
Offense:	Homicide
Complainant(s):	Don Stolz

Evidence Submitted:

The following evidence was received by the laboratory from Grimes County District Attorney:

002-001: One fired plastic wad and eleven lead pellets recovered from autopsy - Legacy item 3(1-12)
002-002: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 4(1 - 11)
002-003: Eleven lead pellets consistent recovered from autopsy - Legacy item 5(1 - 11)
002-004: One fired plastic wad and ten lead pellets recovered from autopsy - Legacy item 6(1 - 11)
002-005: Thirteen lead pellets consistent recovered from autposy - Legacy item 7(1 - 13)
003-001: Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite, serial number BX715042 - Legacy item 69
003-002: Test standards - Legacy items 69TF1 through 69TF6
003-003-001: One unfired Winchester brand 410 shotshell loaded with buckshot - Legacy item 70
003-003-002: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 71
003-003-003: One unfired Winchester brand 410 shotshell loaded with birdshot - Legacy item 72
003-004: Two unfired Hornady brand 45 Colt caliber cartridges - Legacy items 73 and 74
003-005: One disassembled reference 410 shotshell
004-001-001: Twelve unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-002: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-003: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-004: Two unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
004-001-005: Three unfired Winchester brand 410 shotshells loaded with No. 7 1/2 shot
005-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275155
006-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275141
007-001: Taurus 45 Colt/.410 bore revolver, model The Judge, serial number DU275138

Description of Analysis:

This is a supplemental report addressing additional examinations performed using previously submitted items and newly submitted items.

PREVIOUS ANALYSIS

The item 003-001 revolver (Legacy item 69) was received by the laboratory in 2010 for mechanical evaluation testing and for comparison to items recovered during autopsy. In 2010, the item 003-001 revolver (Legacy item 69) was test fired using ammunition chosen from laboratory stock based on projectile type and availability.

A total of six test standards were fired during the 2010 examination and labeled as items 69TF1 through 69TF6,

(item 003-002). During the 2010 examination, the item 69TF3 rifled slug (originally, a Federal brand 410 shotshell containing a rifled slug and plastic wad) was determined to be the best representation of the barrel. As such, it was chosen as the test standard for comparative examinations with the fired plastic wads recovered from autopsy [Legacy items 3(1), 4(1), and 6(1)]. Based on those comparisons, the wads from autopsy were determined to have been fired by item the 003-001 revolver (Legacy item 69).

NEW ANALYSIS

A request was made by Travis Higginbotham, Grimes County District Attorney's Office, for the reanalysis of item 003-001 revolver (Legacy item 69) for comparison to the autopsy wads using ammunition provided by the District Attorney's Office. The ammunition was obtained from the owner of the item 003-001 revolver (Legacy item 69).

Additionally, Mr. Higginbotham requested analysis to determine if identification of the three autopsy wads to the item 003-001 revolver (Legacy item 69) was based on individual characteristics or subclass characteristics of this particular model of Taurus revolvers. Therefore, the District Attorney's Office submitted three newly purchased Taurus revolvers of a similar model to the item 003-001 revolver (Legacy item 69).

Results & Conclusions:

REANALYSIS OF ITEM 003-001 REVOLVER (LEGACY ITEM 69)

The item 003-001 revolver (Legacy item 69) was re-evaluated and determined to be functional as received in the laboratory. The trigger pull force was measured to be approximately 4.373 to 5.474 pounds in single action and 9.823 to 10.661 pounds in double action. These values are consistent with trigger pull values obtained during the previously reported testing period.

The item 003-001 revolver (Legacy item 69) was test fired a total of thirteen times using a combination of submitted and laboratory stock ammunition for test standards. Items 003-003-002 (Legacy item 71) and 003-003-003 (Legacy item 72) were used to create test standards 003-001 TF1 and 003-001 TF2, respectively. Item 004-001-002 includes two shotshells used to create test standards 003-001 TF3 and 003-001 TF4. The ammunition chosen from laboratory stock includes nine Winchester brand 410 shotshells used to create test standards 003-001 TF5 through 003-001 TF13. Each of the shotshells contained a plastic wad in addition to either lead shot or a rifled slug. All of the test standard wads were recovered except the wad from 003-001 TF3 which was lost in the range's backstop media. Test standard slugs from items 003-001 TF12 and 003-001 TF13 were recovered.

The recovered test standard wads and slugs were microscopically compared to each other for the purpose of determining whether the rifling toolmarks in the barrel of item 003-001 revolver (Legacy item 69) were reproducing adequately for identification purposes. The test standard wad 003-001 TF6 could not be identified or eliminated to any of the other test standards listed; however, all of the other test standards were identified to each other, thereby adequately establishing reproducibility of the rifling toolmarks within the barrel of the item 003-001 revolver (Legacy item 69).

To verify that the original test standard chosen as the best representation of the barrel in 2010 still displayed the now-established reproducibility of the rifling toolmarks within the barrel, item 003-002 (Legacy item 69TF3 rifled slug) was microscopically compared to test standard wads 003-001 TF1, 003-001 TF2, 003-001 TF4 through 003-001 TF13 and to test standard slugs 003-001 TF12 and 003-001 TF13. Item 003-002 (Legacy item 69TF3 test standard slug) could not be identified or eliminated to any of the newly produced test standards. One possible explanation for the inability to identify the previously produced test standard (item 003-002 - Legacy item 69TF3) to the newly produced test standards is that there could have been a slight change in the microscopic characteristics within the barrel due to (1) the cleaning of the barrel; (2) multiple firings of the firearm during the

initial examination; and/or (3) multiple firings of the firearm during the most recent examination.

The fired plastic wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) were microscopically compared test standard wads 003-001 TF1, 003-001 TF2, and 003-001 TF4 through 003-001 TF11. While there are areas of similarity, the correspondence of the individual characteristics between the wads recovered from autopsy and the test standards is not sufficient to identify or eliminate the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) as having been fired by the item 003-001 revolver (Legacy item 69).

The original reported conclusion identifying the wads recovered from autopsy to the item 003-001 revolver (Legacy item 69) cannot be confirmed. However, the previously reported conclusion identifying the autopsy wads (items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1))) to each other was confirmed with the caveat that the specific firearm from which they were fired is not known.

The wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) are consistent with having been fired by a 45 caliber/.410 bore firearm having a conventional styling rifling configuration consisting of six lands and grooves. The direction of twist and the measurements of the rifling impressions on the autopsy wads could not be determined.

As previously reported, the lead shot in items 002-001 (Legacy item 3(2 - 12)), 002-002 (Legacy item 4(2 - 11)), 002-003 (Legacy item 5(1 - 11)), 002-004 (Legacy item 6(2 - 11)), and 002-005 (Legacy item 7(1 - 13)) are consistent with No. 6 shot size.

INDIVIDUAL vs SUBCLASS CHARACTERISTICS ANALYSIS

Inasmuch as the Taurus 45 Colt/.410 bore revolver, model The Judge Ultra-Lite is no longer produced, three Taurus 45 Colt/.410 bore revolvers, model The Judge (item 005-001, item 006-001, and item 007-001) were submitted to the laboratory to determine if Taurus revolvers produced subclass characteristics.

Items 005-001 revolver , 006-001 revolver, and 007-001 revolver are mechanically functional firearms as received in the laboratory. They are designed to fire a 45 Colt caliber cartridge or a 2 1/2 inch 410 shotshell. The barrels of each of these firearms have a conventional style rifling configuration consisting of six lands and grooves with a right twist. The trigger pull force for item 005-001 was measured to be approximately 4.102 to 4.545 pounds in single action and 11.114 to 13.195 pounds in double action. The trigger pull force for item 006-001 was measured to be approximately 5.487 to 5.681 pounds in single action and 10.369 to 10.646 pounds in double action. The trigger pull force for item 007-001 was measured to be approximately 4.418 to 6.420 pounds in single action and 10.595 to 11.983 pounds in double action.

Silicone casts of the interior portion of the barrels of items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) were made for the purposes of identifying the presence of microscopic carryover toolmarks from one barrel to the next. The silicone casts were compared microscopically to each other but subclass carryover toolmarks were not viewed on the casts.

Items 005-001 (revolver) and 007-001 (revolver) were each test fired eight times and the item 006-001 (revolver) was test fired seven times, all using a combination of submitted and laboratory stock ammunition. Submitted ammunition in items 004-001-005, 004-001-004, and 004-001-003 were used to create test standards 005-001 TF1 through 005-001 TF3, 006-001 TF1 and 006-001 TF2, and 007-001 TF1 through 007-001 TF3, respectively. The ammunition chosen from laboratory stock included fourteen Winchester brand 410 shotshells loaded with No. 6 shot that were used to create test standards 005-001 TF4 through 005-001 TF8, 006-001 TF3 through 006-001 TF7, and 007-001 TF4 through 007-001 TF8.

Each of the shotshells used for test standards by the items 005-001 (revolver), 006-001 (revolver), and 007-001 (revolver) contained a plastic wad. All of the test standard wads were recovered except the wad from 005-001 TF1, 005-001 TF2 and 007-001 TF1, which were lost in the range's back stop media. None of the shot from the test standards were recovered as the firearms were fired into the range's backstop media.

The test standards and silicone casts of the items were microscopically compared. While a few similar toolmarks were noted, these toolmarks were not considered to be characteristic of subclass toolmarks, or marks that were carried over among the barrels of the items 005-001, 006-001, and 007-001 Taurus revolvers.

Conclusions:

Based on new analyses using previously submitted and newly submitted items of evidence and microscopic comparisons with newly produced test standards, the original reported conclusion identifying the wads recovered from autopsy in items 002-001 (Legacy item 3(1)), 002-002 (Legacy item 4(1)), and 002-004 (Legacy item 6(1)) as having been fired by the item 003-001 revolver cannot be confirmed. Additionally, there were no subclass carryover toolmarks observed among the newly purchased firearms.

Disposition of Evidence:

The listed items of evidence and all recovered test standards will be returned to the investigation agency.

In the event that additional analysis is required, please contact the laboratory.

Heather Thomas
Firearms Examiner
Phone: 214-920-5895
Email: Heather.Thomas@dallascounty.org

EXHIBIT D

CAR: Misidentification in 09P01160

Description of Corrective Action Plan

Cause analysis

A review of the case file documentation for the firearms report dated 11/4/2010 identified no definitive cause for the apparent misidentification in 09P01160. Laboratory procedures were followed in the analysis. The identification of the autopsy wads to the submitted firearm based upon comparison of the wads to test fired slugs was confirmed by a verifying second examiner. The verifier observed the similarities in striations between evidence wads and test fires, and agreed with the primary examiner that those similarities were sufficient to indicate identification.

The current process used by the laboratory requires verification of identifications by a second examiner (the verifier). However, it does not require that the verifications be performed in a blind fashion. At the time that the verifier is asked to perform a verification he knows that the primary analyst has already reached a conclusion of identification. The verification is therefore performed to determine if the verifier agrees that the markings are sufficient to support the conclusion of identification. The verification is not performed to reach an independent finding of identification.

Although the cause of the apparent misidentification in the 2010 analysis is not obvious, the overall process would be strengthened by performing verifications in a blind manner. Performing verifications in a blind manner where the verifier is unaware of the findings of the primary analyst would reduce the possibility of confirmation bias on the part of the verifier. In this way, any final conclusion of identification would reflect the agreed upon conclusion of two independent evaluations of the evidence.

Corrective Action Plan

A process has been developed to perform blind verifications. In order to achieve blind verifications of identifications, the verification process would also need to include the verification of some eliminations and inconclusives. The process that has been developed utilizes a spreadsheet workbook to randomly select comparisons performed by the primary analyst for verification by the verifier. The selection of comparisons for verification is based upon a matrix of probabilities (see Table 1) in which the probability of selecting a comparison for verification depends upon the type of comparison performed (i.e., test fire-to-test fire, test fire-to-questioned, questioned-to-questioned) and the finding of the primary analyst (i.e., identification, elimination, inconclusive).

Table 1. Mock example of a probability matrix for selecting comparisons for verification. Abbreviations, TF, test fire; Q, questioned.

	Primary Analyst's Finding		
Comparison Types	Inconclusive	Identification	Elimination
TF-to-TF	0%	50%	100%
TF-to-Q	50%	100%	100%
Q-to-Q	50%	100%	100%

In this process, the primary analyst would perform analysis using the standard casework procedure, and would document in the workbook the items examined, the comparisons performed, and the results of those comparisons. Based upon the matrix of probabilities, two work lists would be generated for the verifier: 1) a work list of required verifications; and 2) a work list of optional verifications. The verification work lists would not indicate the conclusions of the primary analyst, so the verifier would not know at the time of verification whether he was verifying a finding of identification, elimination, or inconclusive. Following completion of the required verifications, the verifier would have the option of verifying any other comparisons done by the primary analyst. Mock examples of the primary analyst's comparison summary (Table 2), and the planned verifier's work lists (Table 3 and Table 4) are attached.

Following completion of required and optional verifications, any discrepancies between the findings of the primary analyst and the verifier would be resolved through additional work, with the scope of work being determined by the primary analyst and verifier.

Status of Corrective Action

Because of the pending status of the complaint by the TFSC, implementation of this planned corrective action is on-hold until the laboratory receives feedback from the complaint review process. The TFSC complaint review may identify different or additional causes for the misidentification that may require significant modification of this corrective action.

Microscopic Comparison Summary Sheet - Firearms Analysis

Case#: IFS-12-12345

Request #: 008

	Item A			Item B			Comparison	
Batch #	Batch ID	Description	Item Type	Batch ID	Description	Item Type	Comaprison Type	Result
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item 1	TF-P	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	TF-to-TF	ID
2	(1)IFS-12-12345 #1-1	Test fired bullet from Item 1	TF-P	(3)IFS-12-12345 #1-3	Test fired bullet from Item 1	TF-P	TF-to-TF	ID
3	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	Q-to-Q	ID
4	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(6)IFS-12-12345 #4	Autopsy bullet	Q-P	Q-to-Q	ID
5	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	TF-to-Q	ID
6	(7)IFS-12-12345 #5	Bullet from scene	Q-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	Q-to-Q	ELIM
7	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(7)IFS-12-12345 #5	Bullet from scene	Q-P	TF-to-Q	ELIM
8	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	TF-to-Q	ELIM

Table 3. Mock example of required verification work list. Abbreviations: TF, test fire; Q, questioned; P, projectile.

Required Verification Worklist - Firearms Microscopic Comparisons

Case#: IFS-12-12345

Request #: 8

	Item A			Item B			Comparison					
Batch #	Batch Item ID	Description	Item Type	Batch Item ID	Description	Item Type	Type	INC	ID	ELIM	Notes	Initials
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item	TF-P	(3)IFS-12-12345 #1-3	Test fired bullet from Item	TF-P	TF-to-TF					
2	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	Q-to-Q					
3	(4)IFS-12-12345 #2	Autopsy bullet	Q-P	(6)IFS-12-12345 #4	Autopsy bullet	Q-P	Q-to-Q					
4	(2)IFS-12-12345 #1-2	Test fired bullet from Item	TF-P	(5)IFS-12-12345 #3	Autopsy bullet	Q-P	TF-to-Q					
5	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	TF-to-Q					

Table 4. Mock example of optional verification worklist. Abbreviations: TF, test fire; Q, questioned; P, projectile.

Optional Microscopic Verification Worklist - Firearms

Case #: IFS-12-12345

Request #: 8

	Item A			Item B			Comparison					
Batch #	Batch Item ID	Description	Item Type	Batch Item ID	Description	Item Type	Type	INC	ID	ELIM	Notes	Initials
1	(1)IFS-12-12345 #1-1	Test fired bullet from Item	TF-P	(2)IFS-12-12345 #1-2	Test fired bullet from Item	TF-P	TF-to-TF					
2	(7)IFS-12-12345 #5	Bullet from scene	Q-P	(8)IFS-12-12345 #6	Bullet from scene	Q-P	Q-to-Q					
3	(2)IFS-12-12345 #1-2	Test fired bullet from Item 1	TF-P	(7)IFS-12-12345 #5	Bullet from scene	Q-P	TF-to-Q					

DALLAS COUNTY
SOUTHWESTERN INSTITUTE OF FORENSIC SCIENCES

PHYSICAL EVIDENCE SECTION

2355 North Stemmons Freeway
Dallas, Texas 75235

3 February 2016

Follow-up Report: 151105 – SWIFS Firearms Conclusion

Prepared by: Timothy J. Sliter, Ph.D., Chief of Physical Evidence

This report is being issued in response to a 5 November 2015 request from Anna T. Yoder for follow-up information related a disclosure of a significant event that was communicated to ASCLD/LAB on 3 November 2015. The significant event was the vote of the Texas Forensic Science Commission (TFSC) on 14 August 2015 for a finding of negligence related to a firearms analysis performed in 2010, which was the subject of a complaint received by the TFSC 24 April 2014.

Item 1. Confirmation whether the aforementioned laboratory procedures and policies have been *issued* to the appropriate personnel and the effective dates.

Response: The following changes to firearms laboratory procedures and policies have been issued to firearms unit staff to address the root causes of the 2010 firearms analysis misidentification that was the subject of the TFSC complaint:

1. Firearms technical procedures were revised to specify the use of ammunition for test-fires that is physically similar to the questioned evidence ammunition. A requirement to evaluate the appropriateness of the choice of test fired ammunition was added to the firearms technical review requirements.
    - Date of issue: 9/30/2015.
2. Laboratory procedures for microscopic comparisons were revised to require photographic documentation sufficient to justify findings of identification. A requirement to evaluate the sufficiency of photographic documentation was added to the technical review requirements for microscopic identifications.
    - Date of issue: 9/30/2015
3. A procedure for blind verification of microscopic comparisons was developed and implemented that reduces the opportunity of expectancy bias on the part of the verifying analyst.
    - Date of issue: 8/25/2015

4. The Firearms technical procedures were revised to require an evaluation of the need for validation studies when new or unusual materials are submitted for firearms analysis. The evaluation will be performed by the Firearms Unit supervisor or the Physical Evidence Section Chief.
    - Date of issue: 9/30/2015

Item 2. Confirmation whether any action (e.g. review of cases completed after this event and prior to present) have been identified by the laboratory to determine the extent of event. I.e., an isolated or systemic event. If actions(s) were taken by the laboratory to determine the extent of this event, a summary of the actions and outcome.

Response: The root cause analysis determined that the misidentification was directly related to the unusual evidence material that had been examined microscopically: plastic shotshell wads fired from a gun with a rifled barrel. It was determined from interviews with the Firearms Unit supervisor and analysts that this type of comparison had not been previously or subsequently performed by the laboratory. The analyst's proficiency test record in firearms and tool mark analysis since 2003 were reviewed to determine if there had been instances of technical non-conformances requiring corrective action, and no such non-conformances were identified. On this basis it was concluded that a review of cases was not warranted.

Item 3. Confirmation whether the analyst, technical reviewer and/or the verifier are currently employed by the laboratory and what, if any, actions were taken to prevent future cognitive bias by the analyst and/or verifier in casework.

Response: (1) The analyst is currently employed by the laboratory. Following the 14 August 2015 vote by the TFSC for a finding of negligence, she was removed from active casework involving microscopic comparisons pending finalization of the TFSC investigation. A technical remediation program was developed that required her to perform and document examinations of known non-matching fired bullets. This remediation activity included the collection of quantitative data on the number of consecutive matching striae from 25 pairs of known non-matching bullets, in all alignments of land impressions. She has completed this remedial training. She will complete a supplemental competency assessment in microscopic comparisons early in February 2016. It is expected that a quantitative understanding of the similarity that is seen in known non-matching bullets will reduce the potential for cognitive bias during microscopic examinations. (2) The technical reviewer/verifier for this analysis retired in August 2013. A procedure for blind verification of microscopic comparisons has been implemented, which is expected to reduce the potential for cognitive bias during the verification process.

Item 4. Confirmation whether the laboratory received notice that AFTE's review has been completed, and, if so, a brief summary of the outcome.

Response: At the laboratory's request, the TFSC requested that AFTE review the complaint. The laboratory was informed verbally by the TFSC that AFTE has declined to perform a review.

Item 5. Confirmation whether the laboratory received notice of the TFSC final review process, and, if so, a brief summary of the outcome.

Response: The TFSC has not yet finalized its review process. The laboratory anticipates that the review process will be finalized at the TFSC's February 2016 meeting.

Item 6. Confirmation whether the laboratory has closed its investigation of the event.

Response: The laboratory has closed its investigation of the event. However, the following actions are in process at this time: 1) completion of competency testing of the analyst and recertification of the analyst for microscopic comparison casework contingent upon successful completion of competency testing; 2) communication of the results of remedial training and competency testing with the principle customers of firearms analysis services; 3) development of an updated Brady notice for release to attorneys; 4) finalization of the program improvement activity to assess the feasibility of implementing QCMS methods for striated toolmarks.

EXHIBIT E

From: John Murdock [mailto:jmurdock@so.cccounty.us]
Sent: Wednesday, April 06, 2016 9:22 PM
To: Timothy Sliter <Timothy.Sliter@dallascounty.org>
Cc: John Murdock <jmurdock@so.cccounty.us>
Subject: RE: Request

Dr. Sliter, Ph.D.:

I have reviewed Heather Francis's Supplemental Training Program and I am very impressed with its design. Your use of QCMS to evaluate the comparative ability of Heather and her Supervisor, April Kendrick, was brilliant! Without the metric provided by QCMS, it would have been very difficult to compare their relative comparative ability.

I think that the required number of KNM and KM comparisons was quite adequate, and that the five gun/twelve unknown test design was very realistic. I am also impressed that you numbered the land impressions randomly so that the correct answers could not be obtained for the wrong reasons.

It is my belief that your Supplemental Training Program Design could be used as a model for criteria for the identification of striated toolmark identification training. I would encourage you and your staff to publish this training model because I believe that it a very effective way to help ensure that an examiner does not assign too much significance to a small region of striated toolmark similarity.

Although you made it quite clear that these comparative exercises were not conducted to validate a QCMS approach for you laboratory, I think you and your staff can see how useful QCMS could be when trying to evaluate the significance of small regions of striated toolmark similarity.

Thank you very much for allowing me to provide feedback on you Supplemental Training Program. I am glad that Heather successfully completed the program and has been returned to casework. John

>>> Timothy Sliter <Timothy.Sliter@dallascounty.org> 3/28/2016 2:42 PM >>>

I've attached two documents:

1) The summary retraining report and approval document
2) The competency test approval memo, and the document that describes the design of the competency test.

Thanks.

Timothy J. Sliter, Ph.D.
Section Chief - Physical Evidence
Dallas County Southwestern Institute of Forensic Sciences
Dallas, Texas
Ph. 214-920-5980
timothy.sliter@dallascounty.org

From: John Murdock [mailto:jmurdock@so.cccounty.us]
Sent: Monday, March 28, 2016 1:00 PM
To: Timothy Sliter
Cc: John Murdock
Subject: Re: Request

Dr. Sliter:
I would be happy to review, in strict confidence, the Summary Report. And, I cannot begin to tell you how pleased I am that you allowed Heather to go through supplemental training and proficiency testing. As Lynn Garcia reported in an open meeting, it has been my contention all along that this was a training issue, and not a fatal flaw requiring termination. During my review, I was very impressed with the comprehensiveness of Heather's case work documentation.
Thank you very much for giving Heather a chance to take the supplemental training. Speaking as a former Laboratory Director (for 10 years), I would have done the same thing. John
>>> Timothy Sliter <Timothy.Sliter@dallascounty.org> 3/28/2016 9:44 AM >>>
Mr. Murdock,

I am writing you to request your feedback.

Following the Texas Forensic Science Commission's acceptance of your report of your review of the case in which Heather Francis was the analyst, we have taken Ms. Francis through supplemental training and competency testing in microscopic comparison of striated toolmarks, in order to solidify her understanding of the greatest degree of similarity expected between known non-matching bullets, and to objectively assess her visual acuity and pattern matching skills.

Ms. Francis has completed that supplemental training program, and we are ready to return her to her regular casework responsibilities.

However, we would appreciate your feedback on Ms. Francis's supplemental training program, and in particular your opinion on whether this activity adequately addresses the issue that you identified in your report, in assigning too much significance to a small region of similarity.

Would you would be willing to review the summary report that we have prepared for this supplemental training? If you would, please let me know and I will send it to you.

Thank you,

Timothy J. Sliter, Ph.D.
Section Chief - Physical Evidence
Dallas County Southwestern Institute of Forensic Sciences
Dallas, Texas
Ph. 214-920-5980
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