STATEMENT OF STEPHEN G. BUNCH

I, Stephen G. Bunch, , state the following to be true to the best of my knowledge:

1. Since 2002, I have served as a Supervisory Physical Scientist (Unit Chief) at the Federal Bureau of Investigation (FBI) Laboratory in Quantico, Virginia. My principal duties as Unit Chief involve managing the Firearms-Toolmarks Unit.

2. I began my employment with the FBI in 1996. From 1996 to 1999, I assisted Firearms and Toolmark examiners as a Physical Science Technician. In 1999, I was formally qualified by the FBI Laboratory as a Physical Scientist. My principal duties involved examining firearms and toolmarks-related evidence, reporting results to contributing agencies, and sometimes testifying to findings in court. I served in that capacity until becoming Unit Chief in 2002.

3. I earned a B.S. in Mechanical Engineering in 1978 and a M.A. in History in 1988 from the University of Missouri. I also earned a Ph.D in History from the University of Illinois in 1995.

4. Dating back to 1996, I have received a great deal of specialized training in the area of firearms and toolmark identification. A listing of forensic education, workshops, in-service training, and any other sort of specialized training is set forth in my attached resume (Statement of Qualification).

5. From 2001 to date, I have been a regular member of the Association of Firearm and Tool Mark Examiners (AFTE). I also serve as a member of the Scientific Working Group for Firearms-Toolmarks identification (SWGGUN).

6. A listing of my peer reviewed publications is on my attached resume.

7. Over the course of my career, including my training, I have conducted between 600 and 800 comparison examinations of firearms evidence. I have conducted approximately an additional 300 confirmatory firearms examination comparisons.

8. I have been qualified as an expert witness in the area of Firearms and Toolmark Identification on several occasions in federal and local courts in various jurisdictions, including Easton, Pennsylvania; Pittsburgh, Pennsylvania; Hammond, Indiana; White Plains, New York; Topeka, Kansas; Pierre, South Dakota; Grand Forks, North Dakota; Cheyenne, Wyoming; Rapid City, South Dakota; and Williamsport, Pennsylvania.

9. Firearm identification has been a forensic discipline since the 1930s. Firearms identification is a subset of the broader forensic discipline known as tookmark identification. Toolmark examiners are trained to examine the marks left by tools on any variety of surfaces in an attempt to "match" a toolmark to the particular tool that made the mark. Firearms are simply a subset of tools that impart marks to bullets and cartridge cases. Firearm and toolmark identification is based upon two propositions:

Proposition #1: Toolmarks imparted to objects by different tools will rarely if ever display agreement sufficient to lead a qualified examiner to conclude the objects were marked by the same tool. That is, a qualified examiner will rarely if ever commit a false positive error (misidentification).

Proposition #2: Most manufacturing processes involve the transfer of rapidly changing or random marks onto work pieces such as barrel bores, breech faces, firing pins, screwdriver blades, and the working surfaces of other common tools. This is caused principally by the phenomena of tool wear and chip formation or by electrical/chemical erosion. Microscopic marks on tools may then continue to change from further wear, corrosion, or abuse.

10. In the field of toolmark identification, toolmarks imparted onto bullets and cartridge cases generally are the easiest to identify to a particular tool, i.e., to a particular firearm, because ammunition is cycled through a firearm in a predictable manner. Other tools commonly analyzed in connection with criminal investigations, such as knives, are less easily analyzed because they can impart toolmarks at different angles and with varying degrees of force.

11. A cartridge is made up of four main parts: the bullet, the case, the propellant, and the primer. The case is the covering that holds all of the cartridge components together. The bullet itself is the projectile propelled from the weapon. The propellant rests behind the bullet and very rapidly burns upon ignition. The primer is the component at the rear of the case that starts the reaction when the cartridge is fired.

12. When a gun is fired, the interior of the barrel of the gun imparts "rifling" impressions onto the bullet. The barrel of a gun is manufactured to impart a twist on a bullet as it travels, to ensure firing accuracy. The inside of a gun barrel is imprinted with cuts running the length of the barrel. The cuts within the barrel are called "grooves" and the raised surfaces are called "lands." Those rifling characteristics create marks on the bullet as it travels down the barrel. The raised lands cut into the surface of the bullet. Likewise, the bullet also fills the recessed grooves. The corresponding impressions left on the bullet as it travels through the barrel are depressed "lands impressions" and raised "groove impressions." The twist imparted on a bullet can be either left or right, depending on the direction of the lands and grooves.

13. Before a gun is fired, the base of the cartridge abuts the breech of the gun as the cartridge rests in the chamber. When the gun is fired, the cartridge slams into the breech, thereby leaving "breech face marks." An instant before this, the firing pin strikes the primer at the base of the cartridge, initiating the reaction that causes the bullet to fire. The firing pin contact creates a "firing pin impression" on the primer itself.

14. Examiners are trained to observe 3 types of markings, known also as "characteristics," which are imparted onto bullets and cartridge cases:

1. Class characteristics;

2. Subclass characteristics; and

3. Individual characteristics.

15. Firearm class characteristics imparted to a fired bullet or cartridge case allow an examiner to narrow the class of firearm possibilities to certain types of guns made by certain manufacturers. For a fired bullet, the normally used class characteristics consist of the caliber (diameter) of the bullet, the number of land and groove impressions, the direction of twist of the land and groove impressions, and the width of the land and groove impressions. In the case of a spent cartridge case, the examiner looks primarily for the class characteristic displayed by the firing pin impression on the primer. There are several types of firing pin impressions, including, among others, circular, rectangular, hemispherical, and elliptical.

16. On the other end of the spectrum from class characteristics are individual characteristics. Individual characteristics consist of microscopic, random imperfections in the barrel or firing mechanism created by the manufacturing process, wear, corrosion, or abuse. These unintended characteristics are initially caused by changes in the tool as it makes each barrel on the production line. Imparted individual characteristics typically fall into two categories: (1) striated marks made by movement of the bullet within a gun's barrel (typically appearing as scratches), and (2) impressed marks that are pressed into a surface. A spent bullet usually has striated marks, created as it moves through the barrel of the gun. A spent cartridge case, on the other hand, can have both impressed and striated marks. Prior to firing, the process of feeding the cartridge into the chamber can create striated marks. Once the firearm is fired, impressed marks are created on the cartridge case by the guns's firing pin and breech. With semi-automatic weapons, additional marks can be made as the case is expelled from the gun. A spent cartridge is pulled backwards by the "extractor," which can leave striated marks on the case. Subsequently, the "ejector" kicks the case out of the gun, often leaving an impressed mark.

17. A third type of characteristic straddles the line between class and individual characteristics. These are subclass characteristics. These characteristics can exist within a particular production run in the manufacturing process of a certain brand of firearm. Subclass characteristics can occasionally arise from imperfections in a machine tool that persist during the production of multiple firearm components; from extreme hardness differences between the machine tool and the workpieces; or occasionally from particular manufacturing processes such as casting or molding. They cannot be considered class characteristics because they are not common to all units of a particular make and model of firearm. Nor are they individual characteristics because they persist throughout a period of manufacturing.

18. Qualified examiners are trained to distinguish subclass characteristics from individual characteristics, because a true identification may not be made from subclass characteristics. As I discuss later in this affidavit, because potential issues of subclass characteristics are limited to firearms manufactured in the same part of the manufacturing process, researchers have undertaken validity studies specifically designed to test whether firearms examiners could distinguish spent bullets and spent cartridge casings from consecutively manufactured firearms. In each case, examiners were able to match the bullets and cartridge cases to specific firearms, with either no reported errors, i.e., no instances of "false positives," or with error rates under 1%.

19. Since the inception of firearms and toolmark identification as a forensic discipline, firearms examiners have been using a method known as "pattern matching."

20. According to the theory of firearms identification, a qualified examiner often can determine whether two bullets or two cartridge cases came from the same firearm (inconclusive results are fairly common, however). This can be achieved based on an examiner's training and expertise. A conclusion that two cartridge components have a "common origin" can be reached when the examiner concludes that sufficient similarity exists between the patterns on the components.

21. This theory of firearms identification has been utilized throughout the field of firearms and toolmark identification for decades. In 1992, the Association of Firearm and Tool Mark Examiners (AFTE) memorialized the theory of identification in an attempt to explain the basis of opinions of common origin in toolmark comparisons. The AFTE theory of Identification states:

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 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 it 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 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 individualized/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

22. The concept of "uniqueness" can be misleading. No two sets of toolmarks are identical. Said differently, all toolmarks are different on some level. The marks on the items, however, need not be identical for an examiner to declare a match. There need only be "sufficient agreement" between the marks based on the examiner's training and experience.

23. Pattern matching is done by inspecting bullets or cartridge casings under a split-screen comparison microscope, with typical magnifications of 10X-50X. This instrument has been used in this field of forensic science since the 1930s.

24. There are generally four conclusions that examiners reach when conducting an examination:

1. IDENTIFICATION – meaning the toolmarks have been produced by the same tool;

2. INCONCLUSIVE – meaning the toolmarks may or may not have been produced by the

same tool;

3. ELIMINATION – meaning the toolmarks were not produced by the same tool;

4. UNSUITABLE – meaning the evidence is unsuitable for examination.

25. In making an identification, an examiner utilizes sound examination methods by employing the precepts of empirical research or study in the comparison of two toolmarks. Each examiner undergoes standardized technical training that develops cognitive skills to recognize, differentiate, and understand the patterns of marks and their meaning. The method of pattern matching makes it possible for an examiner to make an individual association or identification conclusion.

26. Validation studies have repeatedly demonstrated 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. Another way to properly qualify an identification is to state that the examiner has matched a toolmark to a particular firearm "to a reasonable degree of scientific certainty." Either qualification communicates the examiner's high level of certainty without overstating the significance of the match.

27. Presumptive validity checks involve examiners who investigate a new manufacturing technique to check for indications of "subclass" marking. That is, to see if a tool imparts marks on objects that persist in highly similar form, and that could possibly result in examiners committing false-positive errors for the reason of this similarity. Most of the time the answer is no. On the infrequent occasions when the answer is yes, the results are published or publicized and examiners are thereby informed to be careful about these circumstances.

28. However, the "gold standard" for testing the scientific validity of examiner claims is by means of comprehensive, "black-box" validity tests involving control examiners as participants. In these tests it is known with absolute certainty where each of the test components originated. Of particular interest to researchers is the rate at which an examination results in a "false positive," meaning a false identification (or false match). Over the past decade, firearm examiners, using the same methods and identification criteria as those in actual casework, have consistently reached correct conclusions based upon the samples before them. Usually the error rate was zero. The only published tests that contained a mis-identification error(s) involved marks produced by tools other than firearms. The Scientific Working Group for Firearms and Toolmark Identification (SWGGUN) has tracked the most recent studies, which can be summarized as follows:

STUDY	ERROR RATE

Brundage (1998)	0%
Bunch & Murphy (2003)	0%
De France (2003)	0%
Thompson & Wyant (2003)	0.78%
Smith (2005)	0%
Orench (2005)	0%

Copies of the above-referenced studies are attached hereto.

29. Consecutively manufactured firearms are the most likely to produce similar microscopic marks on bullets or cartridge cases (subclass marks), for the reason that machine tool wear is at a minimum in moving from one workpiece to the next. Thus, the possibility of a false-positive conclusion that two bullets came from the same firearm is highest with bullets that were fired from two different but consecutively manufactured firearms. Validity tests using consecutively manufactured specimens, however, have not undermined the basic underpinnings of firearm and toolmark identification. For example, research has revealed that the fine, microscopic marks on bullets from consecutively manufactured barrels are readily distinguishable.

30. Another type of black-box test is a proficiency test. These are quality assurance devices designed to test an examiner's competence, or the competence of a laboratory system, not test directly the validity of a theory or technique. There are many drawbacks to these tests when used for validity and error rate purposes. Some of these are the following: anyone who pays the fee may participate in these tests, including attorneys and examiner-trainees; they are not as blind as gold-standard validity tests; participants' responses are linked to him or her and thus are not anonymous; and returns are not mandatory. Firearms proficiency tests, unsurprisingly, show higher error rates than validity tests, with an overall average in the range of 1% - 3%.

31. Thus, contrary to critics' assertions, subclass marks in practice are by no means a serious problem for firearms and toolmarks examiners. This is partly for the reasons given above; namely, (1) that examiners are always alert to new manufacturing techniques that could possibly produce subclass marks, and publish any positive findings to the community at large in order that practicing examiners can take special care in cautionary situations; (2) that examiners are trained to remain alert to potential subclass issues, even when research may be silent on particular circumstances; and (3) by all accounts, that subclass marks appear to be rare in actual casework, as they are in validity and proficiency tests.

And this leads to additional relevant observations. Indeed, if subclass marks were a significant problem, then doubtless such problems would materialize in black-box testing, especially for those tests involving consecutively-manufactured items. In the big picture, all types of errors are captured by black-box tests, whether they be comprehensive validity tests or proficiency tests, and whether the errors be from theoretical weaknesses, subclass marks, or from human errors stemming from incompetency, lack of training, or quality assurance mishaps (transposing control and evidence samples, for example). But the record so far is that error rates are not high, and in the best designed tests are very low. Were subclass marks a significant problem, error rates would doubtless be well into the double digits or at least consistently in the high single digits. But they are not.

32. It should be noted that the vast majority of forensic laboratories in the United States and

abroad have standard operating procedures (technical protocols) that set forth in detail the proper examination procedures, and that these procedures are highly similar across laboratories. Throughout forensic firearms laboratories, once an identification is made, the industry "best practices" provides for a firearms examiner to document and explain the identification through either a photograph or narrative text, describing the primary areas on which the identification was based. Best practices also provides for identifications, or representative identifications, to be confirmed by at least one other examiner. Proper technical and administrative review further ensures that the results of the technique are reliable. It should be noted that the practice of confirming identifications suggests that the error rates for validation and proficiency tests may be higher than for actual casework.

33. A small percentage of the community of forensic firearms and toolmark examiners uses a method involving the observation of "consecutive matching striae" (CMS). In principle, CMS can add some quantification to an examination to support an examiner's conclusion of identification. Under CMS, an examiner looks at the number of consecutive striae that match between the bullets being compared. A "run" of striae is essentially a cluster of matching striae that are adjacent to one another. According to the CMS research, correspondence between one six-line run of striae or two three-line runs are generally enough to effect an identification. CMS applies only to striated marks, not to breechface or other impressed marks. For this reason, CMS is only used on fired bullets and generally not on cartridge cases.

34. Thus, the CMS and pattern-matching methods are not mutually exclusive. In practice rather, CMS is merely an extension of pattern matching. CMS is still a method in development and does not undermine the validity or acceptance of traditional pattern matching. In fact, as demonstrated by the attached SWGGUN Survey Summary, the majority of firearms examiners continue to utilize pattern matching and not CMS methods. Also, the vast majority of firearms examiners who use CMS do so in conjunction with, or in addition to, traditional pattern matching.

35. Unlike the small ridges on fingers, a tool will change over time from wear and thus leave different marks on, for example, bullets. In bullets fired through a barrel in sequential fashion, bullet #1 may or may not display significant microscopic correspondence to bullet #2000. But this in no sense diminishes the reliability of examiner conclusions or the validity of the examination technique. As microscopic similarities/correspondence diminish in the firing sequence, an inconclusive result becomes increasingly likely. However, this changing-tool phenomenon does not increase the likelihood of false positive errors.

36. The late researcher Alfred Biasotti recently has been selectively quoted (reference attached) in such a way that suggests reliable bullet comparisons were problematic. The passage in Biasotti's 1959 article reads more fully as follows:

> "Two basic types of data were recorded: (1) The total line count and total matching lines per land or groove mark from which the percent matching lines were derived (Tables 3 and 4); and (2) the frequency of occurrence of each serious of consecutive matching lines for which probability estimates were calculated (Figures 4 to 8).
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> "Dealing first with the data for percent matching lines given by Tables 3 and 4, it will be seen that the average percent match for bullets fired from the same gun ranged from

> 36 to 38% for lead bullets and from 21 to 24% for metal-cased bullets. For bullets fired from different guns (not tabulated) 15 to 20% matching lines per land or groove mark was frequently found. Relatively speaking, this data indicates that even under such ideal conditions the average percent match for bullets from the same gun is low and the percent match for bullets from different guns is high, which should illustrate the limited value of percent matching lines without regard to consecutiveness.... [Alfred A. Biasotti, A Statistical Study of the Individual Characteristics of Fired Bullets. *Journal of Forensic Sciences*; volume 4, number 1, 1959]

The point Biasotti was making was that there is no value in counting the percentage of matching lines (straie) in a bullet comparison, which is a fact understood by firearms examiners for about as long as firearms identification has been practiced. Biasotti went on to re-affirm instead that it is consecutiveness that matters:

> "Since no two objects are ever absolutely identical, a realizable or practical identity must be based on the occurrence of a sufficiently high number of corresponding individual characteristics having a very low probability of having occurred as a result of chance, and therefore must be the result of a common cause. It should be obvious that consecutiveness; viz., the compounding of a number of individual characteristics, is the very basis of all identities.

And it is the consecutiveness of matching straie that counts for much when examiners use the traditional pattern-matching method in their examinations.

37. Firearms and toolmark identification involves some degree of subjectivity when an examiner looks for a high degree of correspondence in patterns. Doubtless the methodology is similar to matching dental records to a particular person. It is also analogous to the manner in which we recognize people in everyday life. When we see a friend or relative in public we are able to make an identification based upon patterns of features that match our memories. Familiarity with a particular subject is what enables us to make an identification of a face with a high level of confidence. This explains why parents of identical twins can typically distinguish between their children with practical certainty. Similarly, a medical researcher may know each mouse by name. The practiced eye of the firearms examiner is trained to recognize corresponding marks on bullets and cartridge casings. It should be noted that all sciences involve some elements of subjectivity, whether it's taking readings from an analog instrument; or interpreting epidemiological data, for example; or interpreting the meaning of a fossil or bone; or a physician diagnosing a fever. Subjectivity is not tantamount to unscientific, nor to unreliability. Each theory or technique, whether more or less subjective/objective, must be empirically tested on its own terms to determine its level of validity and reliability.

38. The AFTE theory of firearms identification merely adopted and articulated traditional principles of pattern matching that have enjoyed broad acceptance within the forensic firearms community for decades. Traditional pattern matching is practiced by firearms and toolmark examiners in forensic laboratories throughout the world. According to the SWGGUN Survey Summary of laboratories in the United Sates, 98% of laboratories that responded to the study utilize traditional pattern matching.

39. The defense points out that "a number of known non-matched test fires from different

firearms" have been observed to appear "near the top of the [same gun] candidate list" in large image databases. This is completely predictable in any large database of ballistic images. But there is no evidence that an increase in similar-images in databases has lead to misidentifications under a comparison microscope. No identifications are effected based upon matches in a database alone. Any positive identifications relating to individual characteristics are made under a comparison microscope. Matches in the National Integrated Ballistic Information Network (NIBIN) are merely a starting point for further examination.

40. Defense has cited an affidavit by William Tobin, a former FBI metallurgist. Although metallurgy and materials science may provide a general understanding of the manufacturing processes for products such as firearms and common tools, they do not provide a detailed knowledge of the firearm and toolmark identification process and the conclusions that can be drawn from examinations under a comparison microscope. There is no indication that Mr. Tobin has performed any firearms identification casework or undergone any formal training in the field. From his metallurgy background, Mr. Tobin makes broad assertions about what conclusions *cannot* be drawn in the field of firearms and toolmark identification, but provides no specific evidence or research studies to support his assumptions.

Based upon Mr. Tobin's affidavit, the defense appears to be asserting that in order to conduct a reliable examination, firearms examiners must watch the production of every single item or have a detailed knowledge of every manufacturing facility and its processes. However, as noted above, firearms examiners are well aware of the issue of subclass markings and are continually investigating new and novel manufacturing processes to insure that such marks are not produced, or if they are, that the examiner community is alerted to them via publication or other means. Further, if in casework an examiner examines items for which he knows subclass marks could potentially have occurred, best practices dictates that he account for this and ensure that the strength of his conclusions correspond to the strength or weaknesses of the underlying evidence examined; or, alternatively, before stronger identification conclusions justifiably could be drawn, that he conduct additional and detailed research in his particular case to ensure no subclass marks were produced. (It should be noted, however, that if subclass marks are suspected, it is highly likely they are present on only one surface area of a specimen. For example, if breechface marks in a particular instance are known to be problematic, then the examiner would not conclude identify unless there were sufficient microscopic correspondence in non-subclass firing pin impressions, chamber marks, etc.)

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Stephen G. Bunch, Ph.D

State of Virginia

SS:

County of

Before me the undersigned, a Notary Public for _______________ County, State of Virginia, personally appeared STEPHEN G. BUNCH, and he being first duly sworn by me upon his oath, says that the statements contained in the above affidavit are true.

Signed and sealed this 29th day of May 2008

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My commission expires _____________