

## Free Executive Summary

### Ballistic Imaging



Daniel L. Cork, John E. Rolph, Eugene S. Meieran, and Carol V. Petrie, Editors, Committee to Assess the Feasibility, Accuracy and Technical Capability of a National Ballistics Database, National Research Council

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## Executive Summary

Since the late 1980s computerized imaging technology has been used to assist forensic firearms examiners in finding potential links between images of ballistics evidence gathered from crime scene investigations, namely, cartridge cases and bullets from fired guns. To support this effort, the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) in 1997 formed the National Integrated Ballistic Information Network (NIBIN). Law enforcement agencies participating in NIBIN contribute to a database of images of bullet and cartridge case evidence recovered from (or test-fired from weapons linked to) crime scenes. This system facilitates rapid comparison with archived evidence and with evidence gathered at other crime sites; when matches look promising, the physical evidence can be retrieved for direct examination and confirmation by an examiner. NIBIN was designed as a tool for search, not for verification, which is always done by an examiner.

The rapid development of computerized ballistic imaging technology has led to speculation about its future potential. A particularly interesting proposal is to create a national reference ballistic image database (RBID) that would house images from firings of all newly manufactured or imported firearms. Proponents of this proposal argue that such a database could provide a quick investigative lead from evidence recovered at a crime scene to the underlying firearm's original point of sale. State RBIDs already exist in Maryland and New York, and wide attention was drawn to the issue when California studied the feasibility of creating its own RBID.

In 2004 the National Institute of Justice (NIJ) of the U.S. Department of Justice requested that the National Academies appoint a committee of experts to address the issues raised by the computerized imaging ballistics technology. The Committee to Assess the Feasibility, Accuracy, and Technical Capability of a National Ballistics Database was asked to "assess the feasibility, accuracy and reliability, and technical capability of developing and using a national ballistics database as an aid to criminal investigations." To accomplish this, the panel's charge is to:

- (1) Assess the technical feasibility, through analysis of the uniqueness of ballistic images, the ability of imaging systems to capture unique characteristics and to parameterize them, the algorithmic and computational challenges of an imaging database, the reproducibility

of ballistic impressions and the ability of imaging systems to extract reproducible information from ballistic impressions.

(2) Assess the statistical probabilities that ballistics evidence presented would lead to a match with images captured in a database, whether and how the base rate can be estimated for those crimes that present bullet or casing evidence that do in fact come from a gun that produced a database entry, and the probabilities and consequences of false positives and false negatives.

(3) Assess the operational utility of ballistics evidence in criminal investigations—that is the extent to which it is used or can be used to identify crime guns and suspects and to solve specific crimes.

(4) Assess the sources of error in ballistics database matching (from examination, digitization, computer matching, chain of custody and documentation of tests, and expert confirmation), how they may be quantified, and how these errors interact.

The charge continues: “The committee’s work will provide scientific and technical knowledge to inform the government’s deliberations on three policy options with regard to ballistics databases:

(1) **Maintain** the National Integrated Ballistic Information Network (NIBIN) on ballistics recovered from crime scenes. It is operated by the Bureau of Alcohol, Tobacco, and Firearms.

(2) **Enhance** the NIBIN system so that it can be used to match crime scene evidence with the gun used.

(3) **Establish** a national ballistics database of images from bullets fired from all, or nearly all, newly manufactured or imported guns for the purpose of matching ballistics from a crime scene to a gun and information on its initial owner.”

Addressing the issues raised by the tasks of the charge permitted the committee to provide guidance to NIJ on the three federal policy options. Specifically, for option 2, enhancing the NIBIN system, we address how to increase its effectiveness as a search tool, including changes to the basic imaging standard used by the system, and improving procedures for working with the existing hardware and software. For option 3, establishing a national RBID, the committee considers it a counterpart to NIBIN, containing images of ballistics samples from all newly manufactured and imported weapons. The committee also considered the feasibility of alternative technologies that could achieve the same goal as a national RBID. These alternative technologies include microstamping to imprint a known, unique marker on firearm parts or ammunition: analysis of such marks would complement or perhaps replace the need to examine the currently used toolmarks.

Underlying the specific tasks with which the committee was charged is the question of whether firearms-related toolmarks are unique: that is, whether a particular set of toolmarks can be shown to come from one weapon to the exclusion of all others. Very early in its work the committee found that this question cannot now be definitively

answered.

**Finding: The validity of the fundamental assumptions of uniqueness and reproducibility of firearms-related toolmarks has not yet been fully demonstrated.**

Notwithstanding this finding, we accept a minimal baseline standard regarding ballistics evidence. 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.

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 of uniqueness. Assessing uniqueness at, say, a submicroscopic level, though probably technically possible, would be extremely difficult and time consuming compared with less definitive but more practical and generally available methods at the macroscopic level. It is an issue of policy and of economics as to whether doing so would be worthwhile. The committee did not and could not undertake such research, nor does it offer any conclusions about undertaking such research. Although it appears to the committee that the needs for research are extensive, specifying the nature of that research was not part of the committee's charge. We also note that the committee does not provide an overall assessment of firearms identification as a discipline nor does it advise on the admissibility of firearms-related toolmark evidence in legal proceedings: these topics are not within its charge.

The committee's charge is to determine the extent to which the toolmarks left on bullets and cartridge casings after firing a weapon can be captured by imaging technology. It is also to assess whether a ballistic image databases—particularly a national RBID containing images of exhibits fired from all newly manufactured and imported guns—would be feasible and operationally useful, by which we mean capable of generating leads for follow-up and further investigation. Whether or not toolmarks are unique to a given weapon does not preclude the committee from addressing this charge. Indeed, in many situations a sufficient level of toolmark reproducibility can be picked up by imaging or other measurement systems to be useful for narrowing a search down to a set of possible weapons, as is currently done. The final determination of a “match” is made by a human examiner.

**FEASIBILITY OF A NATIONAL REFERENCE  
BALLISTIC IMAGE DATABASE**

Independent of the reliability and effectiveness of the technology used in making comparisons of images in a national RBID, there would be significant limitations in the usefulness of such a database. Most importantly, there is a huge existing supply of weapons and ammunition that would not be entered into the database. In addition, revolvers do not eject cartridge cases at crime scenes as do other handguns. Consequently, even under the best of circumstances, when random variability is kept to a minimum, the database itself would be incomplete. Finally, to implement a national

RBID, national protocols would have to be created for the test firing of new and imported guns; ensuring that test-fired cartridge cases or bullets are correctly packaged with their corresponding firearm and maintaining a chain of custody for the exhibits after they are imaged would create a formidable logistical challenge.

In our detailed assessment, three additional points regarding the implementation of a national RBID have particular salience.

First, the current technology in use for automated toolmark comparison, based on two-dimensional greyscale images, is useful for gross categorization and sorting of large quantities of evidence. However, it is less reliable for distinguishing extremely fine individual marks that would be necessary to make successful matches in RBIDs in which large numbers of exhibits on file would share gross class and subclass characteristics.

Second, basic probability calculations under reasonable assumptions suggest that the process of identifying a subset of possible matches that contains the true match with a specified level of certainty depends critically on as-yet underderived measures of similarity between and within gun types. This process is very likely to return too large a subset of candidates to be practically useful for investigative purposes.

Third, the large influence of ammunition type and variability introduces a significant source of error in identification. A standard, protocol type of ammunition could be specified in an RBID (as it is in NIBIN), but it is likely not to correspond with the ammunition actually used in a crime; the choice of protocol ammunition, or a requirement to use multiple ammunition types, would have significant financial implications for both ammunition and firearm manufacturers, as well as on the information systems involved.

**Conclusion: A national reference ballistic image database of all new and imported guns is not advisable at this time.**

### **MAINTAIN OR ENHANCE NIBIN**

By facilitating access by state and local law enforcement agencies to ballistic imaging technology, the NIBIN program provides a valuable service in helping to solve gun-related crimes. However, agencies differ in the degree to which they use the NIBIN resources and, consequently, they differ markedly in the benefits they derive in establishing links between crimes and investigative leads. The committee's principal task includes offering guidance on either maintaining NIBIN as it currently operates or enhancing it in various ways to improve its effectiveness. The former is not really a viable option: there are always opportunities for improvement in any program, particularly one as broad as NIBIN.

**Conclusion: NIBIN can and should be made more effective through operational and technological improvements.**

To this end, the committee offers 15 specific recommendations to improve NIBIN's performance and effectiveness. Seven of the recommendations are oriented

principally at the operation of the NIBIN program itself and the practices of NIBIN partner agencies, and they address:

- priority for NIBIN entry of cartridge casings collected from crime scenes;
- ballistic imaging as a part of the criminal investigation process for state and local agencies;
- cross-jurisdictional tally of hits using the NIBIN system;
- streamlining of the ballistic image acquisition process and reporting requirements;
- development of “best practices” in using NIBIN;
- a protocol for the entry of more than one exhibit from the same crime scene or test firing; and
- allocation of NIBIN system technology.

We also offer eight specific recommendations for enhancing the current technical platform for the NIBIN program, the Integrated Ballistics Identification System (IBIS), and the hardware and software system developed by Forensic Technology WAI, Inc. These eight recommendations address:

- research on the distributions of comparison scores;
- an “audit trail” in the NIBIN system’s hardware and software systems;
- ammunition brand information in NIBIN;
- the capacity for national or cross-regional searches against the NIBIN database;
- NIBIN’s database partition structure;
- enhancements to the NIBIN interface;
- side-light imagery of breech face impressions; and
- the 20 percent threshold used in the IBIS system.

In support of this study, the National Institute of Standards and Technology (NIST) was separately contracted by NIJ to perform experimental work at the committee’s request. This experimental work considered the value of one major technical enhancement to the current NIBIN system: a change in imaging standard from two-dimensional, greyscale photography to three-dimensional surface measurement using noncontact microscopy. NIST’s work included analysis of an extract of cartridges from one of the major existing studies of ballistic imaging performance as well as a new dataset of test-fired cartridges designed by the committee. The work highlights the promise of three-dimensional surface measurement, which performs comparably with—and, for some cartridge markings, often better than—the current two-dimensional methodology. However, there are major substantive challenges—among them the reduction of data collection time and the refinement of image comparison algorithms that make use of three-dimensional information but are still compatible with existing two-dimensional imagery—that need to be addressed before full consideration can be given to adopting the new standard.

## ALTERNATIVE TECHNOLOGIES

The goal of a national reference ballistic image database is to provide an investigative link from ballistics evidence to the point of sale of the weapon or ammunition used in a crime. The same goal could be achieved through an entirely different approach, microstamping, which is to place a known, unique, and unalterable identifier on gun parts, cartridge cases, or bullets at the time of manufacture. These uniquely microstamped products could then be associated with their purchaser when sold. Microstamping, if feasible and practical, would have the advantage of imposing uniqueness as a characteristic of ballistics evidence, substituting known and fixed markings for microscopically fine, individualizing characteristics that result from random processes in manufacture and weapon firing.

A distinct advantage of microstamping is that the marks could be examined at a crime scene using equipment no more sophisticated than a magnifying glass, vastly simplifying and speeding up the process of developing investigative leads. The state of California recently passed a law, to take effect in 2010, that requires microstamping on internal parts of new semiautomatic pistols. However, the committee believes that for such a technology to be implemented successfully, in-depth investigations on several topics are needed. These topics include the reliability and durability of the marks in a variety of firing conditions, their susceptibility to tampering and countermeasures, whether it would be best to place them on guns or ammunition or both, and the cost implications and feasibility of adding a microstamping process to established manufacturing processes.

## PROCESS FOR IMPROVING COMPUTER-ASSISTED FIREARMS IDENTIFICATION

The current technology used in automated examination of images of ballistics evidence is produced and maintained by a single vendor. As a result, it does not benefit from the improvements that could be gained through competition and vetting among the broader research community, and its potential for advancement and innovation is limited. The committee suggests that improvements in matching ballistics evidence be made through government procurement efforts that demonstrate best practices.

Two recent examples of government-mandated large-scale imaging system developments based on initially, nonmature technologies include systems for fingerprint identification and for facial recognition. Both systems required the creation of dedicated pattern recognition algorithms, similar to the requirements of NIBIN. Instead of relying on a single system produced by a single vendor, both systems were organized as competitions between vendors with the goal of advancing the technology as quickly as possible. Both competitions required that well-vetted datasets from several sources be made available to researchers so that the correct features could be identified for extraction. Finally, the results of both competitions were subjected to independently administered evaluations, using well-defined and published evaluation methodologies that allowed for a direct quantitative assessment of the relative strengths and weaknesses of different approaches.

This approach to procurement—removing strict dependence on a sole-source provider and ensuring government ownership of and access to result data—should be applied for all work related to the improvement in ballistics evidence analysis, including large-scale two-dimensional image search engines, three-dimensional topographical techniques, and microstamping processes.



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# **BALLISTIC IMAGING**

Committee to Assess the Feasibility, Accuracy, and Technical Capability of a  
National Ballistics Database

Daniel L. Cork, John E. Rolph, Eugene S. Meieran, and Carol V. Petrie, *Editors*

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# Preface

The Committee to Assess the Feasibility, Accuracy, and Technical Capability of a National Ballistics Database is pleased to submit this final report and wishes to thank the many people who have contributed to our work over the committee's lifetime.

This project was sponsored by the National Institute of Justice (NIJ), Office of Justice Programs, U.S. Department of Justice. We are grateful for the support of NIJ staff and their participation in our meetings. We are particularly indebted to Christopher Miles, the program manager for this project, and to John Morgan, head of the Research and Technology Development Division, for their assistance and their patience as our committee worked through this complex project.

Through a separate contract initiated by NIJ, the National Institute of Standards and Technology (NIST) was engaged to conduct experiments in support of the committee's work. As described in Chapters 7 and 8 of this report, NIST's work for the panel focused on the potential of one possible major enhancement to current ballistic imaging technology: a change from two-dimensional photography to three-dimensional surface measurements. Just as this committee required extensive collaboration between disparate units within the National Academies and representation from a breadth of disciplines, so too did the NIST experimental work for the committee draw together staff from several NIST units, and we have benefited greatly from this collaboration. Susan Ballou, Office of Law Enforcement Standards, provided excellent oversight of the NIST team, and Theodore Vorburger, Surface Metrology Division, was unstinting in his zeal for this work. NIST subcontracted and partnered in this work with Benjamin Bachrach of Intelligent Automation, Inc., whose insights from past and current three-dimensional analysis of bullet and cartridge evidence gave shape to many of the committee's discussions. As the work developed, James Filliben of NIST's statistical unit oversaw the final experiment design and analysis plan, and he provided outstanding assistance. We are grateful to all the current and former NIST staff who worked on this project, including Dewey Foreman, John Libert, Brian Renegar, Mike Riley, John Song, James Yen, and Alan Zhang.

Throughout the panel's deliberations, we benefited from the counsel of two consultants, Anthony Braga and Lawden Yates. Braga, a senior research associate and lecturer at the Kennedy School of Government at Harvard University, provided empirical analysis and extended and elaborated on previous work on the use of ballistic imaging in the Boston area. His paper on the latter topic appears as Appendix A.

When the committee was being formed, it was decided not to include an active firearms examiner. Instead, the committee had the counsel of Lawden Yates, a former firearms and toolmark examiner and laboratory director, who also served as general counsel to the Alabama Department of Forensic Sciences and as assistant district attorney

for Blount and Saint Clair Counties, Alabama. He provided invaluable information and advice to the committee on a range of technical matters.

Though motivated by questions concerning a new data collection system, this project also required a comprehensive review and assessment of the current National Integrated Ballistic Information Network (NIBIN) Program of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). The ATF responded to our requests with exceptional openness and enthusiasm. In particular, we are grateful for the assistance of Benjamin Wilson, Firearms Project Manager at ATF's Office of Laboratory Services. The committee's analyses, described in Chapter 8, required image acquisition and analysis by staff at ATF's Ammendale, Maryland, laboratory; we appreciate the effort of firearms examiner Martin Ols and the other ATF examiners who contributed to this work. We also appreciate the initial guidance to our work provided by Robert Thompson and by Patricia Galupo, former director of the NIBIN program. ATF afforded the committee and staff the opportunity to participate in a meeting of its NIBIN Users' Congress, which proved most valuable.

In March, 2005, a non-disclosure agreement was negotiated between Forensic Technology WAI Inc. (FTI) and the National Academies to facilitate a site visit to FTI's headquarters in Montreal by selected members of the committee. FTI is the creator and manufacturer of the equipment and software (IBIS) used by the nation's forensic laboratories to create and maintain a database of ballistic images consisting of evidence collected from crime scenes or confiscated during arrests. The non-disclosure agreement covered information about this system that FTI and the National Academies Office of Legal Counsel agreed are proprietary within the meaning of Exemption 4 of the U.S. Freedom of Information Act, 5 U.S.C. Section 552(b)(4). The meeting, which took place at FTI's offices in Montreal on March 22, provided a detailed understanding of the features and capabilities of the imaging technology developed by FTI. Only information that was not designated as proprietary information is included, referenced, or quoted in this final report. The committee is grateful to FTI for its cooperation and for the high degree of professionalism and scientific competence it demonstrated at this meeting.

We are particularly grateful for a thoughtful and candid discussion with FTI technical staff; both Michael McLean, project manager for the Integrated Ballistics Identification System (IBIS), and Pete Gagliardi, vice president of marketing and strategic planning, took special interest in the committee's work and provided much useful information. Along with McLean, Alain Beauchamp gave a useful presentation at a committee meeting and responded to other committee requests for information. We appreciate the contributions of other past and present FTI staff, including Robert Walsh, chairman and president; René Bélanger, vice president and general manager; John O'Neil, firearm examiner consultant; Michael Clamen; Cybele Daley; Tim Heaney; Serge Labrecque; and Danny Roberge.

Gerald Zeosky, inspector and director of the New York State Police Forensic Investigation Center (FIC), and John Hicks, director of forensic services for the New York State Division of Criminal Justice Services, were invited to a committee meeting to describe their state's Combined Ballistics Information System (CoBIS), a state-level reference ballistic image database. Following that presentation, both men then invited the committee and staff to the FIC in Albany to perform experimental runs on the CoBIS database. During that visit (and a follow-up visit by committee staff), FIC staff gave

freely of their time and talent; for this, we are particularly grateful to Rebecca Barretta, James Campbell, Mike D’Allaird, Craig Grazier, and Mark Heller.

Similarly, a presentation to the committee by deputy chief Denis McCarthy of the New York City Police Department (NYPD) led to an invitation to visit and perform limited analyses using the NYPD’s ballistic image database, which uses the same technology as the NIBIN program but is not directly linked. At that visit to the NYPD crime laboratory in Jamaica, Queens, Lt. James Kenny, commanding officer of the firearms analysis section, and detective Anthony Pellicio, firearms examiner and microscopist were extremely helpful.

Over the course of the study, every committee member visited at least one NIBIN installation at a state or local law enforcement agency, and various members also visited the ATF national laboratories in Ammdendale, Maryland, and Walnut Creek, California. We thank all involved for their time and talent. Subgroups of the committee also visited firearms and ammunition manufacturers and developers of microstamping technologies. We are grateful to all those who helped make the visits smooth and informative, including: from Federal Cartridge Company, Gary Svendsen, Mike Larsen, Mike Hollen, Ken Croteau, and Rick Vickerman; from Hi-Point Firearms, Tom Deeb; and from Beretta Firearms, Jeffrey Reh, general counsel. Todd Lizotte of Hitachi Via Electronics attended a committee meeting and generously spent time discussing the microstamping of firing pins and other firearm parts at his facility in Londonderry, New Hampshire. Ammunition Coding Systems, a Seattle-based firm acting as proponents of a methodology for microstamping ammunition that was then under active consideration by the California legislature, convened a very helpful session with the firm’s staff and related contractors in Seattle for a group of committee members. We thank Steven Mace, Russell Ford, John Knickerbocker, David Howell, Patrick Grace, and Paul Curry for their guidance in that meeting. We also appreciate the participation of Randy Rossi, California Department of Justice, in the Seattle subcommittee discussion.

Ann Davis, Virginia Division of Forensic Sciences, was president of the Association of Firearm and Tool Mark Examiners (AFTE) when our committee began operations. She offered comments at our first meeting and assembled a liaison committee to interact with the committee as needed; for these contributions, we are grateful. Lucien Haag (Forensic Science Services, Inc., Carefree, Arizona) attended and participated in a panel discussion at a committee meeting in Chandler, Arizona, and subsequently discussed trials that he had performed on microstamped firing pins for a committee meeting in Washington; we thank him for the information he shared with us.

We appreciate the time taken by other experts to present issues to our committee, including Kenneth Green of the Sporting Arms and Ammunition Manufacturers’ Institute, Inc., and Marianne Hinkle, former assistant U.S. attorney for the district of Massachusetts. At the committee’s meeting in Chandler, Arizona—hosted by committee vice chair Eugene Meieran at Intel Corporation—we made use of the fact that several NIBIN sites are located in the Phoenix metropolitan area. Representatives of the various NIBIN-hosting law enforcement agencies participated in a very useful panel discussion: they included Judie Welch, Eric Brown, and Randy Leister of the Phoenix Police Department Crime Laboratory; Patrick Chavez of the City of Mesa Crime Laboratory; Steve Valdez of the City of Scottsdale Crime Laboratory; Dustin Engel of the Maricopa

County Sheriff's Office; and Vince Figarelli and Lisa Pelozza of the Arizona Department of Public Safety.

Emily Ann Meyer provided initial literature collection for the committee during her service as a research associate with the National Materials Advisory Board (NMAB). Michael Siri, senior program assistant with the Committee on National Statistics (CNSTAT) deftly provided logistical support to the committee in the later phases of its work; he was preceded as program assistant and coordinator for the committee's activities by Ralph Patterson during his tenure with the Committee on Law and Justice. Special thanks are due to Barbara Boyd for pinch-hitting as program assistant for one of our committee meetings during a gap in staffing and for generally providing back-up assistance when needed. Toni Marechaux, former director of the NMAB, contributed to the formation of the committee and its early work, and we have also benefited from the counsel of Constance Citro, CNSTAT director, and Jane Ross, director of the Center for Economic, Governance, and International Studies of the Division of Behavioral and Social Sciences and Education.

We were extremely fortunate to have two experienced and extremely capable individuals as staff: Carol Petrie and Daniel Cork. Carol was particularly helpful in the process of forming the committee, managing the panel's consultations with its sponsor and other external parties, organizing meetings, and stewarding this report through the Academies' review process. Dan managed much of the panel's analytic work and had primary responsibility for drafting the report. Together they organized the work of the committee and guided its evaluation of the NIBIN program and its consideration of a national reference ballistic image database. To say we have benefited enormously from their talents and knowledge and are very grateful to have had the opportunity to work with them is a considerable understatement. Regardless of the committee's expertise and commitment, this report would have significantly less value than we believe it does have, but for Carol and Dan's contributions.

This report has been reviewed in draft for by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the National Research Council (NRC). The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their participation in the review of this report: William A. Ellingson, Nuclear Engineering Division, Argonne National Laboratory; David L. Faigman, Hastings College of Law, University of California, San Francisco; Stephen E. Fienberg, Department of Statistics, Carnegie Mellon University; Barry A.J. Fisher, Los Angeles County Sheriff's Department Crime Laboratory, Los Angeles, California; David C. Hoaglin, Abt Associates Inc., Cambridge, Massachusetts; Paul F. Johnson, Emeritus Professor of Ceramic Engineering, Alfred University, Alfred, New York; Alan F. Karr, Director's Office, National Institute of Statistical Sciences, Research Triangle Park, North Carolina; Diane Lambert, Google, Inc, New York, New York; Lyle H. Schwartz, Consultant, Chevy Chase, Maryland; Pete Striupaitis, Northeastern Illinois Regional Crime Laboratory, Vernon Hills, Illinois; Charles F.

Wellford, Department of Criminology, University of Maryland; and James Q. Wilson, School of Public Policy, Pepperdine University.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of the report was overseen by John C. Bailar, III, Professor Emeritus, Department of Health Studies, The University of Chicago, and Hyla S. Napadensky, Office of President, Napadensky Energetics, Inc., Grand Marais, Minnesota. Appointed by the NRC, they were responsible for making certain that an independent examination of the report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring panel and the institution.

John E. Rolph, *Chair*  
Eugene S. Meieran, *Vice Chair*  
Committee to Assess the Feasibility, Accuracy, and  
Technical Capability of a National Ballistics  
Database

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