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MITRETEK TECHNICAL REPORT

Ballistic Identification Capability Modeling— A Guide for State Program Establishment

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ABSTRACT

The Center for Criminal Justice Technology (CCJT) is a nonprofit “center of excellence” that provides unbiased technology expertise to the criminal justice community. Mitretek Systems operates the CCJT in collaboration with the University of Maryland and the state of Maryland.

States are now considering the implementation of ballistic imaging technology to create statewide systems containing reference ballistic images of shell casings and projectiles from test firings of guns sold by dealers in the state. One of the tasks performed by CCJT—supported under Cooperative Agreement 2001-LT-BX-K002, from the Office of Justice Programs, National Institute of Justice, Department of Justice—is to develop a computer-based impact analysis model and handbook to assist state legislators and law enforcement officials in establishing and operating a reference ballistic imaging database (also referred to by the Bureau of Alcohol, Tobacco, and Firearms as a State Legislative Database) that meets national standards. Not only is the model useful for estimating system cost, it is also a useful tool to ensure that key elements of program implementation are not inadvertently overlooked. By creating such state-owned systems, state law enforcement officials can image shell casings and projectiles recovered from crime scenes, search the images against the reference database, and—if there is a match—identify the original owner of the subject gun. This document presents a high-level overview of ballistic imaging technology, as well as a detailed description of the planning model. A substantial list of references, with Internet links where applicable, is also provided.

The electronic version of the planning model, which is a Microsoft Excel-based application, is provided as a separate file.

KEYWORDS: ballistic imaging; IBIS; legislative database; NIBIN; test-fired bullets

EXECUTIVE SUMMARY

Mitretek Systems, a nonprofit company chartered in the public interest, has provided technology-related services and assistance to the criminal justice community for many years. Recognizing the needs and limitations of the thousands of state and local criminal justice agencies across the country, Mitretek Systems, in partnership with the state of Maryland and the University of Maryland, established the Center for Criminal Justice Technology (CCJT). The CCJT, a nonprofit "center of excellence," functions as a national source of unbiased technology expertise for criminal justice agencies by providing a full range of systems engineering and integration services to the criminal justice community.

Utilizing funds appropriated by the United States Congress and administered by the Office of Justice Programs, National Institute of Justice, the CCJT has initiated several projects of significance to criminal justice agencies. Each proposed project must meet two criteria: it must involve an important, demonstrable technical challenge, and it must have broad applicability throughout the criminal justice community.

The fight against violent crime is one of the most important law enforcement initiatives of our day. Although much progress has been realized in reducing the level of violent crime in our nation, there is widespread agreement that more can and must be done.

Forensic science and reference files of all kinds have long played a key role in the detection and solution of crimes. The science of ballistics, in particular, has been an important component in addressing violent crimes, which are often committed with firearms.

Many states are now evaluating the desirability and feasibility of establishing reference databases of projectiles/cartridge cases associated with firearms sold within their jurisdiction. The information contained in these databases could be significant in resolving unsolved cases in which ballistic evidence was recovered at the scene of a crime or as a part of the subsequent investigation. In addition, states are considering using ballistic imaging technology to create statewide systems that contain reference ballistic images of shell casings and projectiles from test firings of guns sold by dealers in the state. By creating such state-owned systems, state law enforcement officials can image shell casings and projectiles recovered from crime scenes, search the images against the reference database, and—if there is a match—identify the original owner of the subject gun.

It should be noted that such state-based efforts are distinct from the National Integrated Ballistic Information Network (NIBIN), which was formed through the collaboration of the Federal Bureau of Investigation (FBI) and the Bureau of Alcohol, Tobacco, and Firearms (ATF). The evolving NIBIN system permits the capture, storage, and searching of images of shell casings and bullets associated with *criminal* activities. The success of criminal ballistic imaging databases has prompted interest among states to implement *reference* systems.

There are many issues associated with the establishment of a statewide ballistics reference database. Some of the most frequently and urgently asked questions involve the mechanics and logistics of such an effort. This paper addresses such issues and serves as a roadmap and technical resource for any state considering the establishment of a ballistics reference database. In providing this service to the national criminal justice community, the CCJT is fulfilling its mission and carrying out its responsibilities.

Under Cooperative Agreement 2001-LT-BX-K002, from the Office of Justice Programs, National Institute of Justice, Department of Justice, the CCJT was tasked to develop a computer-based impact analysis model and handbook that would help state legislators and law enforcement officials establish and operate reference ballistic imaging databases (RBIDs; also referred to by the ATF as State Legislative Databases) that meet national standards. This task was broken down into four primary activities: planning and research, model development, handbook development, and model and handbook validation and refinement.

To date, Maryland and New York are the only states that have implemented RBID programs. These programs were mandated by state legislatures and were required to be operational within a very short period of time, which left little time for planning and implementation by the law enforcement officials responsible for program operation and management. The general concept behind an RBID is that test-fired shell casings and projectiles are provided to the state police at the time of sale for all new or refurbished guns of state-specified models. Once the exemplars are imaged and archived, the images will be stored in an image database, along with such information as serial number, gun model, and vendor. This approach identifies the gun itself rather than the purchaser of the gun. At the same time, depending upon state law, a record containing the serial number of the firearm and information describing the purchaser of the gun will be created and kept either by the state or by the gun-shop owner. The limitations imposed on the collection and use of gun-sales data are determined by state and federal laws.

Mitretek worked with the Maryland State Police Crime Laboratory and the New York State Police Forensic Investigation Center to learn from their experiences of implementing RBIDs. Based on the information gathered, Mitretek developed a computer-based model that will help other states plan, cost, legislate, and implement ballistic imaging systems. The planning model reflects fundamental RBID program elements: types of gun-sales transactions, types of test-fired samples to be imaged, imaging operations and system configuration, test-fire operations, and community relations. Additional program considerations beyond the scope of the model include the distribution and location of gun dealers in the state, optimal means for storing—and later retrieving—test-fired samples, identification of the entity responsible for performing the test firing of weapons (state police or contractor), and determining the specific types and calibers of weapons to be included in the database. The planning model, developed in Microsoft Excel 2000, can be tailored to meet state-specific needs. Not only is the model useful for estimating system cost, it is also a useful tool to ensure that key elements of program implementation are not inadvertently overlooked.

This document contains a high-level overview of ballistic imaging technology, as well as a detailed description of the planning model. A substantial list of references, with Internet links where applicable, is also provided. The electronic version of the planning model, which is a Microsoft Excel-based application, is provided as a separate file.

ACKNOWLEDGMENTS

There are a number of individuals who were critical to the success of this project.

The authors would like to thank Dr. Louis Portis, Director of the Maryland State Police Crime Laboratory, Joseph Kopera, and their team, along with Technical Lieutenant Mark Heller, Director of the New York State Police Forensic Investigation Center Combined Ballistic Identification System (CoBIS) and his team. They shared their experiences and lessons learned in implementing their states' reference ballistic imaging systems and also critiqued the planning model developed under this project.

In addition, the authors would like to thank Lesa Saville, Manager, Firearms Division, California Department of Justice, for sharing the California feasibility study and discussing its implications.

Input and insight from William Casey, Deputy Superintendent, Boston Police Department, is very much appreciated.

Thanks are also extended to Patricia Galupo, Director, Bureau of Alcohol, Tobacco and Firearms National Integrated Ballistic Information Network (NIBIN), Jeff Stirling, and Bill Kullman for discussing the facets of the NIBIN program and clarifying the distinctions between the NIBIN and Reference Ballistic Imaging Database programs.

The authors also appreciate the background information and technical description of the Integrated Ballistic Identification System provided by Pete Gagliardi, Vice President of Operations at Forensic Technology, Inc.

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Note: Supported under Award number2001-LT-BX-K002 from the Office of Justice Programs, National Institute of Justice, Department of Justice. Points of view in this document are those of the author(s) and do not necessarily represent the official position of the U.S. Department of Justice.

SECTION 1
INTRODUCTION

1.1 BACKGROUND

The use of ‘ballistic fingerprints’—ballistic identification—to identify weapons used in crimes has proven to be very effective in prosecuting violent crimes across the country. More widespread implementation of this technology at the state and local levels—and national interoperability of this capability—will prove even more effective.

Ballistic imaging technology was first employed by law enforcement in the early 1990s.[1] Throughout the 1990s, two somewhat similar—but not interoperable—ballistic imaging systems evolved: the Bureau of Alcohol, Tobacco, and Firearms (ATF) Integrated Ballistics Identification System (IBIS®) and the Federal Bureau of Investigation (FBI) Drugfire system. In May 1997, the FBI and ATF agreed to form the National Integrated Ballistic Information Network (NIBIN) Board to develop a unified approach for a national ballistic imaging system. The NIBIN Board consisted of a senior member from both the FBI and the ATF, as well as a senior representative of another branch of law enforcement (Boston Police Department).

At that time, the two systems combined had more than 225 ballistic imaging sites with more than 800,000 ballistic images. These systems capture, store, and search microscopic images of spent shell casings and projectiles recovered at crime scenes. Matching a new image with an image in the database enables law enforcement officials to relate multiple crime events to the same firearm.

In December 1999, the NIBIN Board decided to merge the ATF’s and FBI’s ballistic imaging technology programs and to standardize on a single imaging approach. The FBI’s Drugfire imaging system would be phased out in favor of the ATF’s IBIS®, and a data communications infrastructure would be established based upon the FBI’s Criminal Justice Information Services (CJIS) wide area network (WAN). The IBIS® vendor, Forensic Technology, Inc. (FTI), was asked to implement some desirable features of the Drugfire system that were not present in the original IBIS® product. The FBI and ATF program offices are currently developing the infrastructure necessary to support NIBIN. The ATF is currently in the midst of a 24-month schedule for unified system deployment, with installation priorities based on factors such as the size of the population served; firearms-related crime rate; number of firearm recoveries; and age, condition, and usage of existing systems. The availability of an appropriate communications infrastructure is also a consideration.

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[1] See references [2] and [22].

As a result of the successes achieved with both the FBI's Drugfire system and the ATF's IBIS®, many states either have passed or introduced or are considering legislation to create and support a state *reference ballistic imaging database* (RBID).[2] To date, Maryland and New York are the only two states that have legislated and implemented such systems. RBIDs contain images of a test-fired sample shell casing and sometimes a projectile for each gun of a specified model (typically handguns) sold in a given state. Crime-related image databases of spent shell casings and projectiles recovered from crime scenes are generally kept separate and distinct from gun-sales image data.[3] However, gun-sales–related image data can be useful in identifying a *legally purchased* gun that is used in a crime by matching the crime-related shell casing or bullet with the corresponding stored reference images and archived physical reference samples of an RBID. Law enforcement officials can then use the gun's serial number to cross-reference and identify the original owner of the gun as part of the overall crime investigation. Assuming that state RBIDs employ the IBIS® data format, these databases should be readily searchable with crime-scene data collected by NIBIN. Furthermore, if the RBIDs comply with the IBIS® format, it should permit one state to search another state's database with no data conversion required.

As Maryland and New York have discovered, while the concept of implementing an RBID appears highly beneficial and reasonably straightforward, there are a variety of legal and public-perception hurdles, as well as cost and operational details, that require thorough planning and analysis prior to the crafting of state legislation.[4] Knowledge of these issues and their impacts are critical to appropriate budgeting, scheduling, and planning. Such factors as the geographic distribution of population and gun sales in the particular state, the distribution of guns sold by type, the types of guns to be imaged, and whether shell casings, projectiles, or both will be imaged will determine ballistic identification workload, the optimum system architecture, and the acquisition costs. These factors, in turn, will dictate the number of operations support personnel required and the specific skills needed, as well as the recurring operations and maintenance costs. Trends in gun sales should be analyzed and projected to ensure that the ballistic imaging system acquired and support infrastructure established can be

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[2] The ATF refers to an RBID as a state legislative database; sometimes an RBID is also termed a gun-sales image database.

[3] A state may integrate or electronically connect its criminal image database with its reference image database. However, the U.S. Congress prohibits any federal access to state-maintained gun registration information. Therefore, included in the NIBIN Memorandum of Understanding, which must be executed by all NIBIN participants, is an agreement that NIBIN participants will not electronically connect their reference and NIBIN criminal image systems. See reference [24].

[4] Maryland, the first state to implement an RBID, signed legislation on April 11, 2000, requiring an operational RBID by October 1, 2000. New York State passed legislation on August 9, 2000, requiring an operational RBID on March 1, 2001. Currently, Maryland and New York are the only states operating an RBID.

scaled appropriately to meet anticipated needs. Identifying the anticipated impacts of planned legislation in advance can provide legislators the necessary insight to tailor the legislation and to ensure that the state officials can comply with the legislation once it is passed.

Given the above considerations, the Center for Criminal Justice Technology (CCJT) at Mitretek Systems,[5] serving in the public interest, developed an interactive model and associated handbook that could be used by state law enforcement officials and legislators to plan, legislate, implement, and operate an RBID that conforms to national standards.[6] This model is intended to help guide budgeting and planning activities and addresses the primary general processes of test-fire specimen collection, imaging, correlation, and storage. Easily overlooked but critical ancillary functions, such as public relations, are noted, and the model's user may enter estimated costs associated with such functions. By integrating the lessons learned by the states of Maryland and New York in implementing their RBIDs, as well as some of the information gained in the 2001 California feasibility study,[7] other states will be able to minimize system cost and time for implementation and maximize overall effectiveness and operational efficiency based on their specific needs and circumstances.

1.2 OBJECTIVE AND SCOPE

This document has the following three primary objectives:

- Provide a high-level appreciation for the usefulness of and technology associated with computer-assisted ballistic image capture and analysis
- Provide a detailed description of the use and content of the CCJT Ballistic Imaging Model
- Highlight—but not attempt to answer—outstanding issues that may contribute to the improved impact that ballistic imaging technology has on fighting crime

1.3 ORGANIZATION

Section 1 of this document provides project background information and describes the objective and contents of this document. Section 2 provides an overview of imaging technology with respect to firearm markings and correlation of images. Section 3 summarizes the nature of NIBIN and describes how the federal, state, and local law enforcement

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[5] This project was conducted under a cooperative agreement 2001-LT-BX-K002, from the Office of Justice Programs, National Institute of Justice, Department of Justice.

[6] While there is no formal national standard for computer-assisted ballistic imaging, the *de facto* standard is compatibility with NIBIN.

[7] Tulleners, Frederick, *Technical Evaluation: Feasibility of a Ballistics Imaging Database for All New Handgun Sales*, Sacramento and Santa Rosa Criminalistics Lab, Bureau of Forensic Services, California Department of Justice, Sacramento, CA, October 5, 2001.

communities employ ballistic imaging to process crime-scene evidence. Section 4 describes the nature of an RBID and compares and contrasts it with a criminal ballistic imaging database. Section 5 describes the planning model developed to assist states with RBID budgeting and planning. The capabilities and limitations of the model are described, along with the various internal components and their specific effects on the acquisition cost, operational cost, and overall design and operation of an RBID system. Section 6 notes a variety of issues and observations that impact the performance and effectiveness of ballistic imaging technology. Section 7 summarizes the results of this project. An annotated bibliography, with hot links to references that are available on the Internet, is provided to assist with additional research. Appendix A contains a detailed description of the model worksheets. Appendix B presents sample data entry worksheets from the planning model, and Appendix C is a brief user's guide to the RBID Planning Model.

SECTION 2

AN OVERVIEW OF BALLISTIC IMAGING TECHNOLOGY

The general principle behind ballistic imaging technology is that each firearm imparts markings—unique to that firearm—on the shell casing and projectile of expended ammunition. This project did not address any of the technical aspects of ballistic imaging; however, several sample technical papers have been included in the list of references to provide an appreciation for the types of image processing and search algorithms that are used and intrinsic to ballistic imaging technology.[8] The techniques employed in the IBIS® system are proprietary to FTI, the system's manufacturer. Figure 2-1 illustrates the construction of a "bullet" from a shell casing, projectile, primer, and gunpowder.

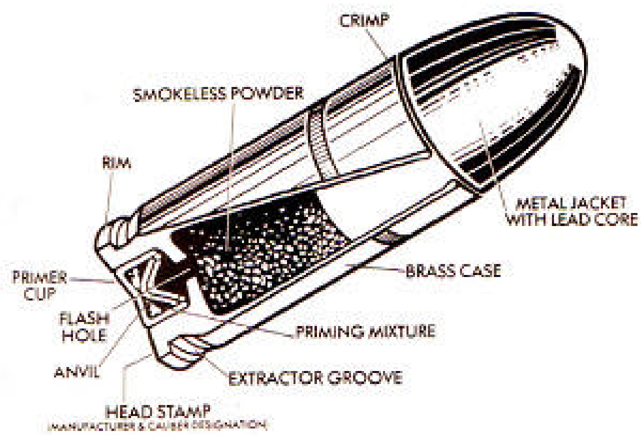

Figure 2-1. Anatomy of a Bullet [Ref 9]

The following are the primary markings unique to a given firearm that are imparted to ammunition:

- **Land and groove markings around the circumference of a projectile**

  Some markings are incidental to the machining of the interior of the barrel, while other markings—such as grooves intended to impart rotation to the projectile when in flight—are intentional (Figures 2-2 and 2-3). Figure 2-4 compares projectile markings from a recovered projectile with the corresponding reference (test-fired) sample.

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8 See references [55]–[60].

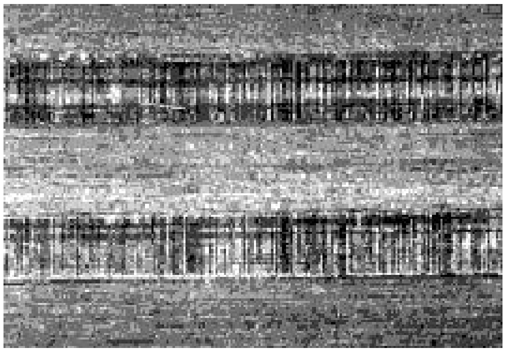

Figure 2-2. Illustration of Gun Barrel (Internal) Rifling Showing Lands and Grooves [Ref 19]

Figure 2-3. Deformed Projectile After Firing [Ref 19]

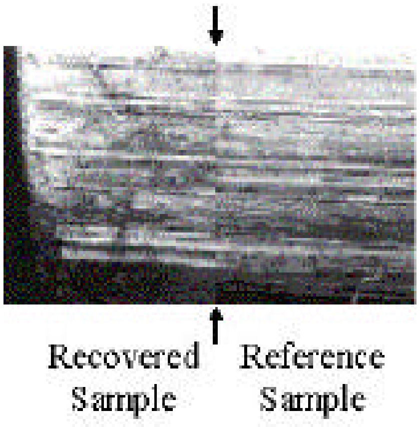

Figure 2-4. Comparison of Projectile Markings—Image of Recovered Projectile Versus Reference Image [Ref 19]

- **Firing pin impression on the primer face of a shell casing**

  The two primary types of firing pins are center firing pins (Figure 2-5) and rim firing pins (Figure 2-6). Figure 2-7 compares center-firing-pin impressions from a recovered shell casing and a reference (test-fired) shell casing.

- **Breech face markings on the primer face of a shell casing**

  When a firing pin strikes the primer, resulting in an explosion inside the shell casing, the projectile is propelled forward out of the barrel of the gun, and the shell casing is propelled rearward towards the breech of the gun. Marks incidental to the machining of the breech are imparted to the primer end of the shell casing (Figure 2-5). Figure 2-8 compares breech-face impressions from a recovered shell casing and a reference (test-fired) sample.

- **Extractor/ejector markings on the primer end of a shell casing**

  In the case of a revolver, when a round of ammunition has been fired, the bullet is propelled out of the gun barrel and the empty shell casing remains within the gun barrel until removed by the gun user. With semi-automatic or automatic weapons, the shell casing is automatically ejected from the gun. The mechanism that extracts the shell casing imparts markings to the shell casing, as illustrated in Figure 2-9.

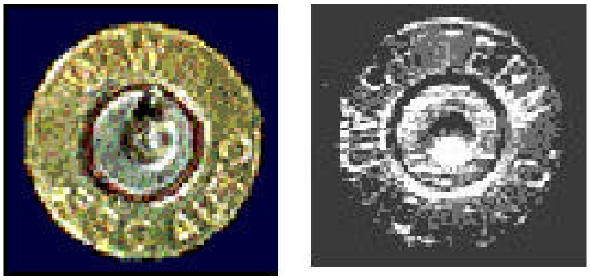

Figure 2-5. Center Firing Pin and Breech Face Impressions [Ref 19]

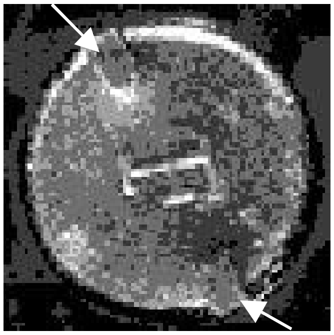

Figure 2-6. Rim Firing Pin Impression [Ref 19]

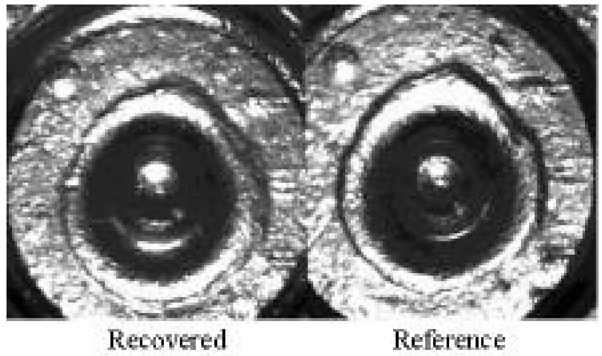

Figure 2-7. Comparison of Firing Pin Impressions—Image of Recovered Shell Casing Versus Reference Image [Ref 10]

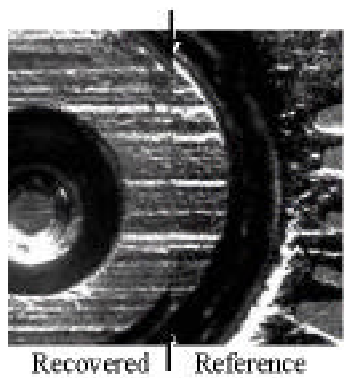

Figure 2-8. Comparison of Breech Face Impressions—Image of Recovered Shell Casing Versus Reference Image [Ref 10]

Figure 2-9. Ejector/Extractor Markings on a Shell Casing [Ref 19]

There are a number of issues associated with the precept that each firearm imparts to the shell casing and projectile of expended ammunition markings that are *unique* to that firearm, which must be recognized and appreciated by users of ballistic imaging technology. In certain circumstances, some issues will limit the usefulness of ballistic imaging technology.

- With use, the components of a firearm that generate the markings noted above will undergo wear and tear. If the firearm has experienced significant use, the markings imparted to expended ammunition will change over time ("age").
- In a similar fashion, if a firearm has been repaired with replacement parts, such as a new firing pin, characteristic markings imparted to the ammunition will change.
- A determined individual may intentionally alter the characteristic markings of a firearm, for example, by filing new markings into key components.
- With some firearms, it has been found that different brands of ammunition fired from the same firearm will be imparted with different characteristic markings.[9] Therefore, if one manufacturer's ammunition is used to create a test-fire sample and a different manufacturer's ammunition is used in the commission of a crime, a comparison of the reference sample with the crime-scene evidence will not result in a match.
- It should also be noted that ballistic images captured and processed on one vendor's system will not be comparable with images captured and processed on another vendor's system unless standard image capture techniques and processing algorithms are used. This behavior is illustrated by the incompatibility of the Drugfire and IBIS® systems. It should also be noted that even when a single vendor's ballistic imaging system is used, if common operational practices—such as standardized illumination techniques—are not used, images of shell casings fired by the same firearm may not correlate (match) with one another.

[9] See reference [32], page 1-2.

SECTION 3

CRIME-RELATED BALLISTIC IMAGING: NATIONAL INTEGRATED BALLISTICS INFORMATION NETWORK

3.1 NIBIN OVERVIEW AND MISSION

As noted in Section 1.1, in May 1997, the FBI and the ATF joined forces to form the National Integrated Ballistic Information Network, under the guidance of the NIBIN Board, to operate a unified national ballistic imaging system.[10] On December 2, 1999, following extensive study, the NIBIN Board announced its decision to phase out, incrementally, use of the FBI's Drugfire system and to support distribution and use of a functionally upgraded version of the ATF IBIS®. Each IBIS® would be interconnected over a telecommunications network to a national ballistic image database. The overall integrated network would be referred to as NIBIN. ATF would be responsible for crime gun operations, such as hardware, software, training, security, maintenance, and database maintenance. The FBI would be responsible for establishing a secure, high-speed nationwide communications network, as well as the development and deployment of ancillary databases to support firearms examiners.

It must be emphasized that NIBIN's use is restricted to the processing of crime-related data. Since Fiscal Year 1979, a rider to the ATF's annual appropriations has prohibited the expenditure of funds for "consolidating or centralizing, within the Department of the Treasury, the records or any portion thereof of acquisition and disposition of firearms maintained by Federal Firearms Licensees." The General Accounting Office's review of this rider has concluded that such information consolidation is permissible only if it is incident to carrying out a specific ATF responsibility. Consolidating information pertaining to firearms transactions goes beyond ATF's responsibility as stated in the Gun Control Act. As a result, no part of NIBIN may be physically or logically connected to any gun registration information, even if such a connection will not be exploited to consolidate registration information.

When announcing the NIBIN Board's decision, John Magaw, ATF Director said

> *"Computer ballistic imaging technology is the most important forensic advancement since the development of the comparison microscope over 70 years ago. The combining of these two technologies will help ensure that when a firearm is used in any crime, law enforcement will have the best information available to be able to quickly identify it, trace it, and pursue the criminal who used it."*[11]

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[10] See references [22]–[25].

[11] See http://www.atf.treas.gov/press/fy00press/121499ballistics.htm

FBI Director Louis Freeh noted

> *"This joint effort is a key component in ongoing programs aimed at permanently reducing gun crime and increasing everyone's safety nationwide. Cooperative programs like these are law enforcement's most effective tool against crime."*[12]

Because the data formats used in Drugfire and IBIS® are incompatible, Drugfire data cannot be transferred electronically into IBIS®. As a result, physical samples processed by Drugfire that are of interest for inclusion in IBIS® would need to be re-imaged on IBIS®.

3.1.1 Relation of NIBIN to State and Local Criminal Ballistic Imaging Systems

Various state and local jurisdictions have implemented ballistic imaging technology with an associated database of ballistic images of *crime-scene evidence*. As these jurisdictions receive NIBIN equipment and connectivity, the state and local systems *may* be connected to NIBIN so that the ballistic evidence can be imaged once and searched against both the state and national criminal databases. However, if a state with an existing criminal ballistic imaging system implements an RBID, the state criminal system cannot be connected to the RBID if the criminal system is connected to NIBIN. As in the case of the state of Maryland, the state criminal system is connected to the RBID. Crime-scene ballistic images can be captured once and searched against both the criminal database and the RBID. However, to search the criminal evidence against the NIBIN, the evidence must be imaged again, this time on the NIBIN system. At the present time, no means has been implemented whereby images produced on one IBIS® can be exported via a removable data storage medium and read into another IBIS®, which would eliminate the need for redundant imaging.

3.2 OPERATIONAL OVERVIEW

Once completed, current plans call for NIBIN equipment to be installed in 233 sites distributed across every state in the United States. Approximately 171 sites in 40 states have already been installed. Ballistic images will be stored in regional, server-based databases. Depending upon workload, each NIBIN site will have one or more Data Acquisition Station (DAS) Remote systems. As shown in Figure 3-1, each DAS includes a computer workstation, a camera, and a microscope. The DAS permits both data acquisition (imaging of shell casing and bullet markings) and results evaluation (comparing the reference images returned from the regional correlation server). Initially, the DAS was deployed in conjunction with a Signature Analysis Station (SAS), a local correlation server, and a database integrated into a local hub configuration (see Figure 3-2). The SAS is employed strictly for comparing evidence and reference images.

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[12] Ibid.

As IBIS® systems were put into operation, it was determined that a more efficient architecture would employ a regional correlation server and database accessed by DAS, MatchPoint, and Rapid Brass Identifier (RBI) workstations. Depending upon the workload and the nature of a given site's operation, MatchPoint workstations (see Figure 3-3) may be employed to perform image analysis from the convenience of a firearms examiner's desk. RBI workstations (see Figure-3-4) may be employed to capture image data in the field at a crime scene and communicate the data to a central IBIS® location for processing and comparison. RBIs may also be used by jurisdictions that do not have their own firearms examiners. The general concept of operation is that searches will first be launched against the correlation server servicing the geographically closest jurisdictions; subsequent searches, if necessary, would be conducted on servers that service more geographically distant jurisdictions. This makes sense not only from the standpoint of system efficiency, but also from a law enforcement standpoint, since statistics have shown that related criminal events tend to be geographically localized.

3.3 NIBIN PARTICIPATION REQUIREMENTS

To become a NIBIN participant, the partnering law enforcement agency must sign a Memorandum of Understanding (MOU) with ATF.[13] This MOU requires that the partnering agency be responsible for all operational, evaluation, and facility aspects associated with their participation in NIBIN. ATF will furnish all NIBIN hardware, initial user training, and evolutionary upgrades. Furthermore, ATF maintains ownership of the NIBIN hardware and the information stored in the database.

Figure 3-1. IBIS® Data Acquisition Station (DAS) Remote Workstation

[13] See reference [24].

Figure 3-2. IBIS® Hub Configuration (SAS on Left, DAS on Right)

Figure 3-3. MatchPoint Workstation

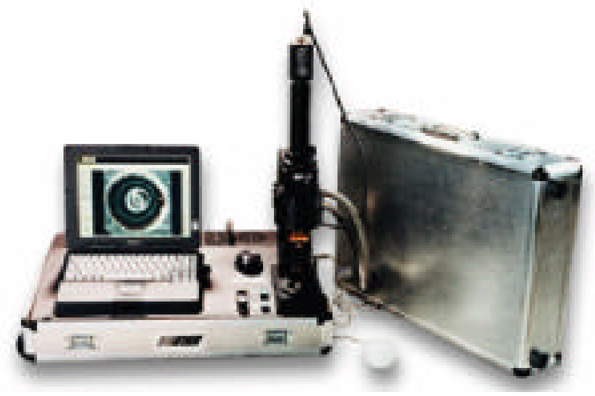

Figure 3-4. RBI System

SECTION 4
REFERENCE BALLISTIC IMAGING DATABASE

In this section, a description of an RBID is provided, followed by Maryland and New York RBID operations.

4.1 OVERVIEW

An RBID is sometimes referred to as either a state legislative database or a gun-sales ballistic database. As noted in Section 1, the success of criminal ballistic imaging databases has prompted states to implement RBIDs. The general concept behind the RBID is that a test-fired shell casing or projectile is provided to the state police at the time of gun sale for all new or refurbished guns of state-specified models. The exemplar will then be imaged and stored in an image database, along with such information as serial number, gun model, and vendor; this information identifies the gun and not the purchaser of the gun. At the same time, depending upon state law, a record containing the serial number of the firearm along with information describing the purchaser of the gun will be created and kept either by the state or by the gun-shop owner. The limitations imposed on the collection and use of gun-sales data are determined by state and federal laws.

Shell casings or bullets that are recovered from crime scenes may be imaged and searched against the RBID. A “hit” will identify the serial number and type of firearm that fired the ammunition recovered at the crime scene. This information, in turn, can be used in conjunction with the state’s permit or registration database to determine the original legal owner of the firearm. Law enforcement authorities will then use this information as a lead to help determine the perpetrator(s) of the crime being investigated. Effectively, this approach permits the conduct of a gun trace without having recovered a firearm.

In the case of a gun that has been recovered from a crime scene and whose serial number has been obliterated, law enforcement officials can test-fire the gun, image the shell casing and/or projectile, and then search the RBID to determine such information as the gun make, model, serial number, and vendor. This information can then be used in conjunction with the state’s permit or registration database to determine the original legal owner of the firearm. Law enforcement authorities will then use this information as a lead to help determine the perpetrator(s) of the crime being investigated.

While images of both shell casings and projectiles may be captured, stored in a database, and later searched, for the most part, RBIDs employ images of shell casings only. The general feeling is that the cost benefit of imaging and searching projectiles is not as compelling as that for the imaging of shell casings. Two primary reasons for the exclusion of bullet images are presented below:

- Gun manufacturers are typically tasked with the responsibility of providing test-fired samples with each gun of a specified type that is manufactured and sold in a particular state. (State police may elect to provide this service either during an initial transition period or over a longer period of time. Beyond an initial transition period, it is likely that a fee would be charged for this service.)

  The process of obtaining a test-fired shell casing and associating it with its generating firearm is a rather straightforward process that requires well-organized processing and record keeping. However, the process of retrieving a test-fired projectile that has not been otherwise damaged from striking an object is a much more laborious and time-consuming process and is quite disruptive to a manufacturer's production line. It is less likely that a projectile that has been recovered from a crime scene will be recovered intact and suitable for imaging and comparison with a reference image.

- The process of imaging a projectile generally takes more than twice as long as it takes to image a shell casing.

Two other factors worthy of note are the size and age of the RBID. The smaller the database size, the less likely that a gun used in a crime will have a corresponding image in the database. On the other hand, the larger the database size or the greater the amount of data against which an image sample needs to be searched, the greater the likelihood that system *reliability*[14] will be degraded; a larger database may miss a true mate or generate false candidates that must then be manually inspected by a trained firearms inspector. This behavior is identical to the inversely proportional relationship between False Accept Rate and False Reject Rate experienced in systems such as Automated Fingerprint Identification Systems. Furthermore, the *newer* the database, the less likely ballistic evidence recovered from a crime scene will have a mate in the RBID. It is more likely that a gun will be used in a crime after more time has passed since the time of purchase. This may be due to the fact that the longer a gun has been in circulation, the greater the chance it will have been stolen and subsequently used in a crime.

Figure 4-1 depicts the general RBID process flow.

[14] System *reliability* is defined as the probability that an image's true mate will be identified when the mate in fact exists in the image database.

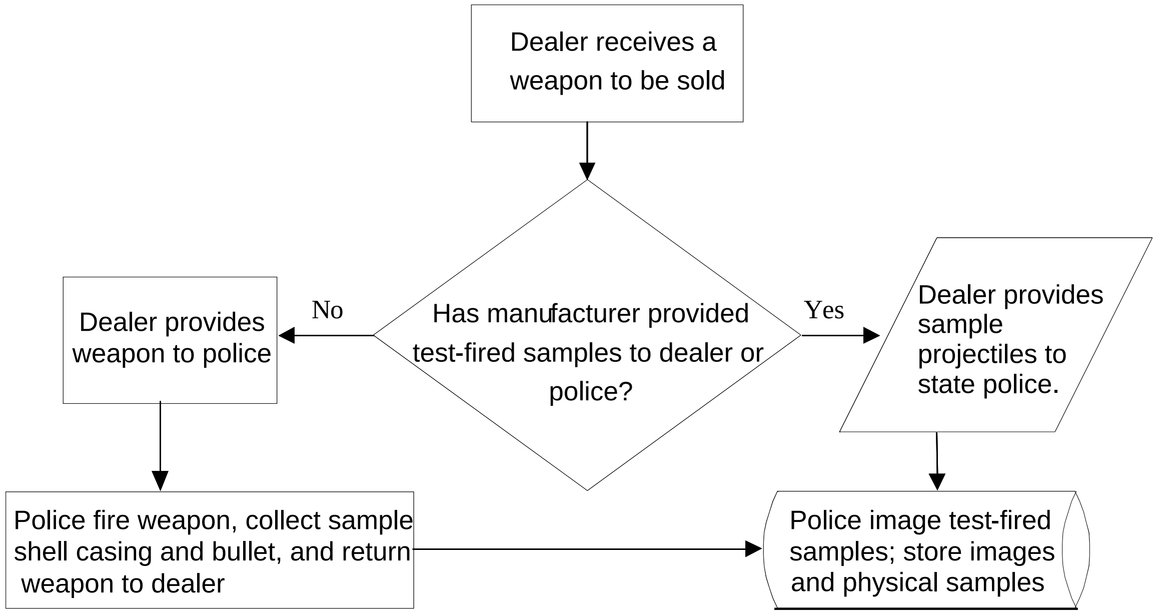

Figure 4-1. Reference Ballistic Imaging Generalized Process Flow

4.2 STATE OPERATIONS

Mitretek initially met with Maryland State Police Crime Laboratory in August 2001 and spoke at length by telephone with New York State Police Forensic Investigation Center in September 2001 to gain understanding of each state's RBID operations. These operations are described below.

4.2.1 Maryland

Once NIBIN is fully operational, there will be three databases: NIBIN, RBID gun sales, and a state-owned criminal database. NIBIN is expected to be operational in late fall or early winter of 2001/2002. Test-fired ammunition samples from recovered firearms, and bullets and shell casings recovered from crime scenes are imaged and recorded in the criminal database. However, only shell casing images are recorded in the RBID. The rationale is that shell casings are recovered from crime scenes more often than bullets (except in the case of revolvers, where the shell casings remain in the ammunition chamber), and bullets that are recovered are usually too damaged to be of practical use. In addition, it is difficult for gun manufacturers to produce undamaged test-fired bullet samples without disrupting their production lines.

Maryland offered suggestions for other states interested in implementing an RBID. Advanced planning for personnel and space is very important. Careful planning for a state program to test-fire firearms is essential. Such a program will be critical to a successful

RBID until there is broader industry compliance with the requirement for manufacturers to provide test-fired samples

Operations

Maryland law does not require ballistic imaging of a transferred weapon unless the weapon has been refurbished. Weapons must be transferred through a licensed dealer.

Sample imaging is performed at the Maryland State Police Crime Laboratory. The operation is one full-time shift per day. A second shift is not necessary.

The Maryland Crime Laboratory has a test-fire program to collect shell casing and bullet samples when the manufacturer does not supply these samples. The test-fire program uses retired state police officers who travel to gun dealers and test-fire new weapons, collect the samples, and return the samples to the crime laboratory for imaging. The officers use a portable bullet trap. A fee of $20 per weapon is charged to the dealer.

There are no designated community liaisons.

Funding

The Maryland State Police Crime Laboratory used its own budget to get the program started, then it was reimbursed by the state. The total program startup cost was about $1.8M. This cost includes equipment, personnel, and an FTI representative on site for one year. The FTI representative was provided in exchange for *sanitized* Maryland data.

The Maryland State Police Crime Laboratory's information technology group contracted FTI to start in July 2000. The system, with some bugs, was operational October 2000.

Personnel

Initially, there were going to be five lab technicians over the course of two shifts per day, with three technicians on Shift 1 and two technicians on Shift 2. Currently, there are only two lab technicians on Shift 1 and none on Shift 2. A third individual logs tracking information pertaining to the test-fired samples.

There is an FTI employee on site for one year as part of the IBIS® purchase agreement. The FTI employee troubleshoots and provides training. It was noted that the first FTI on-site representative had not been trained to provide customer training.

The six retired police officers that test-fire weapons at the dealers will be employed beyond the initially planned six months. Maryland believes that most gun manufacturers will eventually comply with the requirement to provide test-fired samples.

The Maryland system was sized for a five-year time period.

Training

Technicians are trained by FTI for a couple of weeks. Training lasts five to seven days. Two weeks later there is a follow-up to make sure the lab technician is using IBIS® properly. There is no certification for IBIS® operators.

Performance

The current estimate for number of shell casings to be imaged is approximately 30,000 per year, which amounts to about 168 per day. Approximately 3,000 casings have been entered since October 2000. Firing-pin and breech-face images are captured for RBID entries.

The time to process shell casings is 5 minutes to 12 minutes per shell casing; use 12 minutes as an estimate. Currently, the two technicians process 75 to 100 specimens per day. In general, 40 shell-casing images per person, per 8-hour day at 12 minutes per casing is the rule of thumb.

Equipment and Costs

A software package by QueTel—the same software used for criminal logs—is used to log casing information from the dealer/manufacturer. The application information supplied by the dealer is logged. The software has not been modified for RBID purposes.

The system configuration is stand-alone. Three DAS units and one SAS unit were purchased. Two of the DAS units are being used for the RBID. The third unit is being used for the state-owned criminal database on a server separate from the RBID server. The cost was about $1.2M. Equipment maintenance is about $135,000 per year. It should be noted that Maryland has a confidentiality agreement with FTI and is not able to release line item costs.

Originally, the crime lab's RBI from FTI could not transmit images properly. Each RBI costs $35,000 and is used to collect breech-face and firing-pin images. The unit was returned to FTI's factory in Canada for testing and software configuration. The RBI has since been returned to Maryland, and it is believed that the problem has been resolved.

Shell casings—which can only be stored in paper due to decomposition issues of other materials such as plastic—are stored in coin envelopes. These envelopes are stored in file cabinets. For tracking purposes, the serial number is manually inscribed on the shell casing. A barcode sticker is placed on the envelope. Approximately 2,000 envelopes with shell casings may be stored in one file cabinet. Each file cabinet costs $800.

According to the FTI representative at the Maryland Crime Lab, FTI recommends the following equipment be available to support an RBID: DAS, MatchPoint, SGI® correlation server, Oracle Client Database Software, Crystal Reports, uninterruptible power supply (UPS), printer, Microsoft Windows® NT operating system, modem, and Ethernet line for backup. The customization period for Maryland was October 2000 through April 2001, which is probably longer than most. There are seven Crystal Report reports generated, including graphic printouts.

Facility Modifications Due to IBIS®

Maryland Crime Lab DNA operations were moved to another part of the building. The IBIS® equipment now occupies the old DNA lab. The lab was painted, dedicated phone lines were installed, and an ISDN direct line to the FTI Canadian site was installed for maintenance purposes**.**

4.2.2 New York

New York State has a Pistol Permit System that—as of March 1, 2001—tracks the number and type of weapons sold and whether or not a shell-casing sample exists. The Pistol Permit System may retrieve data from the Combined Ballistic Identification System (CoBIS), but not vice versa. The Pistol Permit System is not new, but shell-casing sample data was not previously available, and gun purchases were not identified as new or transfer.

Operations

The *DNA for Guns* program is contained in six strategically located CoBIS Centers throughout the state. The centers are located at the New York State Police Forensic Investigation Center (program headquarters) and five Troop headquarters. Centers were previously equipped with E-Mark high-tech water tanks and an indoor range. The centers also connect to program headquarters for access to the Laboratory Information Management System (LIMS).

DNA for Guns applies only to guns sold at retail within New York State.

Imaging is performed only at the Forensic Investigation Center.

The operation is one full-time shift per day. A second shift is not necessary.

The remaining five Troop headquarters are physical sample collection points only. Dealers receiving guns without shell-casing samples from the manufacturers take the weapons to any CoBIS Center; there, a police officer fires the gun into a water tank and collects the sample. Information about the gun and the shell casings (make, model, caliber) are entered into CoBIS. Samples are forwarded from the five Troop headquarters to the Forensic Investigation Center approximately monthly. A 75-mile maximum radius is the primary criterion for locating centers. The Forensic Investigation Center and five Troop headquarters—strategically located to be accessible to the community—satisfy this criterion. Individual dealers, not wholesalers, bring the guns in for firing. There is no fee, but the dealers must supply the ammunition as defined in the CoBIS rules. Turnaround time is minimal.

Funding

The program is operated with state funding.

Personnel

There are currently three Senior Lab Technicians, a CoBIS Sergeant, and one FTI representative at the Forensic Investigation Center. Each Senior Lab Technician was trained for approximately one week. Senior Lab Technicians may operate equipment, but they are not allowed to perform analyses. The FTI representative will be replaced with a New York State Police Senior Lab Technician at the end of the initial one-year period.

One member and one evidence clerk at each CoBIS center staff the test-fire operations. These personnel also serve as liaisons between the gun dealers and the CoBIS centers. CoBIS personnel will visit each dealer in the state to explain the DNA for Guns program and requirements.

Training

The FTI representative will be there for one year to train staff and perform imaging.

Performance

From March 1, 2001, when the program began, through September 14, 2001, there have been 6,984 guns imaged into the database. Of that total, 1,327 entries were based on samples collected at CoBIS Centers. The remaining 5,657 entries were based on samples provided by the manufacturers (via the dealers). These numbers were taken from the Pistol Permit System Data. The New York State Police speculate that some dealers stockpiled guns prior to the DNA-for-Guns law taking effect. Therefore, the actual number of guns to be imaged is not available, and the number of entries may not be reflective of future trends.

Equipment and Costs

The IBIS® equipment for this program is stand-alone. The configuration is a correlation server and four additional DAS. The system was designed to last 15 years.

The New York purchase order for IBIS® equipment was obtained. Equipment unit costs itemized on the purchase order were as follows:

- Correlation server = $1,237,775 (this correlation server is a high-end server; a less powerful server is available and was purchased for the state criminal database)
- DAS = $250,000 (four units purchased for a total of $1,000,000)
- MatchPoint = $40,000 (four units purchased for a total of $160,000)

Shell-casing samples are retained at the CoBIS centers rather than by the dealers. Samples are stored centrally at the Forensic Investigation Center. The storage facility can be expanded.

When entering data for imaging, the dealer code and the type of information contained on the shipping envelope is entered.

SECTION 5
PLANNING MODEL

5.1 OVERVIEW

The RBID Planning Model in intended as both a planning and an impact analysis tool to help state law enforcement agencies define their processes and estimate the size of the systems required to implement an RBID that meets national standards. This model is also useful for legislators drafting legislation and budgeting for such a program. The model takes a comprehensive, step-by-step approach that provides an overview of the role of an RBID within both the national and state law enforcement environments and offers a comprehensive step-by-step presentation of the details that must be considered when planning and costing such a program.

Fundamental elements of an RBID program are described in Section 5.2. Program elements that are beyond the scope of the model but provide users further insight into the details of an RBID are also described. The planning model is developed in Microsoft Excel 2000. Section 5.3 contains a descriptive summary of the worksheets used in the model. Model verification and validation is addressed in Section 5.4. A detailed description of the planning model and its components is provided in Appendix A. Planning model sample worksheets are provided in Appendix B, and a one-page model user's guide is provided in Appendix C.

5.2 PROGRAM ELEMENTS

5.2.1 Fundamental Program Elements

The model helps the user define program operations and generate costs related to specimen collection, imaging, correlation, and storage. The approach taken provides options to the user based upon fundamental program elements that must be addressed by each state. These fundamental program elements are relevant types of gun-sales transactions, imaging of test-fired samples, imaging operations, test-fire operations, and community relations.

5.2.1.1 Relevant Types of Gun-Sales Transactions

Annual gun-sales volume may be very large. A state may opt to include only a subset of these transactions. These transactions include new sales, refurbished sales, transfers, and state- and local-owned gun purchases. The user must determine the types of transactions to include and the annual volume associated with each type of transaction to be included.

5.2.1.2 Imaging of Test-Fired Samples

There are three options for imaging test-fired samples: shell casings only, bullets only, or shell casings and bullets. The option chosen will drive the imaging performance rate. Database storage requirements will also be affected since more storage space will be required if both shell casings and bullets are stored than if only shell casings or bullets are stored. Likewise, physical storage space will be affected. The model assumes that only one sampling option will be used. Therefore, 100 percent of qualified gun-sales transactions will have shell casings imaged, bullets imaged, or bullets and shell casings imaged.

5.2.1.3 Imaging Operations

Imaging operations may take place at one central site or at multiple sites. For a central operation, all imaging is performed at one site. A distributed operation is one where imaging is performed at multiple, fixed sites. The type of operation determines the feasible system configuration options.

There are three basic system configurations: stand-alone hub, hub network, or remote. A stand-alone hub configuration consists of a correlation server and one or more DAS Local units; there are no remote connections into or out of the system. A hub network consists of a correlation server and a combination of DAS Local(s) and DAS Remote(s); DAS Remote units may be housed at other state-owned locations, and the configuration allows for DAS Remotes owned by another state to connect to the hub. A remote configuration consists only of one or more DAS Remote units; there is no correlation server or a DAS Local. The DAS Remote unit(s) is connected to a hub network owned by another state. This option may be feasible for states with low gun-sales volume and for which the cost of a hub is not justified.

Only one configuration may exist at one time. For example, there cannot be a remote and stand-alone configuration for a single state. A remote configuration implies that a state has one or more DAS Remote units linked to a hub in another state. A stand-alone configuration implies that the state has only DAS Locals and no links to external DAS Remotes.

5.2.1.4 Test-Fire Operations

There are three test-fire operations available to state law enforcement: central, distributed, or mobile operation. At a central operation, test-fires are performed at one test-fire site, using a water tank or firing range. At a distributed operation, test-fires are performed at multiple, fixed sites. Dealers would travel to the sites with weapons to be test-fired or use an approved mailing service to deliver weapons to the test-fire sites. State police personnel would test-fire the weapons and return them to the dealers. A mobile operation is one where state police personnel are dispatched to dealers throughout the state to test-fire weapons, using a portable bullet trap. It is assumed that if imaging operations and test-fire operations are both distributed, these operations will be performed at the same sites.

Test-fire program requirements should decrease with time as more manufacturers become compliant.

5.2.1.5 Community Relations

Public relations may be used to shape the structure of the gun-sales ballistic imaging program, as well as to educate the community about program requirements and benefits. The community includes residents, gun purchasers, dealers, manufacturers, and vendors. Possible benefits include maximizing the manufacturer/dealer compliance rate and minimizing community concerns about privacy.

The model provides the option to include a liaison between the state police and the gun dealers or community in general. There is also the option to include legal counsel to handle any disputes that may arise regarding dealer compliance with the program or disputes regarding buyer-privacy issues. It is assumed that state police do not have jurisdiction over national gun manufacturers. However, state police do have jurisdiction over state dealers.

5.2.2 Other Program Considerations

As noted below, there are a number of other important elements that are beyond the scope of the current model but deserve consideration when developing an RBID program.

5.2.2.1 Number and Distribution of Gun Dealers in the State

This number will affect the number and location of sites for the test-fire program, as well as any community relations efforts. The number of site locations calculated in the model is based only on state square miles and the user-specified maximum distance between sites. The user may alternatively specify the number of locations.

5.2.2.2 Storage of Sample Casings and Bullets

Samples may be stored at the gun dealers, at a central location maintained by state police or another authorized group, or at distributed storage sites maintained by the state police or another authorized group. Other storage options may also be available. Central storage is optimal for logistical reasons and for accountability, availability, and integrity. Central storage, as opposed to distributed storage locations, is assumed in the model.

5.2.2.3 Responsibility for Collecting and Imaging Test-Fired Samples

Collection of test-fired samples by state police is assumed. Costs associated with this operation are calculated in the model. However, a state may wish to contract with an independent group to perform this task. Likewise, a state may wish to contract out its imaging operation, within legal bounds. The current model assumes that state police officials will perform imaging. Cost options associated with state-police–run operations are calculated in the model.

5.2.2.4 Types and Calibers of Weapons to be Imaged

Due to the volume of weapons sold, a phase-in of the types of weapons to be imaged and the types of images to be stored in the database may be practical. Weapons most frequently used in crimes may be the first types of weapons imaged, followed by weapons that are used less frequently.

5.2.2.5 Feasibility Study/Develop Plan

States must have legislation enacted in order to operate a gun-sales ballistic imaging program. States may want to conduct a feasibility study to support the legislation. Subsequent to enacting legislation, a feasibility study would help a state assess costs and define an optimal program design. Conducting a feasibility study and developing a program operations plan may take three to six months.

5.2.2.6 Implementation of RBID Operations

Implementing a stand-alone IBIS® hub takes approximately three months, with the support of FTI, the sole vendor.

5.2.2.7 Cost Benefit of an RBID Program

It is not easy to quantify the Benefits to having a reference ballistic imaging program. Possible measures of benefits and their thresholds have not been defined but may include the additional number of cases closed and the shortened time to close a case, specifically as a result of the program. Additionally, it may take two to three years to build up a database to the point where a positive hit may be made.

5.2.2.8 Beyond the Life Cycle

The model generates costs and equipment for a user-specified life cycle. States must consider program needs beyond the life cycle. It may be necessary to purchase or upgrade additional equipment, operations may need to be modified in terms of staffing and location, or the program may be expanded to accommodate other users.

5.3 MODEL WORKSHEETS: SUMMARY

The model is written in Microsoft Excel 2000 and has many worksheets. A brief description of each sheet is provided below to facilitate the user’s understanding of the model. A sample of each worksheet is provided in Appendix A. Input and output for each sheet is described in detail in Section 5.5.

5.3.1 Worksheet: Map of the Model

The *Map of the Model* sheet contains links to all key components of the model. The sequence in which the user should visit each worksheet in the model is provided. No user input is allowed nor is model output data provided on this sheet.

5.3.2 Worksheet: Read Me First

The *Read Me First* sheet is a summary of information needed to operate the model. Basic gun-sales ballistic imaging operations assumptions are also summarized. No user input is allowed; model output data is not provided on this sheet.

5.3.3 Worksheet: Comments

The *Comments* sheet allows the user to clarify entries, make comments about the model, and make notes about the "what if" scenarios generated to determine an optimal program design. User input is allowed, but no model output data is provided.

5.3.4 Worksheet: Background State Information

In the *Background State Information* sheet, users can create various reference ballistic imaging program "what if" scenarios. These scenarios are defined by gun-sales transactions volume, imaging operations, test-fire operations, community relations, and funding sources. Users are also linked to the *Performance Assumptions* sheet. This sheet requires input from the user.

5.3.4.1 Worksheet: Performance Assumptions

The *Performance Assumptions* sheet is used to calculate imaging rate, test-fire rate, and number of program locations. Each value is calculated separately. Calculations are made based on default times to perform tasks associated with imaging and with test firing. However, the user may opt to use alternative times to perform tasks so that rates consistent with the state's operations may be calculated. The number of program locations are calculated based on a user-specified "maximum distance between program sites" and a generic calculation. As an alternative, the user may opt to specify the number of program locations. This sheet requires input from the user.

5.3.5 Worksheet: Miscellaneous Parameters

General operations data are entered on the *Miscellaneous Parameters* sheet. Default values are provided, but the user may opt to use her/his own values. Entries pertain to expected system life, manufacturer test-fire compliance rate, annual salary increases, annual increase in operating expenses, fees charged for test-fires, and additional cost for setting up or implementing a gun-sales ballistic imaging program. This sheet requires input from the user.

5.3.6 Worksheet: Cost Assumptions

In the *Cost Assumptions* sheet, the user enters equipment unit costs, unit floor-space requirements for personnel, unit floor-space costs, labor categories by type, and unit labor category costs. Labor categories include lab technicians to perform imaging, staff to test-fire weapons, lab technician managers, and personnel to support the gun-sales ballistic imaging program. The user may enter the number of full-time equivalents (FTEs) for support personnel. The number of lab technicians, lab technician managers, and staff to test-fire weapons is calculated by the model and cannot be modified by the user. This sheet requires input from the user.

5.3.7 Worksheet: Results Summary

The *Results Summary* sheet provides a summary of the calculations made in the model, including cost for the initial year and for the life cycle. Costs are for personnel, training, equipment maintenance, floor space (lease), and equipment. Results are shown only for the system configuration preferred by the user. The sheet also provides a review of the gun-sales ballistic imaging operation, as defined by the user on the *Background State Information* sheet, *Performance Assumptions* sheet, and *Miscellaneous Parameters* sheet. Links to the *Results Detail* sheet are provided (see Section 5.3.7.1). Model output data is provided on this sheet, but no user input is allowed.

5.3.7.1 Worksheet: Results Details

The *Results Details* sheet provides initial year FTEs, initial year costs, and life cycle costs for each labor category. The sheet also provides the number of units required for each type of equipment, equipment floor-space requirements, and personnel floor-space requirements. Model output data is provided on this sheet, but no user input is allowed.

5.3.8 Worksheet: Model Calculations

The *Model Calculations* sheet contains all raw calculations for Year 1 through Year 15. Values from the *Background State Information, Performance Assumptions, Cost Assumptions*, and *Miscellaneous Parameters* sheets are reflected in the raw calculations. Results are calculated for each of the three possible system configurations. Equipment footprints and capacity assumptions are found on this sheet. All model calculations are made from and all costs are generated on this sheet, but no user input is allowed. All information provided in the *Results Summary* and *Results Detail* worksheets are taken from this sheet.

5.3.9 Other Worksheets: State Square Miles and Status

The *State Square Miles* is a sheet containing the number of square miles in each state. It is the look-up table used to determine number of program locations when the user enters maximum distance between program sites on the *Performance Assumptions* worksheet.

The *Status* sheet is used to define program options available to the user and to track options selected by the user.

The user should *not* modify the *State Square Miles* and *Status* sheets.

5.4 MODEL VERIFICATION AND VALIDATION

Mitretek worked with staff of the Maryland and New York ballistic imaging programs to verify the accuracy and completeness of the planning model and to identify any additional features that would improve the model’s usefulness. Formal statistical verification and validation was not feasible since there are only two states with operational reference ballistic imaging programs and there is only one system vendor. The approach followed is summarized below:

1. Design the model to reflect viable program options. Provide means to clearly display and easily select available options. (This was achieved by providing users with the option to accept or overwrite default values for quantities that may vary from state to state; these quantities include equipment unit costs, salary, salary rate increase, and gun-sales volume.)
2. Confirm with current RBID states that the model provided all necessary program components and processes.
3. Use vendor specifications where available, particularly for equipment footprints, server capacity, and correlation response times.
4. Verify database-sizing requirements for ballistic images.
5. Verify key equipment quantities and staffing levels at both states. These include imaging equipment, lab technicians, and test-fire personnel.
6. Verify imaging rates and test-fire rates used to determine performance rates.

Items #1 and #2 have been ongoing. Mitretek spoke with the Maryland State Police Crime Laboratory and the New York State Police Forensic Investigation Center in person and by telephone to complete the verification and validation described above. Both Maryland and New York were provided a face-to-face demonstration of the model, and feedback was solicited. New York stated that an inventory system to accurately track and retrieve test-fired samples is complex and should be modeled. This comment was noted, but such a model is beyond the scope of the current effort.

Item #3 was achieved by obtaining imaging equipment footprint data from the FTI website, server footprint and capacity from the SGI® website, and correlation times from the California Department of Justice feasibility study.[15]

For Item #4, database requirements and correlation times for ballistic images were taken from the California feasibility study. The combined firing-pin image, breech-face image, and textual data would be approximately 42.7 KB compressed, assuming a 10-to-1 compression. The time to search a shell casing against a database of 100,000 shell casing images (correlation time) is estimated to be approximately 20 minutes. Correlation times were presented for a Silicon Graphics SGI® Origin 2400 16 co-processor unit. Data was not available for database requirements for bullet images due to lack of response from FTI.

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[15] See reference [32].

Item #5 involved obtaining operations and cost data from Maryland and New York. Operations data was used to generate cost. Model results were compared to actual results available from Maryland and New York. These findings are summarized in Table 5-1.

“Best guess” estimated default values for some variables have been entered by the model developers that may result in differences between model output and actual figures. States may not know the actual values of some input variables. These input variables include performance rate data, floor-space allocation for personnel, turnover rates, annual salary rate increase, and number of FTE support personnel. All of these variables may be adjusted by the user as better estimates become available. Furthermore, it is possible that some of the personnel may be funded under other state programs or fully funded under the RBID program even though allocation to the RBID program may be part-time.

FTI generated cost estimates for California, which will be included in a final report to be presented to the California State Legislature in April 2002. Those costs were not available at the time this handbook was completed. Therefore, cost verification could not be made for California.

There may also have been an over-allocation of initial year resources based on states expecting gun-sales volumes consistent with pre-RBID levels. It is likely that over time, program workload will return to normal. It should be noted that for both Maryland and New York, the gun-sales volume to date has been less than predicted. As a result, not all DAS units are used for the reference ballistic imaging program. Maryland currently uses two of its three DAS units for the program. The third DAS unit has been allocated on a separated server to the state criminal imaging program. Maryland has entered weapon images at a rate of about 10,000 to 14,000 weapons per year. New York has entered at a rate of about 25,000 per year, less than originally expected. New York attributes the smaller number of entries to dealer stockpiling of weapons prior to the effective date of the RBID legislation.

In response to Item #6, Maryland’s experience reflects approximately 13.5 minutes to image a shell casing and 25 minutes to image a bullet. Maryland suspects that the FTI-specified rates are applicable to very experienced technicians.

Table 5-1. Model Verification

<table>
<tr><th>INPUT</th><th colspan="2">Maryland</th><th colspan="2">New York</th></tr>
<tr><td>Annual gun-sales transactions</td><td colspan="2">30,000</td><td colspan="2">40,000
(estimate by model developers)</td></tr>
<tr><td>Imaging operations</td><td colspan="2">Central operation
One location
Shell casings only</td><td colspan="2">Central operation
One location
Shell casings only</td></tr>
<tr><td>Test-fire operations</td><td colspan="2">Mobile operation</td><td colspan="2">Distributed operation
6 locations</td></tr>
<tr><td>System life cycle</td><td colspan="2">5 years</td><td colspan="2">15 years</td></tr>
<tr><td>Initial compliance rate</td><td colspan="2">27%</td><td colspan="2">80%</td></tr>
<tr><td>Per weapon fee for test-fires</td><td colspan="2">$20</td><td colspan="2">$0</td></tr>
<tr><th>OUTPUT</th><th>Model</th><th>Budgeted</th><th>Model</th><th>Budgeted</th></tr>
<tr><td>System configuration</td><td>Stand-alone hub</td><td>Stand-alone hub</td><td>Stand-alone hub</td><td>Stand-alone hub</td></tr>
<tr><td>DAS Local</td><td>3</td><td>3</td><td>4</td><td>4</td></tr>
<tr><td>DAS Remote</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Correlation server</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Lab technicians</td><td>2.1 FTE</td><td>2 plus 1 person to log data part time</td><td>3.5</td><td>3</td></tr>
<tr><td>Technician managers</td><td>0.2 FTE</td><td>1 part-time</td><td>0.2</td><td>Exact figure unknown</td></tr>
<tr><td>Staff to test-fire weapons</td><td>4.4 FTE</td><td>6 part-time</td><td>6</td><td>6
(also function as liaisons)</td></tr>
<tr><td>Imaging equipment and optional equipment costs</td><td>$1,215,000 for correlation server and DAS units; additional $75,000 for one MatchPoint and one RBI</td><td>Approximately $1,200,000 (exact figure not available because of a confidentiality agreement between Maryland and FTI)</td><td>$2,237,800 for correlation server and DAS units; additional $75,000 for one MatchPoint and one RBI</td><td>$2,237,800 for correlation server and DAS units; additional $160,000 for four MatchPoints and zero RBIs)</td></tr>
<tr><td>Imaging equipment maintenance</td><td>$133,700</td><td>$135,000 for imaging equipment</td><td>$246,200</td><td>Exact figure unknown</td></tr>
<tr><td>Additional costs (labor, training, transportation, floor space, and additional equipment)</td><td>$391,020</td><td>Approximately $600,000 [16]</td><td>$775,900</td><td>Exact figure unknown</td></tr>
</table>

[16] Maryland budgeted for 5 FTE lab technicians and 2 FTE firearms toolmark examiners. The model generated 2.1 FTE lab technicians and 0.2 FE firearm toolmark examiners. Thus, the model generated costs for 2.9 fewer FTE lab technicians and 1.8 fewer FTE firearm toolmark examiners than budgeted. The salary cost associated with this difference in FTEs is $161,500, based on model labor costs. If this cost were added to the model generated cost of $391,000, additional costs shown in Table 5-1 would be $552,520. It should be noted that at the time of completion of this handbook, Maryland actuals were 2 FTE lab technicians (plus one person allocated part-time for logging samples) and zero firearm toolmark examiners.

SECTION 6
ISSUES AND OBSERVATIONS

There are various issues associated with the concept and implementation of an RBID that surfaced during this project. Some of these issues may be resolved by thoughtful planning at the state level; others require cooperation among states, further research and development or even action by Congress.

6.1 LEGISLATION AND COSTS

Interest in an RBID among other states is evident, particularly those states that already have some sort of licensing or permit infrastructure in place. However, because of the cost and legislation involved with establishing an RBID, many states are waiting to see the results of the Maryland and New York programs before moving towards implementing their own RBIDs.

6.2 COST BENEFIT

The cost benefit of an RBID is difficult to measure. Lack of concrete measures for such an expensive program may make it difficult for states to secure funding and obtain approval from state legislatures. An additional factor in assessing the success of an RBID is that it may take two to three years to build a database to a level where hits may occur. Possible measures of benefit include additional number of cold cases closed as a result of using the RBID and reduction in time to close cases. Removing criminals from the street before they can commit additional crimes—particularly murder—is clearly a benefit, but how does one assign a monetary value to this benefit (e.g., what is the value associated with saving a life?) Definition and capture of appropriate performance measures may be accomplished through further study of the Maryland and New York programs.

6.3 STATE FUNDING

Availability of state funds for an RBID is likely to decline due to the high priority of programs being established to analyze criminal evidence related to September 11, 2001, and to prevent further attacks.

6.4 STATE-TO-STATE CONNECTIVITY

Currently, there is no direct electronic connectivity between the RBIDs in Maryland and New York. For these states to search one another's RBID, the search data needs to be sent to FTI headquarters in Canada for forwarding to the target database. It is generally understood that crime tends to be regional. Therefore, if states, particularly those adjacent to one another, implement a means to search one another's RBID (ideally by direct electronic connection), the resultant "hit rate" is likely to increase substantially. Furthermore, a means has not been implemented for New York and Maryland to search directly one another's RBIDs via the export of data records on transportable media, sometimes referred to as "sneakernetting." A study of the distribution of gun-related crime would help identify states that may benefit from inter-connectivity. A state should consider compatibility of its system with other state RBID systems when defining its configuration. Implementation plans could also include RBID cost-sharing among states.

6.5 RESTRICTIONS ON CRIMINAL DATABASE-RBID CONNECTIVITY

The prohibition of direct connectivity between an RBID and the national criminal ballistic database stymies the process of searching criminal evidence against RBIDs in an attempt to solve a crime. It would be beneficial to investigate alternative means of comparing images from the two classes of databases within the extent of federal law. Alternatively, Congress could explore legislation that would make more effective use of ballistic imaging technology while safeguarding civil liberties.

6.6 GUN MANUFACTURER COMPLIANCE

Gun manufacturer compliance may be an issue since all gun manufacturers have not bought into the idea of an RBID. Gun manufacturers hesitant to comply will feel the need to comply only when a majority of the states where they provide weapons establish an RBID. States where manufacturer compliance is low will need to allocate resources for a weapon test-fire program and communicate effectively with state gun dealers about RBID program requirements.

6.7 SOLE VENDOR OF IMAGING EQUIPMENT

FTI is the sole vendor of the imaging equipment. Such a sole-source climate makes it difficult for states to obtain competitive pricing and services. It should be noted that an ATF public request for alternative sources of IBIS®-compatible ballistic identification systems did not yield any feasible alternatives.[17]

[17] See http://www.fbodaily.com/cbd/archive/2001/04(April)/09-Apr-2001/70sol008.htm

SECTION 7

SUMMARY AND CONCLUSIONS

Ballistic imaging technology has proven to be very successful in identifying weapons used in crimes. As a result, states have been interested in establishing RBIDs as a means to more readily identify the original owner of a legally purchased gun that has been used in a crime. Cost is only one issue to consider when implementing an RBID. This handbook and the associated planning model provide states with a tool, previously unavailable, to assess the feasibility of an RBID program, plan an operational program, and establish a budget. States should be well aware of the numerous options under which an RBID program may operate; this model presents these options in a step-by-step fashion. Any inconsistencies in options selected by the model user are brought to the user's attention. The planning model is a starting point and can be tailored to individual states' needs. The Maryland and New York RBID operations currently provide the best guidance on program components, as well as suggestions on ways to deal with some of the key issues associated with an RBID.

Using this planning model and handbook, state law enforcement officials should be able to define a program and provide program justification to their legislatures. Conversely, state legislatures interested in establishing an RBID will find this handbook and model useful as well. Legislators may wish to use these tools to help define program requirements for their state crime labs or justice departments. Once an RBID program has been placed into operation, program staff may also use this model to estimate future operations and maintenance costs.

This handbook and the planning model do not address the performance and reliability of specific ballistic image capture and matching algorithms and approaches. A separate study, similar to the California Department of Justice feasibility study, would be needed to address the merits of the technology and the technical approaches currently available commercially or in research laboratories.

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APPENDIX A
MODEL WORKSHEETS DETAILS

It is important to understand the relationships between the user-supplied data, model-generated data, and the key calculations that are made in the model. For each worksheet of the model requiring user information, the sections below describe the requested information and the variables that are affected by the information. For each worksheet of the model with model-generated information, a description of the information used to generate the results is provided. These descriptions will help users understand the relationships and create program scenarios.

A.1 Background State Information: Information Supplied by the User

A.1.1 State Abbreviation

This information is used along with state geographic area (square miles) to estimate the number of sites at which imaging and/or test-fire operations may be performed. State square miles are stored in the *State Square Miles* worksheet.

A.1.2 Gun-Sales Transactions

The numbers of gun-sales transactions define the workload (see the Workload section of the *Model Calculations* sheet). Workload determines the number of FTE lab technicians and number of FTE state personnel needed to test-fire weapons, and the numbers of units of equipment. As workload increases, these values increase. The following must be taken into account:

- Number of new gun-sales transactions to be entered into the database
- Number of refurbished gun-sales transactions to be entered into the database
- Number of guns-sales transfers to be entered into the database
- Number of additional gun-sales transactions to be entered into the database

These values are used to determine total yearly gun-sales transactions to be entered in the RBID.

A.1.3 Anticipated Annual Rate of Change in the Number of Transactions To Be Entered into the Gun-Sales Database

The annual rate of change in the number of transactions to be entered into the gun-sales database is used in the model to make annual adjustments to gun-sales transactions and workload. Change in the number of gun-sales transactions may result from the decision to image additional types or calibers of weapons. It may also represent a trend in sales volume. See the Workload section of the *Model Calculations* sheet for annual gun sales calculated by the model.

A.1.4 Types of Samples To Be Imaged

Shell casings only, bullets only, or shell casings and bullets may be imaged. The types of samples imaged determine imaging performance rates and number of FTE lab technicians needed.

A.1.5 Imaging Locations

Imaging may be performed at one central location or at distributed locations. Imaging location(s) determine the number of DAS units, feasible network configuration, number of FTE lab technicians, and number of FTE technician managers needed to staff each location. Floor space is also affected.

A.1.6 Preferred System Configuration

This option is used to determine which configuration scenario to display in the *Results Summary*. The result for all configuration options may be viewed on the *Calculations* worksheet. Please note that a distributed imaging operation is inconsistent with a stand-alone hub configuration. If this discrepancy occurs, the following message is displayed on the *Background State Information* sheet:

> "Imaging at distributed locations with a stand-alone hub configuration is not feasible. Modify your selection."

A.1.7 Number of Shifts per Day that the Imaging Operation Will Run

The number of shifts to perform imaging determines the number of DAS units needed. The number of FTE lab technicians is approximately evenly distributed across the number of shifts entered by the user. Multiple shifts *may* be a feasible way to reduce cost by reducing the number of DAS units needed.

In addition, 0.2 FTE technician managers per shift per imaging location are assigned to manage lab technicians.

The model does not reflect a relationship between the test-fire operation and the number of shifts.

A.1.8 Test-Fire Operations

Test-fire operations may be central, distributed, or mobile. This affects the test-fire performance rate. The test-fire rate for a central or distributed (stationary) operation will typically be higher than for a mobile operation.

Test-fire performance rate, when coupled with workload, determines the number of FTE state personnel needed to test-fire weapons and related equipment. In addition, a distributed test-fire operation may require additional FTE state personnel to test-fire weapons to be assigned to each location. The type of operation also determines whether water tanks/firing ranges or portable bullet traps are needed.

A.1.9 Liaison on Staff To Communicate Program Requirements to the Dealers and Manufacturers

The user indicates whether or not a liaison is desired as part of the program. The response affects number of FTE liaisons, transportation requirements, and floor-space requirements.

A.1.10 Legal Counsel on Staff to Enforce Program Requirements and Resolve Issues

The user indicates whether legal counsel is desired as part of the program. The response affects number of FTE counsel, transportation requirements, and floor-space requirements.

A.1.11 Funding to Offset Cost of Program

The dollar amount entered by the user is added to Funds to Offset Costs. The Total Operations Costs of the program is reduced by Funds to Offset Costs.

A.2 Performance Assumptions: Information Supplied by the User

This worksheet calculates imaging performance, test-fire performance rate, and number of program locations.

A.2.1 Imaging Performance Rate

Imaging performance rate refers to the number of samples imaged per person, per eight-hour day, with respect to imaging of shell casings only, bullets only, or shell casings and bullets.

a. The imaging performance rate is determined by the performance times of the imaging tasks below. Default times provided by the model developers may be accepted, or the user may supply alternative performance times:

   - Time to prepare weapon
   - Time to take image of shell casing and enter into database
   - Time to take image of bullet and enter into database
   - Time to enter shell casing and/or bullet into physical storage

   The performance times are used to determine performance rate per person, per day, for each test-fired sample option.

b. Samples to be imaged: number of samples imaged per person, per eight-hour day

   These are the calculated performance rates for shell casings only, bullets only, and shell casings and bullets. The rate is based on the performance times for the imaging tasks.

c. Confirmation:

   - Location of imaging operation
   - Daily imaging rate (per person)

   Two sets of imaging rates are calculated, one based on user input and the other based on model-developer input. The user must confirm which of the two rates will be used in model calculations.

   Combined with workload, the imaging performance rate determines the number of FTE lab technicians and number of DAS units needed.

A.2.2 Test-Fire Performance Rate

The test-fire performance rate refers to the number of test-fires performed per day, with respect to mobile, central, or distributed operation.

a. The test-fire performance rate is determined by the performance times of the test-fire tasks below. Default times provided by the model developers may be accepted, or the user may supply performance times:

- Prepare request for test-fire
- Fire weapon, collect sample, log results
- Send sample to crime lab
- Travel time per day

b. Test-fire operation: number of test-fires per person, per eight-hour day

These are the calculated performance rates for mobile or stationary (central or distributed) operations. The rate is based on the performance times for the test-fire tasks.

c. Confirmation:

- Location of test-fire operation
- Daily test-fire rate (per person)

Two sets of test-fire rates are calculated, one based on user input and the other based on model developer input. The user must confirm which of the two rates will be used in model calculations. Combined with workload, the test-fire rate determines the number FTE state personnel needed to test-fire weapons, as well as the amount of water tanks/firing range/bullet traps, transportation, and floor space needed.

A.2.3 Locations of Operations

The calculations below help determine the number of sites needed for program operations. Imaging operations and/or test-fire operations may be distributed among multiple sites. If multiple sites are assumed for either operation, the maximum distance between program sites must exceed one mile to avoid the display of an error message. The model assumes that if imaging operations and test-fire sites are both distributed, these operations will be performed at the same sites.

a. Maximum distance (miles) between program sites

The user specifies the maximum distance, in miles, between program sites. The distance that dealers may have to travel to test-fire sites should be considered when specifying this number. The value is used in the Look-Up Table in the model to calculate the number of program locations.

b. Model estimate of number of program sites needed

This estimate is calculated as an option for the number of program locations needed. The estimate is based on the desired maximum distance between program locations and state area (square miles).

c. User estimate of number of sites needed

This is an alternative number of program locations, entered by the user. The user may prefer to enter the number of sites, especially if facilities that may be used for the program already exist.

d. Number of sites needed if imaging operations or test-fire operations are distributed among multiple sites

The user selects an option for the number of program locations, either the number of locations as calculated by the model or the number of locations as entered by the user. This information is used to calculate the number of locations that will be used in model calculations in the event that the user specifies that imaging operations or test-fire operations are to be distributed among multiple sites.

e. Confirmation:

Based on information entered on the *Background State Information* sheet, model calculations will be based on the following

- Number of imaging sites
- Number of test-fire sites

The user must confirm the number of locations to be used for imaging and test-fires. Coupled with workload, the number of imaging operation locations is used to determine the number of FTE lab technicians, the number of FTE technician managers, and the number of DAS units needed to support all locations. The number of test-fire locations is used to determine the number of FTE personnel to test-fire weapons and the number of water tanks/firing ranges needed to support all locations.

If the user specified a central imaging operation on the *Background State Information* sheet, the number of imaging locations used for model calculations is one. If a distributed imaging operation was specified, the number of imaging locations used for model calculations is the calculated “number of sites needed if imaging operations and/or test-fire operations are distributed among multiple sites.”

If the user specified a central or mobile test-fire operation on the *Background State Information* sheet, the number of test-fire locations used for model calculations is one. If a distributed test-fire operation was specified, the number of test-fire locations used for model calculations is the calculated “number of sites needed if imaging operations and/or test-fire operations are distributed among multiple sites.”

A.3 Miscellaneous Parameters: Information Supplied by the User

The user may enter a rate or accept the default value provided in the model for each of the parameters.

A.3.1 Expected System Life

Typical system life for information technology systems is 5 to 10 years. Upgrades or new technology require system modifications to be made after this point. The system life requested here is used to determine database capacity requirements for the life cycle.

A.3.2 Compliance Rate at Onset of Program

Compliance rate is the percentage of weapons entered into the gun-sales database for which spent shell casings and/or bullets are provided by the manufacturer. This rate determines workload distribution at the onset of the program—the number of weapons that do not need to be test-fired versus the number of weapons that will need to be test-fired. The number to be test-fired determines the number of FTE state personnel needed to test-fire weapons, the number of water tanks/firing ranges, and the number of portable bullet traps.

A.3.3 Compliance Rate at the End of the Life of the System

Final compliance should be near 100 percent. The difference between compliance rate at the end of the life cycle and compliance rate at the onset of the program is distributed evenly as the annual change in the compliance rate over the life of the system.

A.3.4 Annual Rate of Salary Increase

The annual rate of salary increase is applied annually to all labor categories.

A.3.5 Annual Personnel Turnover Rate

This rate is used to determine the number of FTEs that will leave the program each year. Only lab technicians and state personnel to test-fire weapons are considered because of the specialized training needed to perform their program duties. The number of FTEs leaving the program is compared to the number of FTEs needed for the year. This comparison determines the number of FTEs to be added and therefore trained each year.

A.3.6 Annual Rate of Increase in Operating Expenses

This rate is used to annually inflate the per-weapon fee charged for the test-fire operation.

A.3.7 Per-Weapon Fee To Be Charged for Weapons not Having Samples Provided by the Manufacturer

This value may be zero. If used, the cost of test-fires *may* be used to offset program costs. The model doubles this costs beginning in the fourth year of the program. The assumption is that gun manufacturers should have policies in place to supply sample casings and/or bullets by that point in time. The per-weapon fee, combined with the number of weapons needing to be test-fired, is used to determine potential income to the program. This income is one component of Funds to Offset Costs of the program.

A.3.8 Additional Ancillary Costs

Ancillary Costs are included in the Total Operations Costs displayed on the *Results Summary* worksheet. Ancillary Costs are divided into one-time costs and recurring costs.

- A one-time cost may be the cost of a feasibility study, the cost to establish legislation, or the cost of facility modifications. The value entered for one-time cost is included in total costs for Year 1 of the program only.
- Recurring cost may be indirect costs to the program. The value entered is included in total costs for Years 1 through 15 of the program.

A.4 Cost Assumptions: Information Supplied by the User

Cost assumptions are divided into two categories: equipment and labor. These categories are described below.

A.4.1 Equipment Costs

Default unit equipment costs are given in the model. Default unit costs for IBIS® equipment are based on the New York State purchase order for their state-owned IBIS®. The Maryland purchase order was not available due to a confidentiality agreement between Maryland and FTI. Other unit equipment costs are estimates made by the model developers. Users must enter equipment unit cost based on vendor quotes. Footprints for each piece of equipment have been entered by the model developers on the *Model Calculations* sheet and cannot be changed by the user.

Past IBIS® configurations have used a DAS and SAS as the basic imaging and analysis unit. Current configuration includes a DAS and correlation server as a unit. Currently, the most common correlation server options used by IBIS® vendor FTI are from the SGI® Origin 2000 series[18]. The SGI® Origin 2100 has a maximum memory of 16GB, two to eight MIPS@ processors, and 6.24GB/second peak I/O bandwidth. The SGI® Origin 2400 has a maximum memory of 128GB, two to 64 MIPS® processors, and 49.92 GB per second peak of I/O bandwidth. For the purpose of this model, if the number of entries at the end of the intended life cycle of the system exceeds 150,000, the SGI® Origin 2400 is used. Otherwise, the SGI® Origin 2100 is used. This threshold is based on a response time of approximately 30 minutes per search for a database of 150,000 shell casings. Based on the California Department of Justice feasibility study, correlation time using the more powerful SGI® Origin 2400 server increases shell casing search time by approximately 10 minutes per database size increase of 50,000 images.

SGI® will end production of the SGI® Origin 2000 series systems in June 2002. It is assumed that comparable servers will be the option in the future.

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[18] See reference [31]

a. Equipment options are presented below:
   - Imaging Equipment
     - Correlation Server with SGI® Origin 2100
     - Correlation Server with SGI® Origin 2400
     - DAS Remote
     - DAS Local
     - Uninterruptible Power Supply
   - Other Equipment
     - Printer
     - Integrated Services Digital Network (ISDN) line for FTI product upgrades and technical support
     - Telephone line
     - T1 line for DAS Remote-correlation server communication
     - Workbench or tables
     - File cabinets for sample storage
   - Optional Equipment
     - MatchPoint
     - Rapid Brass Identifier (RBI)
   - Equipment for Test-Fire Operations
     - Water tank or firing range
     - Portable bullet trap
     - Official state vehicle

   Unit cost, combined with the number of units needed, is used to determine the cost and total floor-space requirements. Calculations for determining the number of units needed of each type of equipment are described in the discussion of the *Model Calculations* worksheet.

b. Annual imaging equipment maintenance

   This maintenance rate is applied to the total cost of imaging equipment to determine the cost of maintenance and upgrades for the imaging equipment. The equipment vendor typically sets this rate.

c. Annual non-imaging equipment maintenance

   This maintenance rate is applied to the total cost of non-imaging equipment. This rate may be set by the user to allow for the upkeep of products (such as replacement of bullet-trap components).

d. Floor space

- Annual rental cost per square foot: This value is applied to the total floor-space requirement to determine the annual cost of leased floor space. If facility space is owned by the state and available for the program, enter $0.
- Floor space square feet per person requirement: A standard per person square-foot allotment is provided. This standard allotment is assigned to each FTE. The resulting floor-space requirement is used to determine personnel floor-space costs.

A.4.2 Labor Costs

Labor cost assumptions are also included on this sheet. These assumptions include annual salary and number of FTEs for each labor category. Users may accept or overwrite the default salaries.

The number of FTE lab technicians, lab technician managers, and state personnel to test-fire weapons is calculated by the model and cannot be changed by the user. The number of FTEs for these positions is calculated for each of Years 1 through 15 from annual workload and performance rates. Users accept or overwrite the default number of FTEs for other labor categories. Users may change the names of any of the labor categories to reflect their state labor categories.

Note: If the user opts for a liaison position on the *Background State Information* sheet, the number of FTEs entered on the *Cost Assumptions* sheet will be used in the model. If the user does not opt for a liaison position, zero FTEs will be used in the model, regardless of the number of FTEs shown on the *Cost Assumptions* sheet. Likewise, if the user opts for a legal counsel position on the *Background State Information* sheet, the number of FTEs entered by the user on the *Cost Assumptions* sheet will be used in the model. If the user does not opt for a legal counsel, zero FTEs will be used in the model, regardless of the number of FTEs shown on the *Cost Assumptions* sheet.

a. Labor Costs

Labor costs consist of annual salary and number of FTEs for the following labor categories:

- Lab technicians
- Lab technician manager
- State personnel to fire weapons and collect samples
- Firearms toolmark examiner
- Inventory control specialist
- Office clerk
- Dealer and community liaison
- Legal counsel
- FTI/Vendor staffer (This optional position is supplied by the vendor, typically for the first year of the program; this has been a no-cost position to date.)

Annual salary per full-time staff, based on current year dollars is used as the salary for Year 1. The annual salary increase rate, from the *Miscellaneous Parameters* worksheet, is applied to the Year 1 salary to determine the annual salary for each of Years 2 through 15. The number of FTEs needed is applied to the annual salary used to generate labor costs and floor-space requirements. The number of liaison and legal counsel FTEs also determine the number of state vehicles.

b. FTE Factor

The FTE factor is applied to the model-calculated number of lab technicians and state personnel needed to test-fire weapons and the FTEs needed to satisfy the workload. This factor accounts for time away from the job—holidays, sick leave, and vacation. This factor is needed to make sure the workload and performance times are consistent.

A.5 Results Summary: Information Provided to the User

All dollar values have been rounded to the nearest $100.

A.5.1 Recurring and One-Time Costs

Recurring and one-time costs for the initial year and cumulative costs for the life cycle are provided. Values used to generate each cost are provided. Observations and a summary of key user input are also provided. Values shown in the summary are taken from calculations made on the *Model Calculations* worksheet. Refer to the Model Calculations section of this handbook for a description of the formulas and relationships used to make calculations.

a. Labor

Labor costs for each labor category are summed to generate the total personnel cost. Labor costs are based on number of FTEs and annual salary for each labor category.

b. Training

The number of FTE lab technicians and FTE state personnel to test-fire weapons, the respective annual salaries, and the annual personnel turnover rate are used to determine the number of FTEs to be trained annually. The training time for each labor categories is defined by the model developers. The training cost is a function of number of FTEs to be trained, training time, and the annual salary rate. It is assumed that staff in training will be paid at the salary rate for the position for which they are training. In Year 1, all FTE lab technicians and state personnel needed to test-fire weapons will be trained.

c. Equipment Maintenance

The annual equipment maintenance cost is the sum of imaging and non-imaging equipment maintenance costs. The imaging-equipment maintenance rate is applied to the initial year cost of imaging equipment. The non-imaging–equipment maintenance rate is applied to the initial year cost of non-imaging equipment.

d. Transportation

One state vehicle per FTE liaison and counsel is assumed. One vehicle per FTE state personnel to test-fire weapons is also assumed if the test-fire operation is mobile. The total number of FTEs is multiplied by the unit cost of a state vehicle. An annual vehicle maintenance fee is also assumed.

e. Floor Space

Equipment quantities determine total equipment footprints. Equipment footprints are entered by the model developers on the *Model Calculations* worksheet. The number of FTEs determines total personnel space footprints. Floor-space allowance per staff is entered on the *Cost Assumptions* sheet. The total footprints and lease cost per square foot determine floor-space cost.

f. Imaging Equipment

Imaging equipment costs consist of costs for the correlation server(s), DAS Remote(s), and DAS Local(s).

g. Other Equipment

Other equipment costs consists of costs for the printers, ISDN lines, telephone lines, T1 lines, work benches/tables, and file cabinets in which to store the samples.

h. Optional Equipment

Optional equipment costs consists of costs for MatchPoint and RBI. A minimum of one MatchPoint and one RBI are included in the calculations. In general, the number of MatchPoints and RBIs are each equal to the number of hubs.

i. Equipment for Test-Fire Operations

Equipment for test-fire operations costs consists of costs for water tank/firing range, portable bullet trap, and official state vehicles.

j. Total Operations Costs

Total operations costs include costs for labor, training, equipment maintenance, transportation, floor space, and equipment.

k. Ancillary Costs

Ancillary costs are identical to those entered by the user on the *Miscellaneous Parameters* sheet. Ancillary Costs are composed of one-time costs and recurring costs.

l. Potential Funds to Offset Costs

Potential funds to offset costs include income from the test-fire operation and user-specified funds to offset costs, as entered on the *Background State Information* sheet.

m. Potential Final Cost

Potential Final Cost equals Total Operations Costs, plus Ancillary Costs, minus Potential Funds to Offset Cost.

A.5.2 Observations

The initial year test-fire fee per weapon to offset the cost of state personnel to test-fire weapons in the initial year is provided for informational purposes. The value is calculated on the *Calculations* sheet. This value provides guidance if a state chooses to charge dealers for the test-fire service. The fee, along with the cost of the state personnel to test-fire weapons (see Results Details) may be used as a measure against the benefits of providing this service in an effort to maximize the number of weapons that are entered into the gun-sales ballistic imaging database. The user sees the following message.

> The initial year test-fire fee per weapon to offset the cost of state personnel to test-fire weapons, in the initial year, should be: $XX

If the number of shifts or the number of locations selected by the user exceeds the number of FTEs needed to meet the workload, the model assigns additional FTEs. The additional FTEs are needed to staff all shifts or all locations. Such selections do not result in error messages, but they do result in additional personnel costs, additional equipment, and additional equipment costs. If this discrepancy occurs, any of the following observations are displayed on the Results Summary sheet:

> Number of shifts exceeds number of FTE lab technicians needed to satisfy workload. Go to ***Background State Information*** and enter a smaller number of shifts.

> Number of FTE lab technicians needed to staff all locations exceeds number of FTEs to satisfy workload. Go to ***Background State Information*** to select a central imaging operation or go to ***Performance Assumptions*** to reduce the number of locations.

> Number of test-fire personnel needed to staff all locations exceeds number to satisfy workload. Go to ***Background State Information*** to select central or mobile test-fire operation or go to ***Performance Assumptions*** to reduce the number of locations.

a. The following summary information taken from the *Background State Information* sheet is displayed:

- Types of samples to be imaged
- Where imaging will be performed
- Preferred system configuration
- Number of shifts per day for the imaging operation
- Where test-fires will be performed
- Liaison
- Legal Counsel

b. The following information taken from the *Performance Assumptions* sheet is displayed:
   - Maximum number of locations

c. The following information taken from the *Miscellaneous Parameters* sheet is displayed:
   - Equipment life cycle
   - Per-weapon fee charged (to dealer) for test-fire

A.6 Results Details: Information Provided to the User

Detailed results are presented in three sections: labor, equipment, and floor space. A detailed summary is given below for each result. All results are directly or indirectly affected by gun-sales transactions, workload, imaging performance rate, test-fire performance rate, number of FTEs for each labor category, and number of program locations.

A.6.1 Labor

Labor detail includes initial year FTEs, initial year costs, and life cycle costs for each labor category. The number of FTEs, the initial year salary from the *Costs Assumptions* sheet, and the annual salary increase rate from the *Miscellaneous Parameters* worksheet are used to determine initial year and life cycle costs. The numbers of FTEs entered by the user on the *Cost Assumptions* sheet apply to Years 1 through 15.

- Lab technicians: The annual number of FTE lab technicians is based on the number of gun sales, the imaging performance rate, the FTE factor, and the number of locations. This number is calculated by the model.
- Technician Manager: The number of FTEs is calculated by the model to be 0.2 FTEs per shift, per location. This number is calculated by the model.
- State personnel to fire weapons and collect samples: The annual number of FTEs is calculated by the model. The calculation is based on the number of gun sales, the compliance rate, the test-fire performance rate, the FTE factor, and number of locations.
- Firearms toolmark examiner
- Inventory control specialist
- Office clerk
- Dealer and community liaison
- Legal counsel
- FTI/Vendor staff

A.6.2 Equipment

a. Imaging Equipment

   Equipment detail includes the required number of units and total cost for each equipment type. The total cost for each equipment type is determined by the number of units, as calculated on the *Calculations* sheet, and by the unit cost, entered on the *Cost Assumptions* sheet.

- Correlation Server: Correlation server with SGI® Origin 2100 and Correlation server with SGI® Origin 2400 are the server options. The number of correlation servers is determined by the configuration type, entered on the *Background State Information* sheet, and the number of DAS units needed. Server capacity and test-fire image database requirements, as estimated by the model developers, are also used.
- DAS Remote and DAS Local: The number of DAS Remotes and DAS Locals is determined by the configuration type, number of FTE lab technicians, number of locations for the imaging operation, and number of shifts.
- Uninterruptible Power Supply: There is one UPS per correlation server.

b. Other Equipment

- Printer: There is one printer per location or per hub, whichever is larger.
- ISDN line: There is one ISDN line per correlation server. This line is used by FTI for product upgrades and technical support.
- Telephone line (modem): If one or more RBIs are assigned, one modem line is assigned.
- T1 line for DAS Remote-correlation server communication: An assignment of one T1 line per correlation server or one T1 per remote location, whichever is larger, is made.
- Workbench or tables: One workbench/table is assigned for every two DAS units needed.
- File cabinets for sample storage: The number of file cabinets needed is determined by the total shell casing and/or bullet samples collected during the life cycle and the file-cabinet capacity. A capacity of 2,000 casings and test-fired samples per file cabinet is assumed on the *Calculations* sheet.

c. Optional Equipment

- MatchPoint: The number of MatchPoints is defined by the model developers to be the maximum of one plus the number of FTE firearms toolmark examiners. This calculation is made on the *Model Calculations* sheet.
- Rapid Brass Identifier (RBI): The number of RBIs is defined by the model developers to be the maximum of one plus the number of correlation servers. This calculation is made on the *Model Calculations* sheet.

d. Equipment for Test-Fire Operations

- Water tank or firing range
- Portable bullet trap

- The type of test-fire operation, as specified on the *Background State Information* sheet, number of test-fire locations (as confirmed on the *Performance Assumptions* sheet), and the number of model-calculated FTE state personnel to test-fire determine the number of water tanks/firing ranges and portable bullet traps.
- State Vehicles: The number of state vehicles is determined by the number of FTE mobile state personnel used to test-fire weapons, as well as the number of liaisons and legal counsel.

A.6.3 Floor Space

Floor-space detail includes square-footage requirements and costs for equipment and personnel. Equipment floor space is determined by equipment quantity and footprints. Equipment footprints are discussed in the Equipment Specifications section of the *Model Calculations*. Personnel floor space is determined by the square-foot-per-FTE requirement, entered by the user or model developer on the *Cost Assumptions Sheet*. Floor space is allocated for each FTE. Floor-space allocations are classified as follows:

- Floor space for imaging equipment and other equipment (sq ft)
- Floor space for optional equipment (sq ft)
- Personnel floor space (sq ft)

A.7 Model Calculations Details: Source of Information Provided to the User

The information contained in the *Results Summary* and *Results Details* worksheets is extracted from the *Calculations* worksheet. The *Calculations* worksheet, which is divided into numerous sections, includes all model calculations and displays results for each of Years 1 through 15. Due to its size, the entire worksheet is not displayed in this handbook, but the methodology for each section of the worksheet is described below. Review of the *Calculations* worksheet is not required to run the model. The user does not enter information directly on this sheet.

A.7.1 Parameters

Parameters for each of Years 1 through 15 are included. Values are taken from the *Background State Information*, *Miscellaneous Parameters,* and *Cost Assumptions* worksheets.

A.7.2 Staff Performance Rate

Imaging performance rates and test-fire performance rates are included for each of Years 1 through 15. User-confirmed rates from the *Performance Assumptions* worksheet are used.

A.7.3 Workload

Workload is driven by total annual gun-sales transactions. Annual and daily test-fire and imaging volumes are calculated. Volumes are calculated for each of Years 1 through 15. Calculations are based on values from the *Background State Information*, *Miscellaneous Parameters,* and *Cost Assumptions* worksheets.

Number of weapons to be imaged only by state police, **annually**. These weapons have already been test-fired by the manufacturer/dealer.	Total annual gun-sales transactions * compliance rate
Number of weapons to be test-fired and imaged by state police, **annually**. These weapons do not have test-fired samples from manufacturer/dealer test firings.	Total annual gun-sales transactions * (1- compliance rate)
Number of weapons to be imaged only by state police, **daily**. These weapons have already been test-fired by the manufacturer/dealer.	These conversions from annual to daily volumes are based on the assumption that there are 52 weeks a year, with 5 workdays per week.
Number of weapons to be test-fired and imaged by state police, **daily**. These weapons do not have test-fired samples from manufacturer/dealer test firings.	
Total number of weapons to be imaged daily. This applies to all weapons.	Daily number to be imaged only + Daily number to be test-fired and imaged

A.7.4 Imaging and Test-Fire Personnel Requirements

The number of FTEs calculated in this section of the worksheet represent a minimum number of FTEs needed to satisfy the workload constraint. Therefore, the calculations take into consideration workload and types of samples to be imaged, relative to a central imaging operation and a central or mobile test-fire operation. Multiple program locations are not factored into these calculations. Subsequent FTE calculations factor in the effect of multiple locations when distributed operations are specified. See the "Personnel Full-Time Equivalents: Adjusted" section of the *Calculations* worksheet for the modified calculations.

Number of technicians/operators	$\frac{\text{Total number of weapons to be imaged daily}}{\text{imaging performance rate}}$ / FTE factor
Number of firearms testers	$\frac{\text{Total number of weapons to be test fired daily}}{\text{test fire performance rate}}$ / FTE factor
Number of lab technician managers	0.2 FTEs per shift are assumed for model calculations

A.7.5 Equipment Specifications

Key equipment specifications for Imaging equipment, other equipment, equipment for test-fire operations, and optional equipment are needed to run the model. Specifications include unit capacity (where appropriate), unit cost, and unit footprints for non-portable equipment (width, depth, unit square feet). Communication requirements for IBIS® equipment are also noted.

Unit capacities for the correlation server, DAS, and file cabinets have been entered by the model developer. The server capacity is used to determine the number of servers needed to store ballistic images. File-cabinet capacity is used to determine the number of file cabinets needed to store physical shell-casing and bullet samples.

Unit equipment costs are taken from the *Cost Assumptions* worksheet.

Unit equipment footprints—entered by the model developer—are based on vendor documentation.

Other factors, including annual rental cost per square foot of floor space, floor space square feet per person, and annual equipment maintenance, are taken from the *Cost Assumptions* worksheet.

A.7.6 Database Storage Requirements

Each test-fired sample image will require a certain amount of storage space in the database. The model allows for storage space requirements for shell casings to differ from requirements for bullets. It is assumed that if both shell casings and bullets are imaged, both types of images are taken for all weapons.

The maximum number of DAS units that may connect to one correlation server has been entered by model developers. This value is used to determine the number of hubs that will be needed over the life cycle. Exceeding the recommended number of DAS units per hub will result in a very slow response time when searching for images in the database.

Database storage requirement per shell casing image	Entered by the model developer. Cannot be modified by the user. Value based on vendor specifications.
Database storage requirement per bullet image	Entered by the model developer. Cannot be modified by the user. Value based on vendor specifications.
Database storage requirement per shell casing and bullet images	Database storage requirement per shell casing image + Database storage requirement per bullet image
Total (annual) database storage requirement	Database storage requirement per image(s) * Total gun-sales transactions to be imaged The image may be of shell casings only, bullets only, or shell casings and bullets.
Cumulative Database Storage Requirement	Sum of total database storage requirements for the current year and all prior years
Max number of DAS Remotes and DAS Locals to connect to one hub	Entered by the model developer. Cannot be modified by the user. A value of 32 DAS units per server is used, based on vendor specifications.

It is assumed that images will not be deleted, because of age, from the database during the life cycle.

A.7.7 Personnel Annual Salary per Full Time Equivalent

Initial year salary per FTE is taken from the *Cost Assumptions* worksheet. Annual salary per FTE for each of Years 2 through 15 is calculated by inflating the prior year salary by the annual salary increase rate, taken from the *Miscellaneous Parameters* sheet.

Current year salary for a given labor category	Previous year salary * (1 + annual salary increase rate)

A.7.8 Personnel Full-Time Equivalents: Adjusted

The basic number of FTE lab technicians, FTE state personnel to test-fire weapons, and FTE technician managers were previously calculated in the Imaging and Test-Fire Personnel Requirements section of the *Calculations* worksheet. The number of FTEs for other labor categories is taken from the *Cost Assumptions* worksheet.

The previously calculated FTEs take into consideration workload and types of samples to be imaged relative to a central imaging operation and a central or mobile test-fire operation. Adjustments to the previous number of FTE lab technicians and lab technician managers must be made if the imaging operation is distributed and there are multiple imaging sites. Adjustments to the previous number of FTE personnel to test-fire weapons must be made if the test-fire operation is distributed and there are multiple test-fire sites. Additional staffing may be needed to perform imaging and test-fires at multiple sites.

Number of technicians/operators	Maximum of: the basic number of FTEs needed and the number of locations
Number of lab technician managers	0.2 FTEs per shift are assumed for model calculations
Number of firearms testers	Maximum of: the basic number of FTEs needed and the number of locations

FTEs are calculated to one decimal place. This allows for staff to be assigned part-time to the operation. For example, 0.6 FTE lab technicians could represent a full-time employee assigned to imaging test-fired samples for the gun-sales ballistic imaging operation 60 percent of her/his time and assigned to a non–gun-sales ballistic imaging operation 40 percent of her/his time. It could also represent a full-time employee assigned to imaging test-fired samples for the gun-sales ballistic imaging operation 60 percent of her/his time and assigned to another gun-sales ballistic imaging operation 40 percent of her/his time.

A.7.9 Total Labor Cost

Labor cost is calculated for each labor category, for each of Years 1 through 15.

Annual cost for a given labor category	Number of FTEs for the labor category the year * Annual FTE salary

A.7.10 Training Costs

Annual training costs are calculated only for lab technicians and personnel to test-fire weapons. The model assumes that in Year 1, FTEs in these labor categories will need to be trained. In Years 2 through 15, the annual personnel turnover rate is used to calculate the number of FTEs to be trained. The turnover rate is taken from the *Miscellaneous Parameters* sheet. The model assumes that employees leaving the operation will be replaced with employees that need to be trained. The number of FTE lab technicians, or FTE personnel to test-fire weapons, to be trained for the current year is the number of replacement personnel plus the number of additional hires, if any.

Number of FTEs to be trained for the current year for a given labor category
(Turnover rate for the current year * number of FTEs for the prior year) + Maximum [0, (number of FTEs for the current year – number of FTEs for the prior year)]
Training cost for the year for a labor category
Number of FTEs to be trained for the year * annual salary * fraction of year spent in training

Time spent in training, entered by the model developers, is assumed to be two weeks for technicians and one week for personnel to test-fire weapons. Training for other program personnel is not reflected in the model.

Note: It may be possible, external to the model, for users to reduce training costs by replacing departing employees with those already trained in IBIS® imaging and test-fire operations.

A.7.11 Funding to Offset Costs

The Funding to Offset Costs calculation provides an estimate of funds available to help pay for the gun-sales ballistic imaging program, for each of Years 1 through 15. On the *Background State Information* sheet, the user is asked to estimate the amount of funds that may be available, possibly including gun registration fees and grants. The model also calculates funds generated by the test-fire program, if a test-fire fee is charged. Total Funding to Offset Costs is displayed on the *Reports Summary* sheet.

Annual income from test firing guns at the dealer	Per gun fee charged to the dealer to test-fire * Annual number of weapons to be test-fired
Per gun fee charged to the dealer to test-fire a gun	Entered by the user on the *Miscellaneous Parameters* worksheet
Annual expense of personnel for the test-fire operation	Annual cost for state personnel to test-fire weapons labor category
Per gun cost to state, to test-fire a gun, based on annual expense of personnel for the test-fire program	$\frac{\text{Annual cost of state personnel to test fire weapons labor category}}{\text{Annual number of weapons to be test fired}}$
Income from test-fire operation	Annual income from test-firing guns at the dealer's location
Other annual funding to offset costs	Entered by the user on the *Background State Information* sheet.
Total funding to offset costs	Income from test-fire operation + Other annual funding to offset costs

A.7.12 Ancillary Costs

Users enter (or accept default for) Ancillary Costs on the *Miscellaneous Parameters* worksheet. Ancillary Costs are divided into one-time costs and recurring costs. The value entered for one-time cost is applied to Year 1 of the program only. The value entered for recurring cost is applied to each of Years 1 through 15.

A.7.13 Equipment Requirement for the Life of the System

Provided below is the logic for allocating equipment. Allocation logic may vary for each of the three configurations.

<table>
<tr><th>Imaging Equipment</th></tr>
<tr><td>number of DAS units to satisfy system life and volume
$$\frac{\text{number of FTE lab technicians}}{\text{number of shifts}}$$
or number of locations, whichever is larger</td></tr>
<tr><th>Correlation Server (Correlation server with SGI® Origin 2100 or SGI® Origin 2400)</th></tr>
<tr><td>If remote configuration was selected, the number of servers will be zero.

Otherwise, if the number of entries at the end of the intended life cycle of the system exceeds 150,000, the SGI® Origin 2400 is used. Otherwise, the SGI® Origin 2100 is used. This threshold is based on a shell casing search response time of approximately 30 minutes for a database of 150,000 shell casings. Based on the California Department of Justice feasibility study, correlation time using the more powerful SGI® Origin 2400 server increases approximately 10 minutes per database size increase of 50,000 shell casing images.

For stand-alone hub and hub network configurations, the number of hubs is determined by the number of DAS units required and number of DAS units that may be connected to a server. It is assumed that if at least one DAS is needed, a hub is a feasible option.</td></tr>
<tr><th>DAS Remote (in addition to any hubs)</th></tr>
<tr><td>Note: Only DAS Remotes required by the state running the model are calculated. DAS Remotes owned by another state, even if connected to the state running the model, are not reflected.

If a stand-alone hub configuration was selected, the number of DAS Remotes will be zero.

If a remote configuration was selected, only DAS Remote units will be assigned. The number of DAS units is at least as large as the maximum of the number of locations (if distributed), number of shifts, and number of lab technicians.

If a hub network configuration was selected, then a combination of DAS Remote, and DAS Local units will be assigned. The number of DAS units is determined by number of shifts and number of lab technicians. Additionally, if imaging is to be performed at two or more distributed locations, there will be at least one DAS Local at the hub. The total number of DAS Remote units equals one less than the number of imaging locations.</td></tr>
<tr><th>DAS Local (in addition to any hubs)</th></tr>
<tr><td>If a stand-alone hub configuration was selected, only hub and DAS Local units will be assigned. The number of DAS units is determined by number of shifts and number of lab technicians.

If remote configuration was selected, the number of DAS Locals will be zero. All DAS units will be DAS Remote.

If a hub network configuration was selected, then a combination of DAS Remote, and DAS Local units will be assigned. The number of DAS units is determined by number of shifts and number of lab technicians. Additionally, if imaging is to be performed at two or more distributed locations, there will be at least one DAS Local at the hub. The total number of DAS Remote units equals one less than the number of imaging locations.</td></tr>
<tr><th>Uninterruptible Power Supply</th></tr>
<tr><td>One per hub and one per DAS Remote</td></tr>
</table>

Other Equipment	
Printer	One per location or one per hub, whichever is larger
ISDN line	One per correlation server is allocated. Used by FTI for product upgrades and technical support
Telephone Line	If one or more RBI is assigned, one modem line is assigned.
T1 Line to network states	One T1 line per remote location is allocated.
Work bench or table near DAS	One work bench/table for every two DAS units allocated for extra workspace.
File Cabinets for Sample Storage	Total number of shell casing and/or bullet samples collected during the life cycle / file cabinet capacity
Optional Equipment	
MatchPoint	The number of MatchPoints is defined by the model developers to equal the maximum number of firearms tool mark examiners
Rapid Brass Identifier	The number of RBIs is defined by the model developers to be the maximum of one and the number of servers
Equipment for Test-fire Operations	
Water Tank or Firing Range	If the test-fire operation is distributed, then one water tank/firing range per location is assigned. If the operation is mobile, then zero is assigned. If the operation is central, then one for every two FTE state personnel needed to test-fire weapons is assigned.
Water Tank or Firing Range Footprint (square feet)	Number of units * unit footprint
Portable Bullet Trap	If the test-fire operation is mobile, then the number of portable bullet traps is equal to the number of FTE state personnel needed to test-fire weapons. If the operation is central or distributed, no portable bullet traps are assigned.
Transportation - Trooper Car	One car per FTE state personnel needed to test-fire weapons is assigned. The number of FTE state personnel to test-fire weapons, liaison, and counsel determine the number of state vehicles needed. Transportation cost is calculated by Number of FTEs * unit cost of a state vehicle An annual maintenance of $0.35 per mile for 15,000 miles per year per vehicle is assumed.

A.7.14 Costs by Configuration

The *Model Calculations* worksheet concludes with a summary of its calculations. Annual costs for each of the following are summarized separately for stand-alone hub, remote, and hub-network configuration. All dollar values are rounded to the nearest $100.

- Labor
- Training
- Imaging Equipment
- Other Equipment
- Optional Equipment
- Equipment for Test-Fire Operations
- Imaging Equipment Maintenance
- Non-Imaging Equipment Maintenance
- Transportation Costs
- Floor Space for Imaging Equipment and Other Equipment
- Floor Space for Optional Equipment
- Personnel Floor Space
- Floor-Space Costs
- Total Costs
- Ancillary Costs
- Funds to Offset Costs
- Final Costs

APPENDIX B

PLANNING MODEL SAMPLE WORKSHEETS

Samples of the following worksheets are provided in this appendix: Background State Information (Figure B-1), Performance Assumptions (Figure B-2), Miscellaneous Parameters (Figure B-3), Cost Assumptions (Figure B-4), Results Summary (Figure B-5), and Results Detail (Figure B-6).

Figure B-1. Background State Information

BACKGROUND STATE INFORMATION	
Enter Your State Name (two letter abbreviation only). Required Information	**md**
Gun Sales Transactions To Be Entered Into Gun Sales Database Annually	
How many new gun sales transactions will be entered into the database?	30,000
How many refurbished gun sales transactions will be entered into the database?	
How many gun transfers will be entered into the database per year?	
How many additional gun sales transactions will be entered into the database?	
Total gun sales transactions to be entered into the gun sales database during the initial year:	**30,000**
What is the anticipated annual rate of change in the number of transactions to be entered into a gun sales database? This change may reflect a trend in sales volume or the imaging of additional weapon types and/or calibers.	0%
Imaging Operations	
What types of samples do you anticipate imaging?	shell casings only
Where do you anticipate imaging would be done?	one central location
What is your preferred imaging system configuration?	stand-alone hub
How many shifts per day will the imaging operation be run?	1
Test Fire Operations	
Where do you anticipate test fires will be done for the purpose of collecting samples?	mobile operation
Community Relations	
Do you anticipate having a liaison on staff to communicate program requirements to the dealers and manufacturers?	no
Do you anticipate having a legal counsel on staff to enforce program requirements and resolve issues?	no
Funding	
Enter the amount of annual funding that may be used to offset the cost of the program. This may include gun registration fees, grants, or other funds.	$0

Click Here to Calculate Imaging Rates | **Click Here to Calculate Test Fire Rates** | **Click Here to Calculate Number of Operations Locations**

Figure B-2. Performance Assumptions (page 1 of 3)

Performance Assumptions (page 1 of 3)

Return to Background State Information Sheet

Imaging Performance Rate

Based on Forensic Technology (FTI) data, the imaging process only (excluding prep and storage time) is approximately 3 to 5 minutes for shell casings and 6 to 8 minutes for bullets. Default rates at which shell casings and bullets could be prepped, imaged, and stored are provided below. You may substitute for the default "Time to perform each task" values by entering your own estimates in the "My Estimates" column. The model then calculates the "Number of samples imaged per day" based on the "Time to perform each task" data. Be sure to confirm the imaging rate.

	Time to perform each task (minutes)	
Tasks to Be Performed	**Default**	**My Estimates**
Preparation (log, label the weapon)	1	1
Take image of shell casing and enter into database	13.5	5
Take image of bullet and enter into database	25	8
Enter shell casings and/or bullets into physical storage	1	1
	Number of samples imaged per person, per eight hour day	
Samples to be Imaged	**Default**	**My Estimates**
shell casings only	31	69
bullets only	18	48
shell casings and bullets	12	32

Which calculation would you like to use? ○ Accept Default ◉ Use My Estimates

Confirmation

Your operation is imaging:	**At a daily rate (per person) of:**
shell casings only	69

Figure B-2. Performance Assumptions (page 2 of 3)

Performance Assumptions (page 2 of 3)

Return to Background State Information Sheet

Test Fire Performance Rate

Default rates at which weapons are test fired are provided, based on the following sequence of operations. The rates will vary greatly depending on if test fire operation is central, distributed, or mobile. The default values are estimates made by the model developers. You may accept the default values or enter your own performance estimates. Be sure to confirm the test fire rate.

	Time to perform (minutes)	
Additional Tasks to be Performed When Manufacturer Has Not Supplied Sample Casings and/or Bullets	**Default**	**My Estimates**
Prep request for test fire	10	5
Fire weapon, collect sample, log results	10	6
Send sample to crime lab	0	0
Travel time (and other down time), per day, for mobile operations only	60	45

	Test Fires Performed Per day	
Test Fire Operation	**Default**	**My Estimates**
Mobile Operation	21	40
Stationary Operation (Central or Distributed)	24	44

Which calculation would you like to use? (●) Accept Default ( ) Use My Estimates

Confirmation

Your test fire operation is performed at: mobile operation

Test firing at a daily rate (per person) of: 21 weapons

Figure B-2. Performance Assumptions (page 3 of 3)

Performance Assumptions (page 3 of 3)

Return to Background State Information Sheet

Location of Operations

The calculations below help you determine the number of sites needed if imaging operations and/or test fire operations are distributed among multiple sites (see "Background State Information" sheet). If one or both of these operations is to be distributed, then multiple sites are assumed and the maximum distance between program sites must exceed one mile to avoid the display of an error message. You also have the option to supply the number of sites you would like. This option may be preferable if your state already has sites in operation, for other purposes, that may be used for the ballistics identification program. The model assumes that if imaging operations and test fire sites are both distributed, these operations will be performed at the same sites. Be sure to confirm the number of locations.

Enter the maximum distance (miles) between program sites. Enter zero if you want only one location.	75
Model Estimate: Based on the distance you entered, the model estimates that your operation requires this many sites:	1.2
My Estimate: If you prefer, you may provide your own estimate for the number of sites you would like:	6
Which estimate for number of sites would you like to use, if imaging operations and/or test fire operations are distributed among multiple sites?	○ Use Model Estimate ◉ Use My Estimate
Number of sites needed if imaging operations and/or test fire operations are distributed among multiple sites:	6

Confirmation

Based on information you entered on the Background State Information sheet, model calculations will be based on the following

number of imaging operation sites:	1
number of test fire operation sites:	1

Figure B-3. Miscellaneous Parameters

Miscellaneous Parameters

The parameters are used to generate various operations costs. Place the cursor over an item in the left hand column for an explanation of the item.

	Default Estimate	My Estimate		Estimate Used
Enter the Expected Life of System (years). Enter one year up to 15 years.	5	15	◉ accept default ○ use my estimate	5
Estimate the compliance rate (percent of weapons for which the dealer/manufacturer provides casings) at the onset of your gun sales ballistic identification program.	27%	80%	◉ accept default ○ use my estimate	27%
Estimate the compliance rate the end of the life of the system for your state. Overwrite or accept the default value.	80%	95%	◉ accept default ○ use my estimate	80%
What is the annual rate of salary increase in your state?	4%	3%	◉ accept default ○ use my estimate	4%
What is the annual personnel turnover rate for your state.	25%	15%	◉ accept default ○ use my estimate	25%
What is the annual rate of increase in operating expenses for your state?	1%	5%	◉ accept default ○ use my estimate	1%
Please enter the per weapon fee to be charged (to dealers) for weapons not having samples provided by the manufacturer.	$20	$0	◉ accept default ○ use my estimate	$20
Enter any one-time, ancillary costs?	$50	$0	○ accept default ◉ use my estimate	$0
Enter any annually recurring, ancillary costs?	$0	$0	◉ accept default ○ use my estimate	$0

Figure B-4. Cost Assumptions (page 1 of 2)

COST ASSUMPTIONS (page 1 of 2) Equipment Costs		
The default unit costs are for reference only. You must enter your unit costs based upon vendor quotes and to reflect your operations. Your unit costs are used in model calculations.		
	Default Unit Costs (reference only)	**Vendor Quotes for Unit Costs (used in calculations)**
Correlation Server with SGI@ Origin 2100	$465,000	$465,000
Correlation Server with SGI@ Origin 2400	$1,237,800	$1,237,800
DAS Remote	$250,000	$250,000
DAS Local	$250,000	$250,000
Uninterruptible Power Supply		$0
Printer	$200	$200
ISDN line for FTI product upgrades and technical support		$0
Telephone Line		$0
T1 Line for DAS Remote-correlation server communication	$36,000	$36,000
Work bench or table near DAS	$200	$200
File Cabinet for Sample Storage	$800	$800
MatchPoint	$40,000	$40,000
Rapid Brass Identifier	$35,000	$35,000
Water Tank or Firing Range	$20,000	$20,000
Portable Bullet Trap	$1,900	$1,900
Official state vehicle	$17,500	$17,500
Annual imaging equipment maintenance (percent of basic equipment costs)	11%	$0
Annual maintenance for other equipment (percent of equipment costs)	5%	$0
Floor space		
Annual rental cost per square foot of floor space	$0	$0
Floor space (sq ft per person)	100	$100

Figure B-4. Cost Assumptions (page 2 of 2)

COST ASSUMPTIONS (page 2 of 2)

Labor Costs

Labor Category Name, Salary (and Benefits), and some Default Full-Time Equivalents may be changed to reflect state operations.

Labor Category	Initial Year Salary Per FTE	Full-Time Equivalents
Lab Technician	$29,000	FTEs determined by the model
Technician Manager	$50,000	FTEs determined by the model
State personnel to fire weapons and collect samples	$36,000	FTEs determined by the model
Firearms Toolmark Examiner	$43,000	0.2
Inventory Control Specialist	$38,000	0.1
Office Clerk or other	$31,000	0.1
Dealer and Community Liaison	$45,000	0.4
Legal Counsel to Enforce Imaging Laws	$88,000	0.4
FTI/Vendor staffer on site for support and some training	$0	1.0

Note: The number of liaison (or counsel) FTEs per state shown is used in calculations for states requesting a liaison (or counsel) position. If no liaison (or counsel) position is requested, zero FTEs, are used in the cost calculations. You should only change this liaison (or counsel) FTEs value to a number LARGER than zero. Changing this value to zero will ALWAYS result in zero staff allocated for that position. Use the Background State Information sheet to specify your need for liaison or counsel positions.

Full-Time Equivalent (FTE) Factor

Percent of time full-time person works per year (allows for vacation, holiday, and sick leave). Applies to calculated FTE lab technicians and state personnel to test fire weapons.	80%

Note: Fractional FTEs represent staff assigned part time.

Figure B-5. Results Summary (page 1 of 2)

RESULTS SUMMARY FOR:	Maryland	(page 1 of 2)
Costs for a Stand Alone Configuration		
Observations and Operations Summary	**Initial Year Results**	**Life Cycle Costs**
Recurring Costs		
Labor (Details)	$266,400	$1,153,900
Training	$6,100	$12,300
Equipment Maintenance	$145,330	$680,130
Transportation	$113,800	$193,700
Floor space costs (leased) (Details)	$0	$0
One-time Costs		
Equipment (Details)		
Basic Equipment	$1,215,000	$1,215,000
Other Equipment	$60,600	$60,600
Optional Equipment	$75,000	$75,000
Equipment for Test Fire Operations	$97,000	$97,000
Totals		
Total Operations Costs	**$1,979,300**	**$3,487,700**
Ancillary Costs	$0	$0
Potential funds to offset costs	$438,000	$1,885,200
All dollar values have been rounded to the nearest $100.		

Observations	
The initial year test fire fee per weapon to offset the cost of state personnel to test fire weapons, in the initial year, should be:	$8

Figure B-5. Results Summary (page 2 of 2)

RESULTS SUMMARY FOR: Maryland	**(page 2 of 2)**
Operations Summary from "Background State Information" and "Parameters" Sheets	**Return to Top of Page**
Source: Background State Information	
What types of samples do you anticipate imaging?	shell casings only
Where do you anticipate imaging would be done?	one central location
What is your preferred system configuration?	stand-alone hub
How many shifts per day will the imaging operation be run?	1
Where do you anticipate test fires will be done for the purpose of collecting samples, when samples are not provided by the manufacturers?	mobile operation
Do you anticipate having a liaison on staff to communicate program requirements to the dealers and manufacturers?	no
Do you anticipate having a legal counsel on staff to enforce program requirements and resolve issues?	no
Source: Performance Assumptions	
Number of imaging locations needed	1
Number of test fire locations needed	1
Source: Miscellaneous Parameters	
Number of years in the equipment life cycle	5
Per Weapon fee charged (to dealer) for test fire	$20

Figure B-6. Results Detail

RESULTS DETAIL FOR: Maryland

Labor

Return to Results Summary

Labor Category	Initial Year Full-Time Equivalents	Initial Year Costs	Life Cycle Costs
Lab Technician	2.1	$60,900	$331,400
Technician Manager	0.2	$10,000	$54,400
State personnel to fire weapons and collect samples	5.0	$180,000	$684,300
Firearms Toolmark Examiner	0.2	$8,600	$46,800
Inventory Control Specialist	0.1	$3,800	$20,800
Office Clerk or other	0.1	$3,100	$17,000
Dealer and Community Liaison	0.0	$0	$0
Legal Counsel to Enforce Imaging Laws	0.0	$0	$0
FTI/Vendor staffer on site for support and some training	1.0	$0	$0
Total		**$266,400**	**$1,154,700**

All dollar values have been rounded to the nearest $100.

Equipment

Return to Results Summary

	Number of Units to Purchase to Satisfy Life Cycle		Total Purchase Costs
Basic Equipment			
Correlation Server with SGI@ Origin 2100	1.0		$ 465,000
Correlation Server with SGI@ Origin 2400	0.0		$ -
DAS Remote	0.0		$ -
DAS Local	3.0		$ 750,000
Uninterruptible Power Supply	1		$ -
Other Equipment			
Printer	1		$ 200
ISDN line	1		$ -
Telephone Line	1		$ -
T1 Line to network states	0		$ -
Work bench or table near DAS	2		$ 400
File Cabinets for Sample Storage	75		$ 60,000
Optional Equipment			
MatchPoint	1		$ 40,000
Rapid Brass Identifier	1		$ 35,000
Equipment for Test Fire Operations			
Water Tank or Firing Range	0		$ -
Portable Bullet Trap	5		$ 9,500
Official state vehicle	5		$ 87,500

Floor space (sq ft)

Return to Results Summary

Floor space for Basic Equipment and Other Equipment	637	$ -
Floor space for Optional and Test Fire Equipment	11	$ -
Personnel Floor space	870	$ -

APPENDIX C

GETTING STARTED WITH THE RBID PLANNING MODEL

The information below is intended for individuals who are first-time users of this model.

SYSTEM REQUIREMENTS

This model was developed using Microsoft Excel 2000. Therefore, Microsoft Excel is required to run the model.

FIRST-TIME USE INSTRUCTIONS

Use the *File–Save As* option in Excel to make a backup copy of the original model. That way, the original version will be available in the event that inadvertent, permanent changes are made to the model.

GETTING STARTED

- Open the Microsoft Excel model.
- The following options will appear: *Disable Macros*, *Enable Macros,* or *More Information.* Always choose *Enable Macros.*
- The **Welcome** worksheet will appear (Figure C-1).
- Click on the *Go To Model Map* button at the bottom of the page.
- Once at the *Map of the Model* worksheet (Figure C-2), first-time users should review the **Read Me First** sheet.
- Users familiar with the model should enter and retrieve information in the sequence suggested on the *Map of the Model* sheet. The model may be navigated by either selecting the buttons shown in the model map or by selecting the desired Excel worksheet tabs at the bottom of the screen.
- Proceed through the model as outlined in the model map. Refer to Section 5 and Appendices A and B of this document for detailed discussions of the significance of each of the model components.

SAVING YOUR CONFIGURATION SCENARIOS

Changes to scenarios are not saved automatically when using the *Exit Model* button. Remember to use the *File–Save As* option to save your changes. When saving, save each scenario under a different file name; otherwise, previous scenarios will be overwritten.

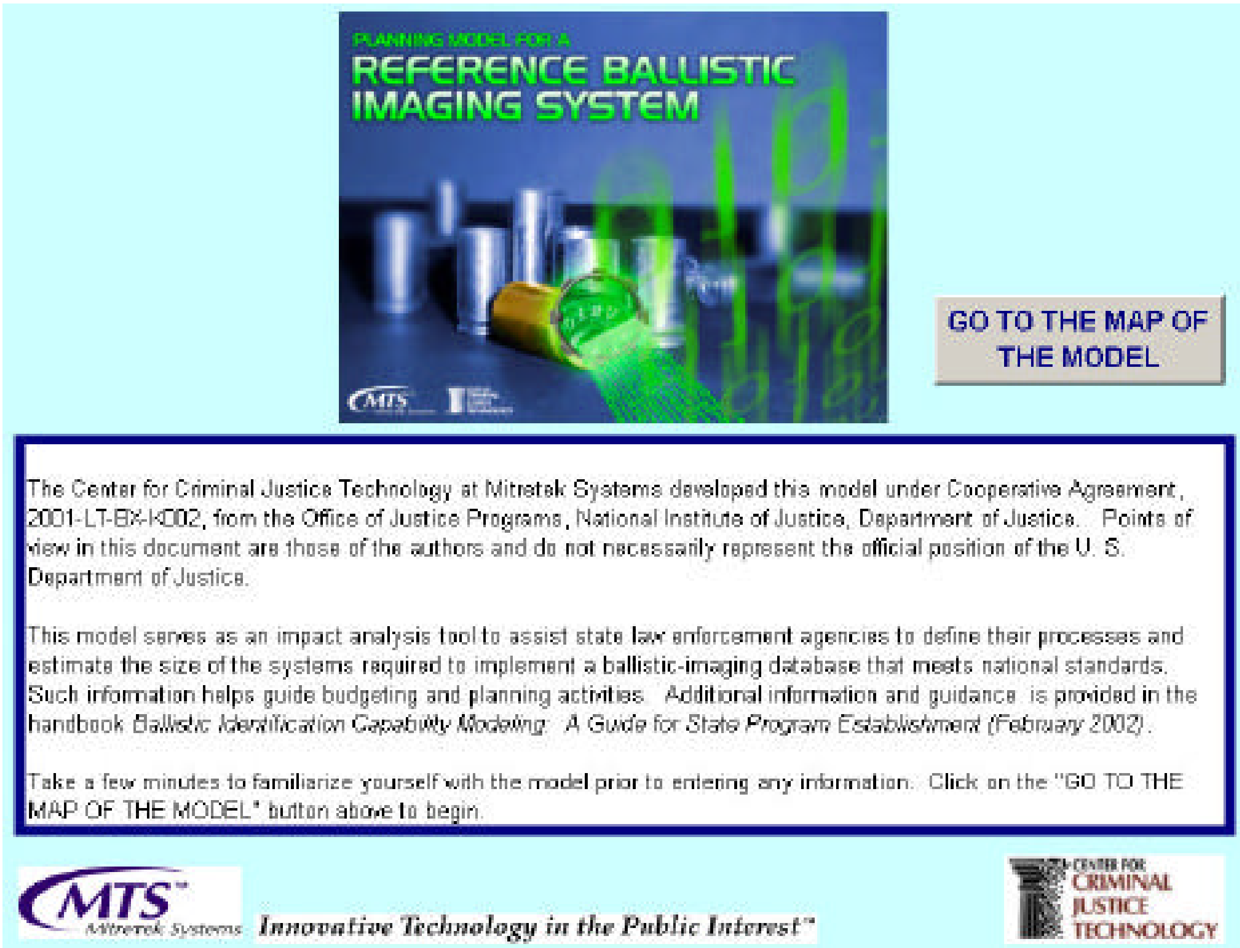

Figure C-1. *Welcome* Worksheet

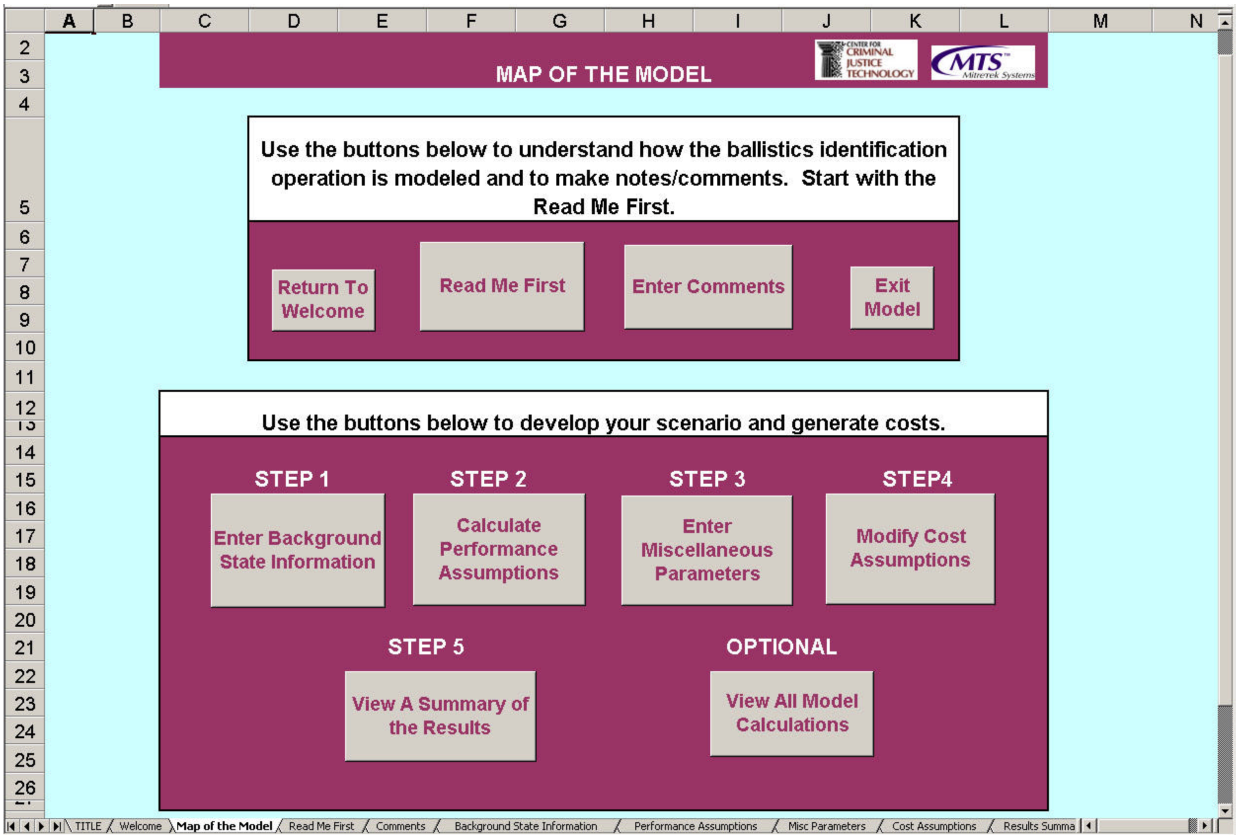

Figure C-2. ***Map of the Model*** **Worksheet**

LIST OF ACRONYMS

ATF	Bureau of Alcohol, Tobacco, and Firearms
CCJT	Center for Criminal Justice Technology
CJIS	Criminal Justice Information Services
CoBIS	Combined Ballistic Identification System
DAS	Data Acquisition Station (FTI product)
FBI	Federal Bureau of Investigation
FTE	Full-time equivalent
FTI	Forensic Technology, Inc.
GB	gigabytes
IBIS®	Integrated Ballistics Identification System (FTI product)
ISDN	Integrated Services Digital Network
KB	kilobytes
LIMS	Laboratory Information Management System
MOU	Memorandum of Understanding
NIBIN	National Integrated Ballistic Information Network
NIJ	National Institute of Justice
RBI	Rapid Brass Identifier (FTI product)
RBID	Reference Ballistic Imaging Database
SAS	Signature Analysis Station (FTI product)
SGI®	Silicon Graphics, Inc.
UPS	Uninterruptible power supply
WAN	Wide area network