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Electronics and Electrical Engineering Laboratory

Office of Law Enforcement Standards

Programs, Activities, and Accomplishments

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The Electronics and Electrical Engineering Laboratory

Through its technical laboratory research programs, the Electronics and Electrical Engineering Laboratory (EEEL) supports the U.S. electronics industry, its suppliers, and its customers by providing measurement technology needed to maintain and improve their competitive position. EEEL also provides support to the federal government as needed to improve efficiency in technical operations and cooperates with academia in the development and use of measurement methods and scientific data.

EEEL consists of five programmatic divisions, two matrix-managed offices, and a special unit concerned with magnetic metrology:

- Electricity Division
- Semiconductor Electronics Division
- Radio-Frequency Technology Division
- Electromagnetic Technology Division
- Optoelectronics Division
- Office of Microelectronic Programs
- Office of Law Enforcement Standards
- Magnetics Group

This document describes the technical programs of the Office of Law Enforcemnt Standards. Similar documents describing the other Divisions and Offices are available. Contact NIST/EEEL, 100 Bureau Drive, MS 8100, Gaithersburg, MD 20899-8100, Telephone: (301) 975-2220, On the Web: http://www.eeel.nist.gov

Cover Caption: The Office of Law Enforcement Standards assists law enforcement and criminal justice agencies though the development of equipment performance standards, standard reference materials, and scientific research. Our logo reflects the type of programs that we conduct: DNA research, arson research, forensic sciences, and law enforcement weapons and equipment. Also shown on the cover is a model of the DNA double helix, an electrophoresis system used in DNA reseach and identification, and a law enforcement officer using a conventional radar speed measuring device.

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U.S. DEPARTMENT OF COMMERCE
Norman Y. Mineta, Secretary

Technology Administration
Dr. Cheryl L. Shavers, Under Secretary of Commerce for Technology

National Institute of Standards and Technology
Karen H. Brown, Acting Director

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Welcome

The **Office of Law Enforcement Standards (OLES)** helps law enforcement, corrections, and criminal justice agencies ensure that the equipment they purchase and the technologies they use are safe, dependable, and effective. The Office, with a staff of eight, is based in Gaithersburg, Maryland, and is one of the two offices within the Electronics and Electrical Engineering Laboratory at NIST.

OLES was established as a matrix management organization in 1971 and was based on recommendations from the President's Commission on Crime. The Commission report, entitled "Crime in a Free Society," recommended that a Federal agency be appointed to assist criminal justice agencies by developing equipment standards and providing technical support and assistance. The report indicated that the then National Bureau of Standards was one such agency suitable for this task. As a result, the Departments of Commerce and Justice signed a Memorandum of Understanding and the Office was established.

Since that date, **OLES** has fulfilled its mission by applying science and technology to the needs of the criminal justice community, including law enforcement, corrections, and forensic science as well as the fire service. The Office focuses on the development of performance standards, which are promulgated as voluntary national standards by the National Institute of Justice (NIJ), the research arm of the Department of Justice (DOJ). **OLES** also conducts studies that result in the publication of technical reports and user guidelines.

NIJ is the primary sponsor of **OLES** projects. Projects are and have also been supported by the National Highway Traffic Safety Administration (NHTSA), the Federal Bureau of Investigation (FBI), the Office of Management and Budget (OMB), and the Federal Aviation Administration.

OLES conducts research on protective clothing, communication systems, emergency equipment, investigative aids, protective and enforcement equipment, security systems, traffic enforcement systems, vehicles, weapons and ammunition, and analytical techniques and standard reference materials used by the forensic science community. The composition of **OLES** projects varies depending on the priorities of the criminal justice community at any given time, and, as necessary, draws upon the resources of NIST's Measurement and Standards Laboratories and outside agencies.

To help law enforcement, corrections, and criminal justice agencies acquire the high-quality resources that they need to do their jobs, **OLES**:

- Develops methods for testing equipment performance;
- Develops methods for examining evidentiary materials;
- Develops standards for equipment and operating procedures;
- Develops users' guides;
- Develops standard reference materials; and
- Performs other scientific and engineering research as required by NIJ.

The NIJ-sponsored activities are managed by **OLES** as part of an overall Law Enforcement and Corrections Standards and Testing Program that includes the development of standards and test protocols, the testing of equipment, and the publication of test results. For example, the Public Safety Communications Standards Program resulted in the development of standards for communication systems items, such as portable transceivers, base stations, mobile digital equipment, and surveillance devices. The Weapons and Protective Systems Program developed standards for revolvers and semi-automatic pistols, shotguns, body armor, protective helmets, and handcuffs.

OLES has published, mostly through NIJ, more than 200 standards, guides, and technical reports over its 28-year history. These publications have dealt with such topics as emergency vehicle warning devices, police clothing and equipment, components of intrusion alarm systems, physical security of door and window assemblies, metal and explosive vapor detectors, arson accelerant detectors, and narcotic test kits. **OLES** also developed standard reference materials for glass comparisons and DNA profiling and reference collections of automobile paints and synthetic fibers for use by forensic laboratories.

The projects listed in this book are those that **OLES** has proposed for fiscal year 2001. The actual portfolio is being negotiated as this book is being prepared. For additional information about the Office of Law Enforcement Standards, please visit our web sites at http://www.eeel.nist.gov/oles or http://www.nlectc.org.

Mission

The mission of **OLES** is to serve as the principal agent for standards development for the criminal justice and public safety communities. **OLES** has been instrumental in the development of numerous standards and the issuance of various technical reports that have had significant impact on both of these communities. Through its programs, **OLES** helps criminal justice and public safety agencies acquire, on a cost-effective basis, the high quality resources they need to do their jobs. To accomplish this task, **OLES**:

- Develops methods for testing equipment performance;
- Develops methods for examining evidentiary materials;
- Develops standards for equipment and operating procedures;
- Develops users' guides;
- Develops standard reference materials; and
- Performs other scientific and engineering research as required by the criminal justice and public safety communities.

Vision

The vision of **OLES** is to apply science and technology to the needs of the criminal justice community, including law enforcement, corrections, forensic science, and the fire service. While the primary focus is on the development of minimum performance standards, which are promulgated by the sponsoring agency as voluntary national standards, **OLES** also undertakes studies leading to new technology development and evaluations, new measuring science protocols, new standard reference materials and standard reference collections for application to the criminal justice system, and the issuance of technical reports and user guidelines.

Values

OLES values its commitment to serve the public safety community in acquiring, on a cost-effective basis, the high-quality resources they need to do their jobs to meet the needs of the criminal justice system. The Office values its collaboration with the national law enforcement technology centers, the forensic community, and all segments of the criminal justice community. **OLES** strives to understand the needs of the community it serves and strives to meet the needs of this community keeping in mind the limited funds at its disposal. **OLES** advocates the needs of the public safety community to the scientific community and encourages the adaptation of available technologies so that these needs can be met.

Weapons and Protective Systems

Project Goals

To manage programs, direct and conduct research, develop test plans, oversee and monitor test and evaluation efforts, and develop performance standards, guidelines and reports to advance the technologies of weapons, protective equipment, and ammunition in support of the goals and priorities of law enforcement, corrections, and criminal justice agencies.

Technical Strategy

The Office of Law Enforcement Standards conducts and monitors programs that are concerned with establishing performance standards for weapons and protective equipment used by law enforcement and corrections personnel. In some cases, existing standards are revised to reflect the current state of technology or to improve the test methodology. The standards in this area that are being revised or studied in FY2001 are as follows:

- Revision of NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor."
- Revision of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor."
- Revision of NIJ Standard–0108.01, "Ballistic Resistance of Protective Materials."
- Revision of NIJ Standard–0106.01, "Ballistic Helmets."
- Revision of NIJ Standard–0307.01, "Metallic Handcuffs."
- Revision of NIJ Standard–0104.02, "Riot Helmets and Face Shields."
- Revision of NIJ Standard–0113.00, "12-Gauge Shotguns for Police Use."

In other cases, it is necessary to develop new NIJ standards or test protocols. Programs in this area for FY2001 are as follows:

- Development of a Bomb Suit Standard.
- Development of a Test Protocol for Gunlocks.
- Development of a Holster Standard.
- Development of a Test Protocol for Evaluation of "Smart Guns."
- Development of an Armored Car Standard.

OLES is developing a state-of-the-art research test facility specifically for addressing weapons, ballistics, and protective equipment issues for the law enforcement and corrections community.

OLES also provides continuing support to standards and test protocols that are in use. The following are examples where we will provide support in FY2001:

- Support of NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor."
- Support of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor."
- Support of Protective Gloves Test Protocol.

OLES also provides technical consultation to law enforcement and corrections personnel and the general public in areas related to equipment selection, ballistics, performance issues, training, etc.

Support of NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor"

The objective of this project is to provide continuing support to the ballistic resistant body armor compliance testing program. Law enforcement and corrections agencies rely on the NIJ Standard to ensure the quality and reliability of their bullet resistant vests. As new developments occur, such as new materials and changing ballistic threats, the standard is updated on a regular basis to respond to these changes.

This latest revision, NIJ Standard–0101.04, is an improvement of the 1987 revision of NIJ Standard–0101.03. Over the years numerous administrative modifications and clarifications had been issued for that standard. The latest revision incorporates these improvements, redefines ballistic threats, specifies more consistent and rigorous test methodologies, requires that armor be characterized in a ballistic limit test, and defines a consistent report format.

The standard was published in September 2000. NIST/OLES worked with NIJ and the National Law Enforcement and Corrections Technology Center (NLECTC) to identify and certify commercial test laboratories to conduct body armor compliance testing to NIJ Standard–0101.04.

OLES will continue to work with NLECTC to monitor the testing of ballistic resistant vests. This is especially crucial during the first year of testing to the "04 standard," to determine if anything needs further attention. While this monitoring effort is underway, some of the changes introduced to the "04 standard" revision

Technical Contacts:

Kirk Rice

Alim Fatah

Kathleen Higgins

Thomas Russell

Staff-Years:

4.6 professionals

1.0 technician

Funding Sources:

Other Government Agencies (100%)

Project Champions:

- Armor & Protective Systems Working Group of government agencies
- EEEL, Electricity Division, Electronic Instrumentation and Metrology Group
- Home Office, Police Scientific Development Branch (PSDB), United Kingdom
- Institute of Surgical Research, Brooke Army Medical Center, San Antonio, TX
- National Law Enforcement and Corrections Technology Center, Rockville, MD
- National Technical Systems, Fredericksburg, VA
- Office of Special Technology, Technical Support Working Group (TSWG) of government agencies, Ft. Washington, MD
- The Tekne Group, Inc., Hot Springs, AR
- Touchstone Research Laboratory, Ltd., Triadelphia, WV
- University of Virginia, Charlottesville, VA
- U.S. Army Aberdeen Test Center (ATC), Aberdeen, MD
- U.S. Army Soldier Systems Command, Natick, MA
- U.S. Secret Service, Washington, DC

will be studied to further validate them through commercial testing. This might include conducting independent testing at the NIST/OLES test facility, consulting with others in the field, or issuing clarifying instructions to address the deficiency.

Of particular interest during this monitoring and evaluation period are the following:

- Evaluate the failure rate of body armor as a result of the somewhat more stringent backface signature (BFS) requirement, which now requires two measurements rather than one.
- Study the ballistic limit data obtained using the Modified Langlie Method.
- Evaluate alternative methods for collecting and assessing ballistic limit data, such as the Kneubuehl method.
- Evaluate the failure rate of new body armor designs as a result of being tested against the new threat rounds.

MILESTONES: During FY2001, OLES will address comments and concerns regarding the latest revision to NIJ Standard–0101.04. A report, or several reports, describing any relevant findings and conclusions on the issues studied will be issued throughout the year. Furthermore, any recommendations for clarifying the "04 standard," or otherwise improving it, will be made.

Revision of NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor"

The objective of this project is to obtain information from numerous studies to support a future revision to NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor."

Experience with the last revision to the NIJ ballistic resistant body armor suggested that this standard needs to be maintained and updated more frequently than in the past. To this end, NIJ plans a program of continued study to make further refinements to this standard.

There are several areas that could benefit from more research or the application of newer technologies. In particular, the methods used to define reasonable threats and then how to best represent those threats in the standard will be examined. The ballistic impact with body armor will be studied to determine if there are better ways to assess the deformation of the armor. Research related to the effects of ballistic blunt trauma to the body and the possible influence this might have on the minimum performance of body armor will be monitored. The statistical confidence of the current tests will be studied, and alternative methods for conducting the tests to produce higher reliability results will be explored. The influence of environmental life cycle on the ballistic performance of armor will be studied. The effect of multiple, nearly isochronic impacts with body armor will be studied and a determination will be made as to whether this test protocol should be adopted in some future revision. The procedures for testing female body armor will be studied, and any special considerations that would influence the design of female body armor will be examined for possible inclusion in a future revision. Methods to test trauma packs will be developed for inclusion in the next revision of the body armor standard. More information on each of these subprojects follows.

As research continues in these areas, reports describing relevant findings and conclusions will be issued throughout the year. Improved methods will be considered for adoption into the "05" revision of the body armor standard; and as these methods are validated, a draft standard will be developed. The final product, that is a revised standard, will probably not be ready until FY2003, depending upon the schedule of supporting studies.

Threat Determination

The threat levels defined in previous versions of the NIJ ballistic resistant body armor standard were based upon a review of firearms likely to be encountered by law enforcement officers. For a given caliber of firearm, there are many variables that will influence ballistic performance. Historically, bullet types and velocities were defined in the standard in such a way that the threat round represented a high performance variant of a typical round that could be fired from a typical firearm of that caliber. For most of the threat levels in the standard, two types of rounds were identified. Generally, one of these is a more serious threat to the penetration requirement, while the other one is a more serious threat to the backface signature requirement. To produce rounds having the specified performance levels, a test laboratory normally purchases commercial bullets meeting the requirements of the standard and then hand loads cartridges to produce the required ballistics.

In this subproject, other methods for defining the threat levels will be explored. One method will base the threat potential on basic bullet properties and ballistic performance. As part of this effort, a database compiling bullet energies and other properties and known performance trends will be established. Properties such as bullet mass, velocity, materials, and construction details will be considered. The data will be analyzed to determine if some empirical method can be used in a predictive manner to lump cartridges into general categories based on the threat they pose to body armor. As a logical extension of this process, modifications or refinements to the relative impact factor (RIF) concept will be examined. The advantage of this approach is that it will provide the same type of threat level definition that is currently used, but because it is more generalized, will also allow other rounds not identified in the standard, but of interest to some law enforcement agencies, to be categorized into specific threat levels that are in the standard. Another extension of this process will be to evaluate the number of NIJ threat levels in the standard to determine if any can be eliminated or if any new ones need to be added.

Another area to be explored deals with using NIJ designed and manufactured bullets and/or cartridges rather than those obtained commercially off-the-shelf. This effort is aimed at eliminating a potential problem with the standard. Ammunition manufacturers sometimes change their bullet designs, and ballistic performance can change as a result of this. A possible solution is to define "standardized" test bullets or cartridges whose properties are carefully controlled so that the threat rounds are more reproducible.

MILESTONES: A report describing relevant findings and conclusions on the issues studied will be issued by year end. Follow-on work to implement standardized ammunition, if deemed appropriate, is expected in FY2002.

Body Armor Impact Phenomena

This subproject is focused on determining if there are better ways to assess the energy dissipating characteristics of body armor. The current method for assessing backface deformation with a clay block is satisfactory under controlled conditions, but it could be improved upon. Other measurement techniques for assessing the impact to the body armor will be explored. Studies into replacement media for the clay are planned, as well as possibly developing an electronic measurement method for measuring the forces and energies applied to the body armor.

MILESTONES: Throughout the year, concepts for study will be developed and test fixtures will be built. A report describing relevant findings will be issued by year end. Follow-on work to assess the feasibility of these methods through evaluation testing is expected in FY2002.

Optoelectronic Method to Measure Body Armor Deformation

This subproject will examine the feasibility of using optoelectronic methods to measure the time-history of projectile-induced deformation of a backing material. If successful, this work will be the basis for the development of an automated system for measuring the energy and force imparted to a backing material through body armor. Such a method could lead to reduced test costs, shorter test times, increased test accuracy, and a greater understanding of impact phenomena.

The proposed work is to determine whether there are materials that can be used in the development of an optoelectronic test system. Material requirements are:

- Optically transparent over the wavelengths of conventional and inexpensive light sources.
- Withstand many projectile impacts without affecting optical properties or mechanical properties.
- Fast (within 10 s) elastic relaxation to initial geometry to allow nearby or same-location measurements.
- If penetrated, damage limited locally to penetrated region.

To find a suitable material will require contacting manufacturers and testing candidate materials. Testing will consist of performing impact events at the OLES test facility and then optical transparency measurements using a suitable laser in the Electricity Division labs. Mechanical property changes will be noted by comparing deformation under static conditions.

If a candidate material is found to be suitable for the development of a measurement system, follow-on work will be proposed to design, construct, and test an automated measurement system.

MILESTONES: In FY2001, candidate materials will be identified, procured, and characterized. In FY2002, the ballistic test system will be built and initial ballistic deformation tests will be

conducted. In FY2003, the results will be assessed and a report will be written, with recommendations on whether to adopt the method.

Behind-Armor Effects Research

Several efforts are planned to study behind-armor trauma effects. OLES participates as a member of the Technical Support Working Group (TSWG) of government agencies. Through the TSWG, two contracts are planned to study the validity of the 44 mm backface signature and to compile a database of blunt trauma induced by ballistic phenomena. Recent developments during the contract proposal evaluation phase have left a contract award in doubt. If the contract does come to fruition, OLES will serve as the government technical lead on the effort.

In addition to the TSWG approach, OLES plans to collaborate with the International Association of Chiefs of Police (IACP) and industrial partner, DuPont, to examine the records they maintain in the Survivor's Club database to identify any data that would prove valuable.

Other areas that will be examined for potential relevance to this research involve other government contracts with Battelle and Wayne State University.

MILESTONES: A report describing relevant findings will be issued by year end. Follow-on work is expected in FY2002.

Statistical Basis of Testing

The number of ballistic impacts (shots) to provide meaningful information on the failure of ballistic armor has been examined several times in the past. Most recently under the "04" revision, a decision was made to retain 48 shots, even though the "dry" tests were eliminated. This was done to maintain the same degree of statistical confidence in the results. Under this new subproject, other methods for conducting the test sequence will be explored, with the goal to obtain meaningful results more quickly. The method for ballistic limit testing will also be examined to determine if there is a better way to conduct this test. Ideally, some method will combine the assessment of ballistic limit testing, penetration evaluation, and backface deformation (energy dissipation) assessment into a single test series.

MILESTONES: In FY2001, NIST/OLES will define the required levels of test reliability and statistical confidence. Test methods that allow for efficient test conduct will be developed, and these will be evaluated to determine their statistical characteristics. Other methods for estimating the ballistic limit of body armor will be explored. Data collected as part of the NIJ Standard–0101.04 testing will be utilized for this work. Pass/fail criteria for ballistic limit testing will be developed. A report describing relevant findings will be issued by year end. Follow-on work is expected in FY2002.

Environmental Effects on Body Armor Ballistic Resistance

Past studies on the ballistic performance of body armor have been limited to either new armor or armor that was worn routinely by law enforcement officers. The problem with testing previously worn armor is that the environmental exposure history is uncertain. TSWG is planning to issue a contract to study how the ballistic resistance of body armor is influenced by aging, as well as other environmental effects. OLES will serve as the government technical lead on this contract.

MILESTONES: Under this contractual effort, appropriate life-cycle environment will be determined. Selected types of armor will be subjected to the environment and periodically tested for possible degradation. NIST/OLES will conduct some in-house studies to supplement the TSWG effort. Progress reports describing the TSWG effort will be forwarded as they are received. This effort is expected to carry into FY2002.

Multi-Hit Test

The law enforcement community has indicated that the performance of body armor subjected to multiple, nearly isochronic impacts is of concern to them. To assess this, Bosik Consultants Limited in Canada has developed a multi-hit gun fixture. OLES will provide technical consultation to the Canadian contract that will eventually result in the delivery of a 3-barrel test rig and test method.

MILESTONES: The test rig and test protocol are expected in late calendar year 2001.

Female Body Armor

The current version of the body armor standard specifies some special treatment for female body armor. This subproject is aimed at a more detailed study of female body armor to determine if there are better ways to assess the performance of female body armor. TSWG is planning to issue a contract to address this area. OLES will serve as the government technical lead on this contract.

MILESTONES: NIST/OLES will monitor the planned TSWG contract on "Female Body Armor Studies," and we will assist with defining the test method. Progress reports describing the TSWG effort will be forwarded as they are received. In addition, NIST/OLES will evaluate the state of technology and conduct in-house studies to supplement the TSWG effort. Based on the results of the TSWG contract and any related studies, any special requirements, test equipment, and test methodologies specific to female armor will be developed. This effort is expected to carry into FY2002.

Test Protocol for Body Armor Trauma Packs

Presently, supplemental trauma packs included with armor are not tested with the armor during compliance testing. Past efforts to study trauma packs through TSWG contracts have not been successful, so OLES plans to conduct in-house testing. The purpose of this effort is to determine a suitable method for testing and evaluating soft body armor that includes trauma packs. Significant suggestions resulting from this study would be incorporated into a future revision of the soft body armor standard.

MILESTONES: In FY2001, samples of various trauma packs will be obtained and tested by conventional methods. Additionally, we will monitor work that will be sponsored by the TSWG in the areas of backface deformation research and blunt trauma literature survey. A test method will be identified and validated through testing, and incorporated into a future revision of the standard. Reports or white papers that recommend a position on key topics will be drafted for use in the future revision of the ballistic resistant body armor standard, but the standard will not be revised for several years.

Support of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor"

The objective of this project is to provide continuing support to the stab resistant body armor compliance testing program. NIJ Standard–0115.00 is the first true U.S. standard addressing the stab resistance of personal body armor, and it provides a consistent measure by which stab resistant body armor performance can be assessed. The stab threat from sharp and edged weapons represents the primary threat to corrections officers and a secondary threat to police officers in the United States. Many agencies are expected to take advantage of the matching funds offered through the Bulletproof Vest Partnership Act Program and to purchase stab resistant body armor certified to this standard.

OLES stab test apparatus used to support development of NIJ body armor standard for stab resistance.

This standard was published in September 2000. NIST/OLES worked with NIJ and NLECTC to identify and certify a commercial test laboratory to conduct body armor compliance testing to the "stab standard." The implementation of the formal compliance testing program is modeled after the one used for ballistic resistant body armor. OLES will work with NLECTC to monitor the testing, which is especially crucial during the inaugural year of testing to determine if anything needs further attention.

MILESTONES: NIST/OLES will monitor testing taking place under the compliance testing program to identify any potential problem areas, and work to resolve those. This might include conducting independent testing at the NIST/OLES test facility, consulting with others in the field, or issuing clarifying instructions to address the deficiency. NIST/OLES will also participate in the process of identifying and certifying a second commercial test laboratory that will conduct body armor compliance testing to the standard. Throughout the year, any relevant findings will be documented and, if necessary, clarifications will be made to the standard.

Revision of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor"

The objective of this project is to continue studies that will provide information to support a future

revision of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor."

The stab resistant body armor compliance testing program began in October 2000. While the baseline version of the standard was being prepared, several areas were identified that would benefit from further study. In particular, these areas dealt with slash testing, tip sharpness testing, and backing material specification. NIST/OLES plans to study these areas and provide guidance for future improvements to the standard. To effectively do this, NIST/OLES will continue collaborating with the Police Scientific Development Branch (PSDB). An annex to the existing bi-lateral agreement has been developed jointly between the U.S. and U.K. technical points of contact.

The slash threat was not directly addressed in NIJ Standard–0115.00, although it is not believed to be as severe as the stab threats. Future improvements to this standard will incorporate a slash test methodology.

The tip sharpness of the knife blades and spike that are defined in the NIJ standard must meet certain requirements. Not addressed in the standard are any requirements for knife blade edge sharpness. Future improvements to this standard will probably incorporate an edge sharpness requirement and test methodology.

The backing material specified in the NIJ standard consists of multiple layers of commercially available rubber and sponge foam sheets. These materials typically have fairly large variations in their physical properties due to routine production variations. Future improvements to this standard will probably incorporate better definition of these materials or specify new and improved materials.

The portion of the standard dealing with stabs from spikes needs more attention. A very close variant of the test methodology developed by PSDB in their 1999 stab standard was adopted in this NIJ standard. Not addressed by PSDB was the threat due to a spike-style weapon. OLES adopted a spike based on a design similar to the California Ice Pick threat, while retaining the standard test methods already specified in the NIJ standard.

MILESTONES: NIST/OLES will champion further collaboration with the U.K. through the Technical Support Working Group, Personnel Protection Subgroup (TSWG-PP). Issues to be addressed through this collaboration are: further research on spike threats, the development of an edge sharpness test, further studies on backing materials, and development and validation of a slash test methodology. Throughout the year, any relevant findings will be documented for future incorporation into a new revision of the standard.

Revision of NIJ Standard–0108.01, "Ballistic Resistance of Protective Materials"

The objective of this project is to establish minimum performance requirements and methods of test for ballistic resistant protective materials. These materials are of many types, and can be found in shields, ballistic resistant plates, vehicle armor, and transparent bullet-resistant materials.

The current revision of the standard, NIJ Standard–0108.01 was released in September 1985. It added another ballistic threat level and established threat level classifications that were consistent with other NIJ standards for ballistic protection.

This effort was identified in last year's plan, but a decision was made to postpone revising this standard pending finalization of the latest revision of the ballistic resistant body armor standard, NIJ Standard–0101.04, so that improvements to that standard could be carried over into this one.

From the body armor standard work, a test methodology that estimates the ballistic limit, that is, the velocity at which a ballistic resistant material is expected to fail 50 % of the time, has been adopted. It is based on a modified Langlie method of test. The ballistic threats were also reviewed and updated. Further improvements were made by specifying formal test procedures and requiring a uniform reporting style.

MILESTONES: Throughout the year, a newly revised draft of NIJ Standard–0108.01, that incorporates improvements from the body armor standard, will be developed. The draft standard will also include special provisions for testing transparent materials. The draft standard is expected by the end of FY2001. Progress reports will be provided quarterly. Work is expected to continue in FY2002 when the test methods will be validated through extensive experimental testing. The draft standard will then be available for comment and review. A final version is expected to be ready for publication by late FY2002.

Revision of NIJ Standard–0106.01, "Ballistic Helmets"

The objective of this project is to revise NIJ Standard–0106.01, "Ballistic Helmets." This standard establishes minimum performance requirements and methods of test for ballistic helmets. Law enforcement agencies rely on the NIJ standard for "Ballistic Helmets" to ensure the quality and reliability of their bullet resistant helmets.

While this effort was identified in last year's plan, a decision was made to postpone revising the standard pending two things: the release of the latest revision of the ballistic resistant body armor standard, NIJ Standard–0101.04, and the conclusion of the Army contract with the University of Virginia (UVA). The rationale for this is that many of the improvements incorporated in NIJ Standard–0101.04 can be carried over into the new revision of NIJ Standard–0106.01; and completion of the first couple phases of the UVA contract in September 1999 and May 2000 suggest that the findings from the entire UVA effort will be very helpful.

The original standard, NILECJ–STD–0106.00, was issued in September 1975. In December of 1981, the next revision (NIJ Standard–0106.01), brought the threat level definitions into agreement with the body armor standard. There are still several deficiencies in the current helmet standard: 1) it does not include all of the latest threat levels; 2) the impact measurement system needs to be revised to make it easier to apply; 3) there is some question about the amount of impact reduction necessary for short duration impacts, such as those produced when a handgun bullet is stopped; and 4) the current standard only tests for impact reduction at the maximum threat level for which the helmet is rated. It is conceivable that a lower threat level impact would not be attenuated, and therefore, could transmit dangerous impacts to the head.

In prior years, a helmet literature search revealed studies whose results would establish a realistic basis for assessing the protection performance of ballistic helmets. Then in FY1999, an Interagency Agreement between NIST/OLES and the U.S. Army Research Laboratory (ARL) at Natick, Massachusetts created a means to support additional research through a 5-phase, 28-month R&D contract to UVA. ARL/Natick manages the contract. The Army and OLES jointly fund the contract, with a majority of the funding coming from the Army. The Army also administers the contract. The primary goals of the contract are to assess the limiting performance of helmets for the prevention of head injury and to define risk-of-injury criteria under ballistic impacts. A secondary goal is to identify an experimental test using anthropometric test devices (ATDs). This correlation can subsequently be used to predict the risk of human injury through the use of ATDs alone. A kick-off meeting was held in February 1999 at Aberdeen Proving Ground, MD to define research plans for high-fidelity tests to study head trauma effects as a result of ballistic loading of helmets.

The Army is interested in ballistic helmet test standards because they have a requirement to provide lighter weight ballistic head protection to their troops. As helmets grow lighter, through the utilization of new and improved materials, the shock loading to the head from ballistic impacts may increase. Correlation of forces recorded on an ATD with physical effects on individuals will promote the development of improved, lighter weight, energy absorbing, protective helmet systems for both the military and the law enforcement community. The ability to validate the existing NIJ helmet standard or establish a standard ballistic test method which can discriminate marginal from acceptable ballistic protective helmets is key to the successful transfer of technology to the law enforcement community.

MILESTONES: In FY2001, NIST/OLES will continue to monitor and participate in a research program underway at UVA through the Army contract. The findings from that effort will be evaluated for potential inclusion in this revision of the standard. The helmet test capability at NIST/OLES will also be reestablished. Several items will be addressed in the revision to this standard, including: adoption of the NIJ Standard–0101.04 ballistic threat levels; ballistic limit testing; revision of the impact measurement system for performance testing; re-evaluation of baseline performance requirements; improvements in the area of test quality assurance by specifying the use of formal test procedures; and normalized compliance testing report forms. After the UVA contract is completed, a draft of the revised standard will be developed. This is expected to occur in FY2002. Progress reports will be provided quarterly.

Revision of NIJ Standard–0307.01, "Metallic Handcuffs"

The objective of this project is to revise NIJ Standard–0307.01, "Metallic Handcuffs." The improvements to this standard would provide a better way to test and evaluate handcuffs,

resulting in better equipment being available to public safety officers.

The classic mass-produced steel handcuff, little changed over the last 90 years, is used for arrests and for prisoner transport. The limitations of traditional handcuffs become evident, particularly during the transport of prisoners, where prisoners have been known to pick the double lock with a bit of wire, or defeat the pawl directly with a piece of thin material, or break the "cheek plates" apart at the ratchet pivot. An improved standard could force desired improvements in the design of metallic handcuffs.

OLES has been conducting an investigation into handcuff design parameters and performance test options. A force-torque apparatus for evaluating loads applied to typical handcuffs was developed. A theoretical analysis describing the handcuff components as curved beams was developed and used to examine the way in which the stiffness of those "beams" depends on shape and material composition.

A contract with Touchstone Research Laboratory addressed design details and shortcomings including: longitudinal testing of handcuffs having no tongues on the cheek plates; factors affecting the picking of handcuff locks; and handcuff size issues.

MILESTONES: This effort was identified in last year's plan, but was then postponed because of resource limitations. In FY2001, NIST/OLES will evaluate the Touchstone report for relevant information that could be used to improve the standard. Improved test methods will be developed, and designs for any special equipment needed to test handcuffs will be finalized. A draft of the revised standard and specifications of specialized test equipment is planned for September 2001. Follow-on work to validate the testing methodology is planned for FY2002.

Revision of NIJ Standard–0104.02, "Riot Helmets and Face Shields"

The objective of this project is to review NIJ Standard–0104.02, "Riot Helmets and Face Shields" and to issue an improved revision. The current version of the standard was published in October 1984. Since that time the safety equipment testing industry as well as the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI) have switched to "headforms" endorsed by the International Organization for Standardization (ISO) for all protective headgear testing. OLES has received, over the past few years, many complaints from the safety equipment testing laboratories about the lack of availability of the "headform" specified in the NIJ Standard and that this NIJ Standard is not conforming to the adoption of international standards wherever feasible. The anticipated improvements to this standard would allow test laboratories to use commercially available test equipment.

MILESTONES: This standard was identified in last year's plan, but was then postponed because of resource limitations. In FY2001, NIST/OLES will review the standard to identify whether upgrading the identified threat levels covered in the current standard is necessary and whether changing to an ISO "headform" will change the protection levels covered under the old standard. Other standards bodies will be consulted to discuss their rationale for and experiences with the ISO headform. If changes are necessary, revised test procedures will be developed and validated through experimental testing. Any relevant findings will be documented. If changes to the standard are warranted, a draft of the new revision will be developed by the end of FY2001.

Re-Establish OLES' Research Test Facility

The objective of this project is to relocate and improve OLES' Research Test Facility. The test facility is used to support work on projects requiring ballistics capabilities as well as those that do not. Some of the ballistics-related projects that will be conducted at this facility involve gunlock effectiveness, "Smart" gun evaluations, pistol safety and reliability, standards development for ballistic resistant materials, ballistic resistant body armor, and ballistic helmets. Some of the nonballistics projects that will be conducted there involve the development of standards for stab resistant body armor, riot helmets, handcuffs, and holster safety.

Currently, the laboratory is located in an underground concrete bunker (the "Pit") at an abandoned "NIKE Missile Site" that is adjacent to NIST property. The Pit was designed to house missiles, not serve as an R&D laboratory.

MILESTONES: Throughout the fiscal year, NIST/OLES will work with the NIST Plant Division: Facilities Planning, Engineering, and Construction to discuss options, and to develop plans for a new test facility. Construction will begin as soon as possible.

Development of a Bomb Suit Standard

The objective of this project is to establish minimum performance requirements and methods of test for bomb suits to satisfy the

needs of law enforcement bomb disposal personnel. This standard will provide a convenient means whereby agencies can confidently purchase bomb suits that meet certain basic safety and functional requirements.

Currently, there is no NIJ standard for bomb suits used by law enforcement explosive disposal personnel. Suitable standards may exist, but they have not yet been identified or adopted for use by NIJ.

MILESTONES: In FY2001, NIST/OLES will consult with explosives experts in law enforcement and the military to identify essential features of bomb suits and rating categories. Existing commercial, military, and international standards will be evaluated to determine if any are suitable for use by law enforcement. The standard, whether it is an adopted standard, a modified version of an existing standard, or a new standard, will be validated through experimental testing in FY2001. The final draft standard will be available for comment and review in FY2002. Progress reports will be provided quarterly.

Revision of NIJ Standard–0113.00, "12-Gauge Shotguns for Police Use"

The objective of this project is to establish minimum performance requirements and methods of test for shotguns to be used by law enforcement officers. This standard can be used to ensure that shotguns selected for use meet certain basic dimensional, functional, safety, and firing requirements.

The current base version of the standard, NIJ Standard–0113.00, was released in March 1989. It is due for a periodic review and update.

MILESTONES: In FY2001, NIST/OLES will evaluate the current version of the standard and consult with law enforcement and corrections representatives and industry to obtain their comments. A revised draft of the standard will be developed. In FY2002, the test methods in the standard will be validated through experimental testing and then the draft standard will be circulated for comment and review. Progress on this effort will be provided quarterly. A final draft is expected by the end of FY2002.

Development of a Test Protocol for Gunlocks

The objective of this project is to develop a standard test protocol for evaluating gunlocks. This test protocol will serve the interest of the general consumer and also provide guidance to lock and firearms manufacturers. This test protocol will ultimately promote public safety by establishing a consistent method for assessing the performance of gunlocks.

Some work was done last year to survey the market for popular products used to safely store guns. An informational brief was prepared for NIJ, describing safe firearm storage options while also considering the intended uses of the firearms.

Gun safety is a common theme in the news media. Congress requested the U.S. Department of Justice (USDOJ) to investigate ways of increasing handgun safety. This project is one of the steps taken to address the Congressional request. Other projects, such as the development of a "smart gun," also address the Congressional request.

Several states have recently passed firearms safety measures. A Maryland law now requires that all new handguns be sold with locks. This law also requires that by 2002, all firearms sold in the state must have an internal integrated locking device to prevent children and other unauthorized users from using the firearm. Massachusetts uses consumer protection regulations to prohibit the sale of firearms without tamper-resistant serial numbers, child-protection features, and trigger locks. Michigan and New York also require trigger locks to be sold with each new firearm. California is currently considering enacting similar types of legislation.

With such emphasis on firearm safety measures, it is inevitable that certain issues will be raised; such as defining how good a locking mechanism must be, and describing how to assess the locking mechanism to determine if it is acceptable for its intended application.

MILESTONES: The research needed to support the development of a draft test protocol will be conducted in FY2001, and the protocol is expected in FY2002. In FY2001, NIST/OLES plans to award a contract in this area. Manufacturers will be consulted to identify their concerns and develop ideas for standardized test methods that can be used to stress a lock to reasonable levels to ensure that it performs as intended.

Development of a Holster Standard

The objective of this project is to develop a standard for holsters used by law enforcement. This standard will provide a consistent method for assessing the performance of holsters and defining acceptable performance levels for law enforcement purposes.

Holster retention systems for law enforcement officers have saved lives.

The advancement in holster design has been unprecedented in recent years, and the development and use of "security" type holsters may well be a factor in the general reduction in the number of officers killed by their own guns in the past several years. Manufacturers have developed a preliminary ranking system, which designates holsters as Level I, II, or III retention holsters. This ranking effectively evaluates the difficulty encountered by someone, other than the officer, in removing the gun from the holster. There is also an increased difficulty for the officer to draw his gun as the retention level increases, resulting in the need for an increased amount of training and practice to become proficient. To standardize the definitions of retention, NIJ has indicated a need for an NIJ Standard for Law Enforcement Holsters.

MILESTONES: In FY2001, holster manufacturers will be surveyed to determine if the methods they employ to design and evaluate the quality, durability, reliability, and security of their holsters can be applied to this standard. Information will also be gathered from law enforcement agencies, primarily to identify problems with holsters, and identify the types of holsters which need to be addressed by the standard. The OLES force-torque apparatus will be evaluated to determine if it is useful for characterizing the forces necessary to defeat various holster retention levels.

A draft standard is expected in FY2002. Once the draft standard has been completed and preliminary validation tests conducted, the draft standard will enter the standard review process for comments from the manufacturers and law enforcement community. Comments will be reviewed and incorporated as appropriate, and a final draft of the standard will be submitted for promulgation.

Support of Protective Gloves Test Protocol

The objective of this project is to provide technical support to NLECTC at Rockville, Maryland in their testing program for protective gloves for law enforcement and corrections users.

Samples of protective gloves.

Law enforcement and corrections officers have been increasingly requesting hand protection as part of their protection equipment package. They need gloves that will protect them from sharp objects such as blades and hypodermic needles. The gloves also have to be resistant to pathogen penetration and have sufficient dexterity and tactility such that officers can perform their normal duties.

OLES issued the protective glove test protocol as NIJ Test Protocol 99–114, "Test Protocol for Comparative Evaluation of Protective Gloves for Law Enforcement and Correction Applications," in June 1999. OLES also helped NLECTC in selecting qualified glove testing labs through a competitive process. This resulted in the selection of Touchstone Labs and TRI/Environmental Labs as the two NIJ qualified labs to conduct protective glove testing in accordance with NIJ Test Protocol 99–114.

MILESTONES: In FY2001, OLES will provide technical support to NLECTC, including travel to the testing labs, observing the glove testing, providing technical support to the labs and clarifying to them any questions that they may have with regard to the glove testing protocol and helping NLECTC with interpretation of test data from the labs.

Development of a Test Protocol for Evaluation of "Smart Guns"

The objective of this project is to develop a standard test protocol for evaluating firearms that will function only when operated by the authorized user(s). This test protocol will ensure that there is a consistent method for assessing smart gun performance. This is expected to result in better comparisons between competing designs, and identify products suitable for law enforcement applications.

Gun safety has received significant coverage in the news media. The USDOJ was requested by Congress to investigate ways of increasing handgun safety. One project described earlier deals with gunlocks. Other projects, such as this one dealing with the development of a "smart gun," also address the Congressional request.

NIJ awarded a contract to a major firearms manufacturer to develop a "smart gun" prototype. After several years of research and development (R&D), the manufacturer developed a prototype. Recently, the contractor ceased further development of its "smart gun," and made a business decision to dramatically scale back its stake in the firearms industry. Meanwhile several other manufacturers are continuing with their versions of the "smart guns," but they must be evaluated before NIJ can endorse any of them. To do this, comprehensive laboratory testing at NIST/OLES, as well as limited field-testing, is necessary.

A study conducted by Sandia National Laboratories in the mid-1990s defined the operational requirements for firearms utilizing smart gun technologies. A consistent test protocol is needed so that the performance of smart guns against those, or somewhat modified, requirements can be assessed.

MILESTONES: Depending upon the pace of smart gun development, NIST/OLES will tailor a program to satify NIJ's needs in this area. NIST/OLES will continue to meet with manufacturers to evaluate their designs and offer feedback that will improve the design. As designs mature, NIST/OLES will assist in developing a plan to conduct limited field testing of prototype smart guns at participating law enforcement agencies.

Development of an Armored Car Standard

The objective of this project is to develop an NIJ standard for the minimum performance requirements and methods of test for armored cars. A standard would provide a consistent means by which to assess the performance of armored cars, allowing the purchasing agent to purchase an armored vehicle with confidence that it will meet certain performance levels.

OLES has been working with the U.S. Secret Service, Department of State, and Department of Defense to settle on an acceptable approach. Existing ballistics and explosives test protocols from American and European groups have been reviewed and a proposed test sequence has been performed several times to evaluate these protocols for consistency and ease of use.

There currently is no U.S. standard describing the protection levels of armored cars used for personal protection. As a result, there have been instances where vendors have advertised their armored cars as being able to defeat certain types of threats. Field tests have shown some of these claims to be false. To rectify this situation, a uniform standard is needed that clearly defines the types of threats being tested and the test methods. In addition to the ballistic and explosive threats, this standard must also consider that other automotive performance parameters are important, such as acceleration, braking, and handling.

MILESTONES: This effort was identified in last year's plan, but was then postponed because of resource limitations. NIST/OLES will collaborate with working group members to better define the proposed test methods and threat levels, and then develop a draft standard. Test methods will be validated through experimental testing. A preliminary draft standard is planned for early FY2001. For further review, there are plans to convene an advisory group to assess the preliminary draft standard. Comments from the advisory group will be addressed before the final standard is drafted. Further refinements to the standard are expected to carry over into FY2002.

Accomplishments

- *Publication of NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor."* This latest revision of the "body armor standard" forms the basis of the compliance testing program run by NIJ to certify body armor.

- *Completed work on stab resistant body armor standard.* The collaboration with the Police Scientific Development Branch in the U.K. led to the development of NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor." The standard was published in September 2000.

- *Publication of Revision A to NIJ Standard–0112.03, "Autoloading Pistols for Police Officers."* This revision provided additional clarification to the recently published standard. NIST/OLES participated in the evaluation of test results of many models of autoloading pistols that were tested to this new standard at two approved independent laboratories.

- *OLES' Ballistics Research Test Facility was utilized* to obtain residue from gunshots in support of NIST's Chemical Sciences and Technology Laboratory (CSTL) forensics projects.

- *Overview of body armor standards presented at the Personal Armour Systems Symposium (PASS).* An international audience was briefed on the standards development process used in the U.S. to develop the ballistic resistant and stab resistant body armor standards.

Publications

NIJ Standard–0101.04, "Ballistic Resistance of Personal Body Armor," September 2000.

NIJ Standard–0115.00, "Stab Resistance of Personal Body Armor," September 2000.

NIJ Standard–0112.03A, Autoloading Pistols for Police Officers, Revision A, July 1999.

NIJ Test Protocol 114–99, "Test Protocol for Comparative Evaluation of Protective Gloves for Law Enforcement and Corrections Applications," June 1999.

Detection, Inspection, and Enforcement Technologies

Project Goals

To manage programs, direct research and development efforts, and develop performance standards, guidelines and reports for equipment for detection, inspection, and enforcement in support of the goals and priorities of both NIST and the outside agency sponsors. To provide technical support to the traffic enforcement system as administered by the National Highway Traffic Safety Administration (NHTSA) and the International Association of Chiefs of Police (IACP).

Technical Strategy

Detection, inspection and enforcement technologies employed by law enforcement to safeguard civilians in and about public premises and on our roads and national highways are investigated. To promote cost effective purchases of equipment by the law enforcement community, OLES develops and publishes technical reports, equipment guides, and standards. To evaluate and test equipment, OLES also creates performance specifications and reference artifacts. Representative technologies in this program area currently investigated include: devices for imaging and detecting concealed weapons, detectors for locating electronically detonated bombs, improved surveillance cameras, human and vehicle recognition systems, and x-ray systems for bomb disarmament. To promote safe roads, OLES works with NHTSA and the IACP to develop performance specifications and procedures for testing radar, lidar, and photoradar speed enforcement devices. OLES also works on emergency vehicle warning-light systems and sirens, and has developed computer software to aid police fleet managers to select and purchase patrol vehicles, to estimate expected repair costs, and to make vehicle disposal/replacement decisions.

Development of Systems to Evaluate Magnetic Fields Produced by Walk-Through and Hand-Held Metal Detectors

Walk-through (WT) and hand-held (HH) metal detectors, primary tools used in security screening applications, produce time-varying magnetic fields that may cause personal medical devices (PMEDs), such as cardiac defibrillators, infusion devices, or spinal cord stimulators to malfunction. If an affordable magnetic field emulator can be developed, PMED manufacturers would be able to test devices for interferences from WT and HH metal detectors, and the Food and Drug Administration (FDA) could assess interference thresholds and issue regulatory susceptibility standards for PMEDs.

MILESTONES: By mid FY2001, design and construct one prototype emulator for WT detectors and deliver to the FDA.

Terahertz-Wave Concealed Weapon Imaging and Detection System Development

The Law Enforcement and Corrections Technology Advisory Council (LECTAC) has listed concealed weapon detection and imaging as their top law enforcement and corrections (LEC) priority. Present metal weapon detectors are inadequate because of their limited range (less than 15 cm for a hand-held device and less than 0.5 m for a walk-through device) and form (hand-held device is a wand and the walk-through is a portal). Presently, the techniques that have been mentioned use frequency-modulated continuous wave radar (FMCW) and passive millimeter-wave (PMMW) technologies. Both FMCW and PMMW techniques are expensive and do not provide unambiguous images. The ambiguity of these images presents liability issues for subsequent search. Furthermore, present PMMW research systems are not capable of providing images inside or near buildings.

MILESTONES: By mid FY2001, assemble and validate electronics subsystem for processing and displaying image data.

Improved Handgun Replica for Test and Evaluation of Hand-Held (HH) and Walk-Through (WT) Metal Detectors

To ensure that WT and HH metal detectors function properly requires that the metal detectors exhibit positive detection of threat objects, that is, weapons (such as handguns,

Technical Contact:

A. George Lieberman

Thomas Russell

Staff-Years:

9.0 professionals

Funding Sources:

100% Other Government Agencies

Project Champions:

- Building and Fire Research Laboratory (BFRL), Office of Applied Economics
- EEEL, Electricity Division:
  - Electrical Systems Group
  - Electronic Instrumentation and Metrology Group
  - Fundamental Electrical Measurements Group
- EEEL, Radio-Frequency Technology Division:
  - Radio-Frequency Electronics Group
  - Radio-Frequency Fields Group
- EEEL, Electromagnetic Technology Division, Cryoelectronic Metrology
- Federal Bureau of Investigation (FBI), Engineering Research Facility, Quantico, VA
- Home Office, Police Scientific Development Branch (PSDB), United Kingdom
- Independent Testing and Consulting, Inc., Eaton Rapids, MI
- Information Technology Laboratory (ITL), Mathematical and Computational Sciences Division
- Manufacturing Engineering Laboratory, Automated Production Technology Division
- Royal Canadian Mounted Police, Ottawa, Ontario, Canada
- University of Maryland, College Park, Center for Automation Research, College Park, MD
- University of Texas at Dallas (UTD), The School of Human Development, Richardson, TX

knives, razor blades) or other objects that can be used to defeat security restraints (such as handcuff keys or paper clips). Actual threat items cannot be used as test objects because variability of manufacture would not allow measurement reproducibility. Therefore, threat object replicas having well-defined material composition and dimensional sizes and tolerances must be used. Unlike most threat objects, the handgun has a complex shape and consists of several metals.

MILESTONES: By end of FY2001, identify minimally detectable handguns for use as exemplars and design accurate replicas (based on the exemplars) for testing WT and HH metal detectors.

Measurement of Electrical Properties of Metals Used in Hand-Held (HH) Weapons

The law enforcement community has demanded improved detection performance, performance tests, and performance specifications for the hand-held (HH) and walk-through (WT) metal detectors. These demands have resulted in performance tests that are more complex, time-consuming, and costly than previous test procedures. To allay the cost of tests for development of more complicated metal detection systems and to expedite the development of these systems, it is important to have reliable data on the electromagnetic properties of weapon-grade metals from which to perform computer simulations of detector performance. Reliable conductivity and permeability measurements of many metals used for weapons do not exist in the literature.

MILESTONES: By end of FY2001, measure the magnetic permeability and electrical conductivity of metals commonly used in hand-held weapons from 100 Hz to 10 MHz frequency range; produce a material database; and summarize the measurement techniques in a report.

Development of 2D Monolithic Microbolometer Imaging Arrays for Concealed Weapons Imaging

Presently, there are no monolithic imaging array technologies that are being developed in the frequency range of 100 GHz to 1 THz. This range is the most appropriate for concealed weapons imaging because of the relatively short wavelength and the ability to penetrate clothing material. Monolithic detector arrays, using silicon integrated circuit processing technology, have the promise of being very inexpensive compared to present hybrid approaches (the detector, mixer, local oscillator, etc., for each pixel). Furthermore, the present hybrid arrays must be scanned to provide sufficient areal coverage and resolution, and this scanning reduces system ruggedness and increases system cost. The low cost microbolometer arrays would simplify the design and lower the cost of 100 GHz to 1 THz concealed weapons imaging and detection systems, and this cost savings would benefit the law enforcement community.

MILESTONES: By end of FY2001, integrate wafer-scale microblometer detector array with reflective optics and read-out electronics.

Identification and Characterization of Materials that Emulate the Low Frequency Electromagnetic (EM) Properties of the Human Body

Hand-held and walk-through metal detectors used for security applications may emit frequencies close to those used by PMEDs. The safety of persons that rely on PMEDs is not an avoidable issue. Unfortunately, there is little information, other than anecdotal, about the interaction of PMEDs with HH and WT metal detectors. Furthermore, recent revisions of the NIJ standards for HH and WT metal detectors contain a body cavity concealment test. This test is based on using concealment by a person and, although this test is representative of actual use, it is not reproducible or accurate. What is desired is a material that can mimic the electromagnetic properties of the human body over the frequency range of 80 Hz to 10 MHz so that the body cavity concealment test can be made reproducible and repeatable. Moreover, these materials can be used by PMED manufacturers and the FDA to more accurately evaluate the effect of metal detectors on PMED operation and performance. Presently, NIST is working in collaboration with the FDA and the Federal Aviation Administration (FAA) regarding metal-detector-induced failure and malfunction of PMEDs.

MILESTONES: By end of FY2001, complete measurements of candidate materials and recommend optimal phantom material.

Liquid-Filled Camera for Enhancement of Shadow Detail

Video cameras used for surveillance and machine-vision applications often suffer from inadequate contrast capabilities, particularly in rendering details in shadows or dark regions. A camera technology that simulates the design of the eye promises to enable electronic cameras to

render shadow detail that was previously impossible.

MILESTONES: By end of FY2002, build a 12 bit to 16 bit scientific grade charge-coupled device (CCD) liquid-filled camera with housing and plumbing to provide continuous particulate filtration of the identified, low-viscosity, index-matching liquid-filler; test performance of internal aperture and computer model front lens design; increase dynamic range using thermoelectric cooling for mitigation of thermal gradient; reduce surface scattering at front lens element by wetting external surface of lens.

NIJ Standard–0603.00, X-Ray Systems for Bomb Disarmament

The latest Justice Department standard for x-ray systems for bomb disarmament was published during 1975. Changes in technology and changes in safety requirements imposed by other agencies have not since been documented. The laboratory selected for developing this standard, the Police Scientific Development Branch (PSDB) in the U.K., has considerable expertise and experience in testing and deploying portable x-ray equipment. The PSDB has comprehensive laboratory facilities, including a large lead-lined laboratory and a variety of x-ray generators. The Explosive and Weapons Detection Group staff at PSDB are familiar with the general requirements of x-ray imaging systems and generators, as well as the associated health and safety issues.

MILESTONES: By the end of FY2001, the standard will be revised. Available commercial equipment will be tested for compliance to the standard and reported upon.

Emergency Vehicle Sirens Project

The objective of this project is to provide law enforcement agencies and other users of emergency vehicle sirens, such as emergency medical and fire services, with a single, improved, comprehensive document that includes test methods, performance criteria, and mounting and installation guidelines for sirens, which can be referenced in purchasing and other documents. It would be very useful if this siren document were cited by all public safety agencies and used in a siren certification program that includes an independent test laboratory and laboratory certification agency. To support the project, an NIJ siren guide was recently produced that informs law enforcement agencies about other documents that are currently recognized and used by the siren industry to specify siren tests, performance requirements, and mounting and installation guidelines.

MILESTONES: By the end of FY2001, the initial phase 1 revision of a document of the Society of Automotive Engineers (SAE), SAE J1849, will be completed and forwarded to the SAE Emergency Warning Devices Committee.

Developing Evaluation Standards for Video and Still-Face Recognition Systems

During FY1997 and FY1998, a digital video picture and still-picture database was collected and methods for evaluating digital video-based face recognition systems were developed. These two activities laid the foundation for the Digital Video Face Recognition Evaluation Conference (DV-FREC). The project will run from FY1999 through FY2002, and is jointly funded by the Defense Advanced Research Projects Agency (DARPA) and NIJ. DV-FREC will independently evaluate the performance of digital video-based face recognition algorithms and develop standardized test procedures.

Under this project, three DV-FREC evaluation conferences will be held. The product resulting from the first conference is expected to be ground truthing and scoring software, and an evaluation protocol. Conference proceedings and a final report of the conference will be published. Two additional conferences will be held to encourage and to measure progress. Appropriate evaluation and data collection protocols will be designed to support the focus areas of the subsequent conferences.

A separate research effort, funded through OLES, involves continued collaboration with the University of Texas at Dallas (UTD). This project compares human and algorithm performance, and attempts to characterize how humans recognize faces.

MILESTONES: During FY2001, video-based close-up face recognition combined with gait at a distance will be developed and evaluated. Trials based upon the First Human Identification Database Conference (HID-1) will be used to baseline algorithmic performance and establish empirical performance matrices.

Auto Rank

The disposal and replacement of police patrol vehicles have major cost consequences for law enforcement budgets. Auto Rank is a sophisticated, statistical repair model developed at NIST and implemented in DOS software. The method uses data on the frequency of repairs for a vehicle class to estimate a generalized model of vehicle repairs based on the Weibull distribution,

which is widely used for reliability analysis. Then, for each vehicle in the fleet, the model uses data on the particular vehicle's pattern of repairs to estimate expected repair costs for that vehicle over the coming period. Vehicle repair estimates can be grouped by repair category. The model then ranks all vehicles for disposal based on expected repair costs, operation and maintenance costs, and loss of resale value. The fleet manager then disposes of those vehicles with the highest predicted costs, resulting in a cost-effective strategy for vehicle disposal and replacement.

MILESTONES: By end of FY2001, complete all data collection on the failure/repair experience of several large fleets and prepare standardized data files for statistical analysis. Conduct statistical analysis on the failure/repair data to develop national estimates of repair frequencies, given the repair category, model, year, and time of (or mileage at) the most recent failure/replacement (this analysis will rely on the Weibull distribution statistical model that NIST has already developed). Design and develop data files on repair frequencies to support dynamic computation of estimated future repair costs, even for small fleets, without sufficient data for on-line Weibull analysis. Develop software user interface, menu structure, and data entry modules for fleet managers to record all their vehicles and repair histories. These data will be used to support estimation of future repair costs for each vehicle, taking into account its particular repair history.

AutoBid

A microcomputer system called AutoBid was developed to help police fleet managers select patrol vehicles best suited to their needs. The system is based on vehicle performance data for police patrol models published annually by the Michigan State Police and NIJ. AutoBid currently runs only on the DOS platform in character mode and has no graphical, windows-like features. An updated version of AutoBid with a modern, graphical interface is needed for all computer platforms.

Purchasing of police vehicles is aided by AutoBid.

MILESTONES: In FY2001, prepare the data files for the 2001 model year vehicles based on the latest Michigan State Police test results. These files will include the performance scores for ranking vehicles as well as the detailed hardware specifications of all tested vehicles. Post the new files on the NIJ web site and modify the HTML page for accessing the Java AutoBid software to permit users to select whether they want to analyze the 2000 or the 2001 model year data. Complete the AutoBid version that supports value based analysis based on comments and suggestions received from the beta test. Add help screens to support the new features and design. Release the new software to the NIJ Internet site. Develop a brochure on AutoBid describing its features and how to access it on the NIJ Internet site.

Support of NHTSA Speed Enforcement/Measurement Program

Across-the-road Doppler radar systems are being increasingly used by law enforcement authorities for measuring vehicle speeds on the nation's highways. These systems differ from older, down-the-road radar guns that are aligned with the direction of motion of the moving target vehicle, to obtain a more accurate reading of vehicle speed.

Law enforcement officer using a traditional down-the-road radar gun during speed enforcement operations.

The principle advantage of the across-the-road configuration, from a law enforcement viewpoint, is that the radar can readily differentiate between vehicles in dense traffic and can provide fast and automated identification of offenders using photographic techniques, while giving drivers essentially no advance warning of the radar's presence. The disadvantage of this technique is that the Doppler frequency shift from which the target speed is derived is no longer constant, but will vary with time as the cosine of the angle between the fixed direction of target motion and the fixed radar beam changes. This creates a very complex Doppler Spectrum with time, which is processed by the radar system using

proprietary algorithms to yield a measurement of the vehicle's speed. Consequently, it is essential that the measurement accuracy of these systems be guaranteed through frequent calibration using a reliable and traceable calibration standard.

MILESTONES: By end of FY2001, develop and build two improved prototype calibration devices intended to be used in compliance testing of automated across-the-road radar. One device is to be operated at the assigned police radar frequency centered at 24.1 GHz (K-band), the other centered at 34.7 GHz (Kalpha-band).

Support for Concealed Weapon and Contraband Detection Technology

There are a variety of activities and technologies pertinent to the detection of concealed weapon and contraband in which OLES is involved. These technologies include chemical weapon detection, drug detection, metal weapon detection, explosives detection, etc. The activities include standards development, writing user guidelines, and funding research appropriate for justice-related programs. The number of technologies covered by OLES is extensive and it is difficult to maintain the expertise required for providing assistance to the law enforcement and corrections community without adequate manpower.

The objective of this project is to provide technical assistance to OLES in the area of concealed weapons and contraband using electromagnetic technologies (EM).

MILESTONES: In FY2001, 1) participate in Law Enforcement and Corrections Technology Advisory Council meetings and other pertinent meetings, 2) review proposals related to EM detection methods for contraband and weapon detection, and 3) provide technical assistance to OLES staff regarding EM detection methods for contraband and weapon detection.

Law Enforcement Data Exchange of the World Wide Web

For more than a decade, NIST has sponsored the development of data interchange standards within the law enforcement community. This effort has culminated in the recent adoption of ANSI/NIST–ITL 1–2000, a data format for the interchange of fingerprint, facial, and scar mark and tattoo (SMT) information. This standard defines a structured framework for representing and exchanging rap sheets, fingerprints, and mugshots, and it has been implemented and integrated into virtually all commercial fingerprint identification systems.

In the past, a law enforcement agency would purchase technology from a vendor who would provide a proprietary dedicated network for interchanging proprietary formatted data records. The proprietary nature of these systems often restricted the exchange of data between different agencies and jurisdictions. The ANSI/NIST standard has made great strides in facilitating the open exchange of law enforcement data. The impact of this open exchange will be significantly increased by taking advantage of the accessibility, connectivity, and mobility afforded by the World Wide Web.

The primary objective of this proposed project is to implement the ANSI/NIST standard on the World Wide Web, thereby merging the open exchange of data provided by the ANSI/NIST standard with the desktop accessibility provided by the Web.

MILESTONES: 1) Release ANSI/NIST plug-ins four months after the start of the project, 2) Release Workstation software 10 months after the start of the project, and 3) Publish a technical summary of project 12 months after it starts.

Accomplishments

The manuscript, Equations for the Magnetic Field Produced by One or More Rectangular Loops of Wire in the Same Plane, was accepted for publication in the July-August issue of the NIST Journal of Research. This paper contains equations and a Basic program, which predict the magnetic flux density from up to three rectangular coils situated in a common plane. The coil geometry can be found in some walk-through metal detectors and product surveillance systems.

- *Drafted NIJ Guide 600–00, User's Guide for Hand-Held and Walk-Through Metal Detectors, April 2000.* This guide addresses the theory and operational limits of hand-held (HH) and walk-through (WT) metal weapon detectors. It is intended to clarify NIJ Standard–0601.01 and NIJ Standard–0602.01 for HH and WT metal weapon detectors. It also includes general training information for instructors and supervisors, a brief discussion of safety topics, as well as a list of present suppliers of HH and WT devices.

- *Drafted NIJ Guide 602–00, Guide to the Technologies of Concealed Weapon and Contraband Imaging and Detection, April 2000.* This guide provides information to help present or potential users and operators of Concealed Weapons and Contraband Imaging and Detection Systems (CWCIDS) understand the operation,

limitations, and applicability of CWCIDS and to provide an overview of the state of development. It contains a review of various technologies (such as x-ray imaging, microwave holography, acoustic detection) and discusses CWCIDS configurations that are now being used or developed to detect and image weapons and contraband on humans.

- *Published NISTIR 5096, Detection of Quasi-Static Electric Fields Radiated by Electrically Small Emitters, June 2000.* This report presents the theory for near-field detection of quasi-static electric fields produced by electrically small emitters that radiate as small electric dipoles. The intended application is the detection of electronic timers of the type that could be used in bomb detonators.

- *Submitted Report DOT HS 808–999, Speed Measuring Device Performance Specifications: Photo-Radar Module, to NHTSA for publication.* Developed under an interagency agreement with NHTSA, this report sets systems performance requirements and verification procedures for automated across-the-road radar. Adoption of the specifications by the IACP is expected to result in improved system accuracy and reliability, and in traffic administrators making better informed purchasing decisions. As automated across-the-road radar systems become more prevalent, the number and severity of automobile accidents on U.S. highways resulting from excessive speeds is expected to significantly diminish, as it has elsewhere in the world under similar conditions.

- *Submitted Report DOT HS 808–998, Speed Measuring Device Performance Specifications: Radar Module, to NHTSA for publication.* Traffic radar devices meeting or exceeding these performance specifications are internationally recognized by police, courts, and the public as being reliable and accurate. Compliance testing is performed at independent university laboratories administered by the IACP under a grant from NHTSA. High speed and congestion are the leading causes of automobile crashes on urban interstates. Speed enforcement utilizing IACP-certified compliant radar units helps police and courts promote traffic safety.

- *Presented at SPIE Conference and published in Conference Proceeding 3795, the paper, "Antenna-Coupled Niobium Bolometers for mm-Wave Imaging Arrays," July 1999*. Millimeter-wave imaging pixels were tested. The pixels consist of half-wave dipole antennas coupled to niobium microbolometer detectors on an electrically thick silicon substrate. To improve the signal-to-noise ratio, the uncooled detectors are operated in a pulsed illumination and gated integration architecture. These arrays are being developed to demonstrate the feasibility of an active mm-wave concealed weapon imaging system. Most clothing and many common building materials are transmissive to electromagnetic radiation at millimeter wavelengths.

- *Siren Testing: Round-Robin Testing Shows Good Agreement.* Showed the feasibility and reliability of doing acoustic testing on siren loudspeakers separately from their electronic signal amplifiers. In a project for OLES, the Manufacturing and Engineering Laboratory's Acoustics, Mass, and Vibration Group, in cooperation with a committee of the SAE, did an intercomparison of siren tests using NIST's large anechoic chamber, and two industrial laboratories. The results were in close agreement, on the order of 1 dB, for sound pressure levels measured by the laboratories. This is encouraging to the SAE committee, which hopes to revise a recommended practice, permitting siren loudspeakers and siren amplifiers to be tested separately.

- *Siren Amplifier Testing: Instrument Comparison Shows Good Agreement.* Ten siren amplifiers from six manufacturers were tested, using two dissimilar instruments: a one-third octave band real-time analyzer and a Fast Fourier Transform (FFT)-based dynamic signal analyzer to characterize their electrical output. The SAE committee responsible for siren standards is developing new procedures in which siren speakers and siren electrical components can be tested separately. Currently, the plan is to define standard signals that can be used to test siren loudspeakers, and develop test procedures that compare the amplifier outputs with these standard signals. (A siren amplifier, by definition, incorporates a signal generator.)

- *OLES' Police Car Purchasing Aid is now a Click Away.* DOS-based police car selection program, AutoBid, was written into a Java program. One version can be run by itself, while the other so-called applet version is only a couple clicks away. Both versions are available on the Web at the following address: http://www.nlectc.org/autobid/overview.html.
The user describes numerically what features are most important to his or her department, and the program ranks available police cars. This project

was done by NIST's Office of Applied Economics, BFRL, and sponsored by OLES.

Publications

NIJ Guide 201–99, "Video Surveillance Equipment Selection and Application Guide," October 1999.

NIJ Guide 500–00, "Guide to Test Methods, Performance Requirements, and Installation Practices for Electronic Sirens Used on Law Enforcement Vehicles," August 2000.

NIST Technical Note 1398, "Portable Calibrator for Across-the-Road Radar Systems," May 1998.

NISTIR 5072, "Spherical-Wave Characterization of Interior and Exterior Electromagnetic Sources," December 1997.

NISTIR 5079, "Dipole Moments of Weak, Electrically Small Emitters from TEM-Cell Measurements," December 1998.

NISTIR 5096, "Detection of Quasi-Static Electric Fields Radiated by Electrically Small Emitters," June 2000.

NISTIR 5787, AutoBid 2.0, "The Microcomputer System for Police Patrol Vehicle Selection," revised June 1998.

NIST GCR 99–771, "State of Oregon Criminal Justice Information System: Mug Shot Imaging Project," approved for publication September 1999.

Proceedings of SPIE Reprint, "Enforcement and Security Technologies," November 1998.

"Specific NIST Projects in Support of Concealed Weapon Detection and Imaging Program," SPIE Volume 3575, Law Enforcement and Securities Technology Conference (November 1998), Boston, MA (N. Paulter).

"Antenna-Coupled Niobium Bolometers for mm-Wave Imaging Arrays," SPIE Volume 3795, Optical Science, Engineering and Instrumentation Conference (July 1999), Denver, CO (S. Nolen, et. al.).

"Equations for the Magnetic Field Produced by One or More Rectangular Loops of Wire in the Same Plane," NIST Journal of Research, (July/August 2000), Gaithersburg, MD (M. Misakian).

NIJ Standard–0601.01, "Walk-Through Metal Detectors for Use in Weapon and Contraband Detection," September 2000.

NIJ Standard–0602.01, "Hand-Held Metal Detectors for Use in Weapon and Contraband Detection," September 2000.

NHTSA Technical Report DOT HS 808–998, "Speed Measuring Device Performance Specifications: Radar Module," in print.

NHTSA Technical Report DOT HS 808–999, "Speed Measuring Device Performance Specifications: Photoradar Module," in print.

NIJ Standard–0227.00, "Digital Intercept System for Integrated Services Digital Networks," in print.

Technical Contact:

Alim Fatah

Susan Ballou

Thomas Russell

Staff-Years:

7.8 professionals

Funding Sources:

100% Other Government Agencies

Project Champions:

- Chemical Science and Technology Laboratory (CSTL), Analytical Chemistry Division
- Building and Fire Research Laboratory (BFRL), Office of Applied Economics
- EEEL, Electricity Division
- U.S. Army Research Laboratory (ARL), Aberdeen, MD
- U.S. Department of Justice
  - National Domestic Preparedness Office (NDPO)
  - Office of State and Local Domestic Preparedness Support (OSLDPS)
  - Federal Bureau of Investigation (FBI)
- University of Utah, Center for Human Toxicology (CHT), Salt Lake City, UT

Chemical Systems and Materials

Project Goals

To manage programs and direct research and development efforts in the areas of polymers, chemical systems and materials, including, but not limited to, protective clothing and equipment, detection drugs of abuse, less-than-lethal technologies, and weapons of mass destruction. To develop quality assurance programs and performance standards, guidelines, and reports in support of the goals and priorities of both NIST and the outside agency sponsors.

Technical Strategy

Development of a NIST Standard Reference Material "Additives in Gunpowder"

Most handgun and improvised explosives (pipe bomb) crimes involve the use of smokeless gunpowder. Forensic investigators are increasingly measuring the composition of the gunpowder and its recovered residues to help identify the source of the powder as part of criminal investigations. However, there currently are no smokeless powder samples of known composition for use in analytical method evaluation and measurement proficiency testing. To assure the quality of gunpowder measurements, OLES is funding work through the Analytical Chemistry Division of the Chemical Sciences and Technology Laboratory (CSTL) at NIST to develop a Standard Reference Material (SRM), "Additives in Smokeless Gunpowder," that will aid forensic investigators in testing and validating their analytical measurement techniques.

Smokeless gunpowder is a mixture of propellants, such as nitrocellulose and nitroglycerin (NG), as well as stabilizers such as diphenylamine (DPA) and ethyl centralite (EC). The proposed SRM will consist of two types of gunpowder, ball and extruded powders, with certified concentrations of NG, DPA, and EC. The certification of chemical composition SRMs typically requires the use of two or more chemically independent analytical techniques to provide measurements, which if in agreement, are used to assign certified values to the material.

MILESTONES: The development of the analytical methods for certification of the SRMs will be completed and preliminary compositional measurements on the two prototype SRMs will be made to assess the agreement of the independent techniques. The independent techniques will be applied to the detailed certification measurements of the candidate gunpowder materials for the SRM. Rigorous statistical evaluation of the data will permit determination of the certified values for the three additives.

Standard Reference Materials for Bullets and Casings

As with fingerprints, every firearm has unique characteristics that leave unique signatures on the bullets and casings that it fires. By analyzing these ballistics signatures, examiners can connect a firearm to bullets or casings discharged during criminal acts. The Integrated Ballistics Identification System (IBIS) has proven extremely effective as an automated tool for this process. IBIS uses techniques of image capture, image analysis, and electronic databases. However, to demonstrate completely the reliability of this system, high quality measurement standards for bullets and casings are required. Their key properties include uniformity, reproducibility, and stability. These standard bullets and casings will serve as check standards to demonstrate both the consistency of operation of IBIS from day to day as well as the consistency between systems. Under the first objective above, we will complete the project to manufacture these materials and demonstrate their utility.

The objectives of this project are: 1) to provide the final prototypes, designs, and manufacturing plans for standard reference materials (SRMs) for bullets and casings for use in the validation of image analysis systems for ballistics identification; and 2) to develop traceable parameters for use in certifications that will accompany SRMs for bullets and casings.

MILESTONES: To deliver: 1) A refined set of prototype standard bullets; 2) A set of prototype standard casings; 3) A final report presenting test results, final designs, and manufacturing plans for standard reference materials for bullets and casings; and 4) An article describing the rationale and testing results for the use of the cross-correlation function to quantify similarities between two-dimensional surface profiles.

Computer Database of Energetic Materials Spectra

Currently, forensic identification of energetic materials (explosives and propellant formulations) is accomplished in a variety of ways. Typical test methods include gas chromatography (GC), liquid chromatography

(LC), mass spectrometry (MS), infrared (IR) reflection spectroscopy, and IR absorption spectroscopy, and the tandem applications of these techniques (e.g., GC-FTIR-MS, LC-MS, etc.). Each of these methods has its advantages and disadvantages. Liquid chromatography usually requires significant sample preparation and yields limited information unless employed in tandem with other techniques. Mass spectrometry and gas chromatography require some portion of the sample in the gas phase, often requiring sample heating. For many explosive materials this is difficult to achieve without decomposition.

Infrared spectroscopy can be used to measure the vibrational spectrum of nearly all energetic materials. Raman spectroscopy is also an excellent technique for identification and characterization of energetic materials and propellant formulations. Each of these techniques can yield excellent results for many samples. This project is aimed at expanding the current Raman spectral database to include spectra of energetic materials. This expansion will include mass spectra and infrared absorption spectra of energetic materials, and will use the framework currently employed for the Raman spectral database (GRAMS32). The current Raman spectral database (Version 1.0) is available to all law enforcement agencies as a forensic tool for identification and characterization of energetic materials. As with the current version of the database, the expanded database can be upgraded, allowing new spectra to be entered as needed. The inclusion of mass spectra and infrared spectra of energetic materials will make the database even more accessible to other investigators. The Army Research Laboratory (ARL) at Aberdeen, Maryland, which has extensive experience measuring mass spectra and infrared spectra of energetic materials by several techniques, including GC-MS, LC-MS, solid probe MS, infrared reflectance spectroscopy, photoacoustic spectroscopy, and normal transmission spectroscopy, will do the work.

MILESTONES: ARL will supply an expanded database of spectra to include Raman spectra, mass spectra, and infrared absorption spectra of energetic materials, propellant ingredients, and propellant and explosive formulations. The expanded database will be contained within the framework of commercial spectral manipulation software. The database will be available to all federal and state agencies free of charge.

Support of Domestic Preparedness Programs

Developing Biological and Chemical Protection Equipment Standards

The objective is to develop a suite of national chemical and biological protective equipment standards and to facilitate the adoption of these standards so that they can be used by local, state, and federal emergency first responders and other public safety workers. To accomplish this mission, strong working relationships must be established with the public safety user community, to the point where the community's representatives play a key and integral role in all facets of the standards development process, through the Interagency Board (IAB). The suite of equipment standards will cover: 1) Detection equipment (for both chemical and biological); 2) Decontamination equipment; 3) Personal protection equipment (PPE, including suits, boots, gloves, and respiratory equipment); 4) Interoperable communications equipment; and 5) Medical equipment. The equipment standard that has been identified as the first priority by the IAB is that for respiratory equipment.

A) Respiratory Equipment Standards

The objective is to develop National Institute of Occupational Safety and Health (NIOSH) approved respiratory protection equipment against terrorism agents for emergency first responders and public safety workers.

A typical protective mask for first responders, law enforcement officers, corrections officers, and EMS providers.

To develop these, the following tasks will be performed: 1) Determine applicability of existing industrial and military warfare agent standards;

2) Develop key chemical/biological (CB) design and performance requirements; 3) Modify and/or develop terrorism agent-specific test methods; and 4) Prepare final evaluation, testing, and certification standards.

MILESTONES: 1) Certification and testing of equipment: After NIOSH CB respirator standards are established, respirator equipment manufacturers will submit approval application to NIOSH. NIOSH will test, evaluate, and certify candidate respirators in NIOSH laboratories or through authorized test facilities, in support of NIJ, U.S. Army Soldier and Biological Chemical Command (SBCCOM), and NIST/OLES; and 2) Formal rulemaking on CB Standards: NIOSH will follow established federal regulatory rule making processes and will schedule public hearings and open a docket for public comments on the proposed standards. NIOSH will provide scientific, technical, and organizational support for these efforts as requested by NIST/OLES.

B) Hazard Analysis/Vulnerability Assessment: Initial Hazard Assessments of Emergency Responders in Specific Scenarios

The objective is to develop a vulnerability assessment of responding emergency personnel to three specific outdoor chemical hazard scenarios. These initial studies will provide a technical/operational baseline to determine personal protective capabilities within a specific operational context or scenario.

Three specific hazard scenarios will be developed using probable chemical hazards and delivery systems at particular outside venues. An assessment will be made to provide a time-based hazard distribution at specified locations throughout the venue. Probable dose exposures of unprotected and protected personnel wearing both military and civilian protective clothing will be included in this assessment.

Doses received by protected emergency personnel will be estimated based on operations in the hazard area. The assessment will determine levels of hazard based on protection factors of the protective ensemble worn and the estimated exposures based on location, prevailing meteorological conditions, and time.

MILESTONES: Delivery of an automated computer-based assessment of three outdoor scenarios, which can be used as a simple model to determine hazards wearing specific protective ensembles (military and civilian) within one year of project startup date. This assessment will include probable hazard distribution over time and local space and an effects distribution based on level of protection worn. Approach: This task will be accomplished through a joint in-house and contract effort. It will build off of existing modeling accomplished for other domestic preparedness related efforts accomplished by SBCCOM. The framework for the computer generated assessment tool is in place and the specific scenarios from this study will be added to expand the existing system capabilities.

C) Development of Chemical and Biological PPE/Detection/Decontamination Equipment Standards

The objective is to develop standards for personal protection equipment (including suits, boots, gloves, etc.), detection equipment, and decontamination equipment for chemical and biological agents for emergency first responders and public safety workers.

A chemical/biological protective suit

SBCCOM will act in a support role to NIST/OLES. SBCCOM's facilities and expertise in CB testing of PPE, detectors, and decontamination equipment and information regarding toxicity of CB agents will be leveraged during this effort as well as the expertise at other DoD laboratories to perform:

1) Hazards Analysis/Vulnerability Assessment;
2) Standards development, which involves reviewing existing test methods, analyzing these test methods for applicability, and providing a matrix of prospective standards with preliminary analysis and selection of the appropriate standards test;

3) Testing of representative equipment to document test procedures, developing a certification plan, and qualifying laboratories for CB certification testing.

MILESTONES: Complete the first draft of respiratory equipment standards and circulate for review and public comment. The delivery of the complete suite of standards is expected to take three to four years if fully funded.

D) Chemical and Biological Protection Equipment Guides for Emergency First Responders

The heightened national concern that terrorists will employ chemical agents, toxic industrial materials (TIMs), and/or biological agents against domestic targets is prompting state and local first responders to enhance their response capabilities. NIJ is the focal point for providing support to state and local law enforcement agencies in the development of counterterrorism technology and standards, including technology needs for CB defense. In recognizing the needs of state and local emergency first responders, NIST, supported by NIJ, the Technical Support Working Group (TSWG) of interested government agencies, SBCCOM, and the IAB, is developing CB defense equipment guides. The guides will focus on CB equipment in areas of detection, personal protection, decontamination, medical, and communication. The purpose of these guides is to provide CB equipment information to the emergency first responder community when evaluating and purchasing CB defense equipment. This sharing of information is critical to the many emergency first responder communities who have received or are in the process of receiving funding from the Office of State and Local Domestic Preparedness (OSLDPS).

Six chemical and biological equipment selection guides will be developed and made available in both paper and electronic format. The six guides include chemical agent and toxic industrial material detection, biological detection, medical, communications, personal protective, and decontamination.

To date all guides have been started, but they are in various stages of development. The Chemical Detection Guide was published in mid-year 2000. A draft guide on decontamination is currently out for review. Draft guides on medical and biological detection are anticipated to be released in July 2001. Draft guides on personal protection and communications equipment are anticipated to be released in August 2001.

MILESTONES: 1) Delivery of drafts and final versions of each guide; 2) Delivery of printed guides and CD-ROM versions of the guides by end of July 2001.

Less-than-Lethal Technologies: Examination of Pepper Spray Canisters

At the present time, the "pepper spray" commercial products on the market are not well defined. There is no specification of active ingredients and manufacturers use a wide range of formulations and labeling schemes.

OLES is planning to solicit, through a competitive contract, a qualified laboratory to perform research and conduct a study involving sampling and analyzing the contents of commercial pepper spray canisters from five different manufacturers. This laboratory will make quantitative measurements of the internal pressure of the canister, the concentration of active agent(s) capsaicin and the compounds present in the aerosol spray, and the concentration of propellants and carriers. The study will also include shelf-life stability studies of the canisters (devices) at specified environments, aerosol firing tests, spray range tests, and drop tests to gauge device mechanical safety and stability. It is hoped that data from this type of study will suggest improvements and serve as the basis for minimum voluntary labeling and performance standards.

The project will examine a number of canisters from particular lots and manufacturers that have been used (as well as unused cans from the same lots) by measuring propellant pressure, oleoresin capsicum (OC) concentration, and other properties of the canister that correlate with the reason for the failure. NIJ Standard–0110.00, which deals with testing hand-held aerosol tear gas weapons, will be used as a guide in measuring the spray pattern of canisters.

MILESTONES: The delivery of quarterly progress reports and the final report on project results of the study by the end of 12 months from the date of contract award.

Less-than-Lethal Technologies (LTL): Human and Animal Dose Response, Toxicokinetic and Potency Assessment of Pepper Spray Products Following Topical and Aerosolized Exposure

The objectives of this three-year proposal are to: 1) Chemically characterize a series of LTL OC

pepper spray products as a method of determining, and ultimately predicting, product potency; 2) Apply the products and the individual capsaicins identified in the products to human skin to determine response and potency; 3) Investigate the toxicological effects of inhalation of the same products; and 4) Determine the extent of absorption and the distribution of these analogs following dermal and nasal exposure. Nasal exposure will be to drug-free and drug-treated rats.

The data generated will be utilized to: 1) Predict product potency by chemical analysis, dermal response, or a combination of the two methods; 2) Determine the relative potency of the individual capsaicin analogs; 3) Determine and quantify the effects of the products and the individual capsaicins when applied dermally; 4) Develop sensitive and specific analytical methods that can be used to identify and quantify capsaicin analogs in pepper spray products and in biological samples; 5) Determine the extent of dermal absorption of the major capsaicin analogs; and 6) Determine toxicity and the extent of nasal absorption of the major capsaicin analogs following aerosolized exposure, and determine if stimulant drug use affects toxicity or absorption.

MILESTONES: 1) Chemically characterize the OC content of a select series of pepper spray products; 2) Verify that a combination of potency determinations by pharmacodynamic methods and capsaicin analog determination by HPLC and HPLC/MS/MS can be used to assess the potency/efficacy of commercially available OC LTL products; and 3) Determine the relative respiratory tract toxicity of pepper sprays following aerosolized exposure to the chemically characterized pepper spray products.

Minimizing Compliance Costs of the Life Safety Code for Correctional Facilities

The Fire Safety Evaluation System (FSES) for Detention and Correctional Facilities (Chapter 4 of the NFPA 101A Guide to Alternative Approaches to Life Safety) offers the managers and fire safety engineers of such facilities many alternatives equivalent to prescriptive code compliance. This flexibility makes possible major cost savings when achieving compliance with the Life Safety Code. Because so many acceptable solutions are available, the most cost-effective solutions cannot be found by simple trial and error. What is needed is a systematic procedure for finding a practical set of low-cost, safety-equivalent solutions from which the facility manager can choose. The NIST Office of Applied Economics has successfully developed a similar procedure and supporting software for Health Care Occupancies. The Public Health Service has applied this software to 86 military hospitals and identified code-compliant solutions with cost savings of over 40 % (about $2,200 per bed) compared with the prescriptive solution.

MILESTONES: Develop the life-cycle cost model for design alternatives. Obtain all cost data and develop the algorithms necessary to estimate the life-cycle cost of qualifying for each of the 56 states of the fire safety parameter table of NFPA 101A. Complete the cost minimization model and supporting algorithms capable of systematically evaluating the costs of all safety-equivalent alternatives to identify quickly the least-cost alternative for any correctional facility. Design and develop software for easy user specification of the current safety conditions for each of the 13 fire safety parameters and for the quantities of each construction retrofit to be considered for evaluation by the cost minimization model and algorithms. Design and develop software modules to apply the cost minimization model and supporting algorithms to identify the least-cost alternative for any correctional facility.

Accomplishments

- *NIJ Guide 100–00, "Guide for the Selection of Chemical Agent and Toxic Industrial Material Detection Equipment for Emergency First Responders"* was published. This Guide contains detailed information that is useful to the emergency first responder community in the selection of chemical agent and toxic industrial materials detection techniques and equipment for different applications. It includes a through market survey of these technologies.

Publications

NIJ Report 603–00, "Development of NIST Standard Bullets and Casings Status Report," submitted to NIJ for publication.

NIJ Report 601–00, "NIST Random Profile Roughness Specimens and Standard Bullets," July 2000.

NIJ Guide 100–00, "Guide for the Selection of Chemical Agent and Toxic Industrial Material Detection Equipment for Emergency First Responders," June 2000.

NIJ Guide 100–99, "Guide for the Selection of Commercial Explosives Detection Systems for Law Enforcement Applications," March 1999.

NIJ Report 100–99, "Evaluation of a Test Protocol for Explosives Trace Detectors Using a Representative Commercial Analyzer," September 1999.

NIJ Guide 601–00, "Guide for the Selection of Drug Detectors for Law Enforcement Applications," August 2000.

NIJ Report 602–00, "Trace Detection of Narcotics Using a Preconcentrator/Ion Mobility Spectrometer System," WERB approved.

Forensic Sciences

Project Goals

To manage forensic science programs and direct research efforts to develop performance standards, guidelines, and reports to advance the technologies associated with the forensic science field. To provide innovative and validated test methods that will successfully undergo the scrutiny of our adversarial justice system.

Technical Strategy

The National Software Reference Library

Forensic analysts work to balance the stress of increasing case backlogs and maintaining quality in the examination of the evidence. In the forensic discipline of electronic evidence, a possible solution to reducing case backlog is being developed. The basic concept of this solution is the creation of a standard reference material (SRM) of all commercial off-the-shelf software packages and, through their hashing algorithms, create a file signature for each package. This information would then be downloaded into a searchable database. The National Software Reference Library (NSRL) is such a database and has been designed to provide a repository of known software, file profiles, and file signatures for use by law enforcement organizations in electronic forensic investigations. In a typical case, a seized desktop computer may contain 5000 to 20000 files, each of which must be reviewed for evidentiary content. To eliminate as many standard files as possible, an automated filter program can screen each file for specific profile and signatures. If the file profile and signature match a verified profile and signature in the NSRL, the file will be dropped and no further analysis will be conducted. Those remaining files that did not match signatures in the NSRL will then be subjected to detailed examination.

This project has been conducted in the Information Technology Laboratory (ITL) at NIST and supported by NIJ grants and FBI tools.

MILESTONES: In FY2001, to produce an extractable NSRL CD-ROM that will be made available to law enforcement agencies and to implement a NSRL Web site to support the use of the CD-ROM.

Establishment of a Computer Forensic Tool Verification Capability at NIST/Validation of Computer Software Tools

It is critical during court testimony to have validated tools or standardized procedures supporting the submitted evidence. In the law enforcement community, the validation of electronic tools and procedures has not yet been addressed. ITL was seen as a neutral party in the area of commercial products and was tasked to verify the operation and output of automated tools used in electronic investigations. At the current time, tools commonly used by law enforcement investigators fall into one of three categories: disk-imaging products, write blockers, and selected suites. Further classifications will develop as tools are added to the verification list. A framework for performing tests on each category has been evaluated and the disk imaging products will be the first area tested.

The common characteristics of each classification are decomposed into testable requirements. Assertions are derived from these requirements along with assertions from specific capabilities of individual tools. Each assertion is then tested within the overall testing framework to produce results that are repeatable and objectively measurable.

MILESTONES: In FY2001, to continue the refinement of testing programs for the validation process. Publish the hard-disk-locking test report and to plan and publish the Automated Computer Examination System (ACES) test.

Development of Best Practices for Electronic-Crime Investigation

The fast paced world of electronic technology has shown that many law enforcement agencies have inadequate resources to address electronic crime. As developments in technology improve, it is imperative that resources are provided to law enforcement individuals in an effort to increase their knowledge, skills, and abilities regarding electronic crime. To address these issues, NIJ through OLES has promoted the preparation and the dissemination of best practices guidelines for conducting electronic-crime investigations. In developing the best practices, OLES will enlist the support of expert practitioners from all levels of the criminal justice community, including crime lab analysts, field investigators, and litigation experts. A series of pocket-sized best practices booklets will be produced that, collectively, cover topical areas that range from

Technical Contact:

Sue Ballou

Alim Fatah

Staff-Years:

13.5 Professionals

Funding Sources:

100% Other Government Agencies

Project Champions:

- Building and Fire Research Laboratory (BFRL), Fire Safety Engineering Division
- Chemical Science and Technology Laboratory (CSTL):
  - Biotechnology Division
  - Analytical Chemistry Division
- Department of Defense (DoD), Computer Forensics Laboratory
- Federal Bureau of Investigation (FBI)
- Information Technology Laboratory (ITL), Software Diagnostics and Conformance Testing Division
- Institute for Social Analysis (ISA), Alexandria, VA
- Manufacturing Engineering Laboratory (MEL), Precision Engineering Division
- Materials Sciences and Engineering Laboratory (MSEL), Ceramics Division
- National Cybercrime Training Partnership (NCTP), under the Computer Crimes and Intellectual Property Section of DOJ
- Royal Canadian Mounted Police (RMCP), Forensic Laboratory, Ottawa, Canada
- TASC, Inc., Arlington, VA
- University of Utah, Center for Human Toxicology (CHT), Salt Lake City, UT
- U.S. Secret Service (USSS), Washington, DC

management awareness to courtroom presentations. The topics identified for incorporation into a series of separate booklets are as follows:

- Managing Technology in Law Enforcement.
- Crime Scene Investigation: Identification, Collection, Preservation, Transfer, and Storage.
- Analysis of Computer Evidence.
- Investigative Use of Technology.
- Investigating Technology Crimes.
- How to Set Up a Digital Evidence Laboratory.
- Courtroom Presentations of Digital Evidence.

The booklet addressing crime-scene investigation was initiated in 1999 and has been targeted for completion by the end of the year 2000. The National Center for Forensic Science (NCFS), also with NIJ support, has taken responsibility to manage the planning panel for the booklet "How to Set Up a Digital Evidence Laboratory," leaving five booklet topics to be addressed.

For each booklet, a planning panel will be formed consisting of approximately 12 to 18 experts with various backgrounds in electronic evidence. The planning panel will convene to define the scope and content of the booklet, and to prepare a draft outline for the booklet. The planning panels will also assist OLES in identifying appropriate criminal justice and electronic-crime experts that will serve on a technical working group (TWG) to be formed for each of the individual best practices booklets. TWGs will consist of about 50 to 70 expert persons. Each TWG will develop a first draft booklet and edit each successive draft.

MILESTONES: In FY2001, to submit the Electronic Crime Scene Investigation draft for publication and to initiate two additional planning panels to develop and draft guideline booklets on the next selected topics.

Burn Pattern Recognition Program

Previous research has shown that fire patterns provide data useful for the determination of the origin of fires. Due to the large number of factors that affect the formation of these patterns, the Burn Pattern Recognition Program has sought to understand fire pattern formation from ignitable liquid spills and their interaction with surrounding structure components.

Past work provided insight into variables affecting burn patterns and the effects of imposed radiant heat flux on fire patterns in regard to controlled tests. This information has shown that some traditionally used indicators, or burn patterns, may erroneously imply that flammable liquid accelerants were used in a fire. The conclusions from these experiments are contained in NIJ Report 601–97, "Full Scale Room Burn Pattern Study." One conclusion is that the formation of burn patterns are highly dependent on ventilation conditions, and the study would benefit from tightly controlled experimental conditions.

To continue evaluating burn patterns, further research will dwell on the position of the gasoline spill. The spill will be moved from the center of the room to locations near the walls and corners. As resources allow, various floor coverings will be investigated and the affect of furniture or the absence of it will also be addressed.

MILESTONES: In FY2001, the new fire pattern experiments with flammable spills at locations near walls and corners will be completed and a technical report will be compiled for publication.

Establishment of NIST/NIJ Forensic Analysis Fellowship

Forensic science requires an increasing amount of technical sophistication. However, support for the post-baccalaureate education of forensic scientists is woefully inadequate. In the U.S., there are currently only seven universities offering Master's degree programs and only one recently established Forensic Science Ph.D. program. Most forensic practitioners with advanced degrees have crossed-over from allied fields such as the sciences or engineering, and have achieved their knowledge of forensic science via "on-the-job" training.

The lack of support for graduate students pursuing a degree in forensic science is a serious impediment to expanding advanced degree program enrollment in forensic sciences. Traditional funding sources, such as the National Science Foundation, generally sponsor more basic scientific research at Ph.D. and post-doctoral levels. This leaves forensic science faculty and students little opportunity for research funding.

In its role as the primary national resource for criminology and jurisprudence, the NIJ is the most appropriate locus for an effort to improve the quality of forensic scientists via advanced educational opportunity. Of particular importance is the ongoing NIJ program to assess

and meet the advanced technology needs of the forensic community. Through this activity, NIJ is uniquely suited to prioritizing the research advances required to meet national needs. OLES/NIST also brings a unique and advantageous perspective to the effort for improving the quality of forensic measurements. As the needs for technical accuracy and quality of forensic measurements continue to advance, NIST is uniquely suited to help meet those needs. Our well recognized technical competence is combined with our neutral status to build a powerful and influential effort to advance forensic measurement research.

During the past years, participants in the summer fellowship program have been selected from the Master of Forensic Sciences curriculum of the George Washington University. The selected summer topics originated from the NIST Analytical Chemistry Division. Selected topics were research on the detection and measurement of organic compounds in handgun and explosives residues and the evaluation of factors that control the retention of gunshot residues on the shooter's body. To further detail the research on residue retention factors, a series of handgun test firings were performed under a number of scientifically controlled conditions. The effect of sweat, oil, and static on the retention of residues on the shooting hand was evaluated. Optical and chemical analyses were used to evaluate residue retention.

In future years, we envision this program growing to support a limited number of student interns at NIST or other federal forensic agencies, or student researchers at universities with forensic science degree programs. Priorities for research support will follow the national forensic science needs determined by NIJ. Proposals from all major universities with forensic science degree programs will be solicited. Evaluation of proposals will be based on quality, alignment with NIJ forensic research priorities, and by student qualification as determined by NIST/OLES staff and will include at least one independent review.

MILESTONES: In FY2001, to propose a partnership between NIJ and NIST/OLES to establish a NIST/NIJ Forensic Analysis Fellowship as one mechanism to advance the skills of the next generation of forensic scientists.

Gunpowder and Handgun Residue Research

To utilize current experience with issues regarding gunpowder residue, OLES is funding work through the Analytical Chemistry Division of the Chemical Sciences and Technology Laboratory (CSTL) at NIST. The purpose of this research is to examine the compositional characteristics of gunpowder and its post-firing residues as a means of detecting handgun use and investigating crimes involving pipe bombs. Quantitative determination of the propellant (nitroglycerin-NG) and stabilizer (diphenylamine-DPA and ethyl centralite-EC) components in smokeless gunpowder is being investigated as a means of associating evidentiary residue and gunpowder samples with unfired powder exemplars. Current gunshot residue methods (based on the detection of the metallic primer particles: barium, antimony, and lead and using such techniques as Scanning Electron Microscopy/Energy Dispersive x-ray analysis), are costly to perform and seldom successful at determining handgun use.

A detailed firing range experiment was performed to evaluate seven boxes of commercial ammunition. 38-caliber ammunition was fired with a revolver, and the muzzle exit residues were collected. Unfired cartridges were retained for compositional comparison to the collected residues and to each other. Based on the qualitative identification of the additives present and determination of the propellant to stabilizer (P/S) ratio, powder samples from four of the seven boxes of ammunition could be easily differentiated. The remaining three boxes had the same additives in roughly similar proportions. Valuation of the P/S ratio could only partially differentiate these powders. If the physical morphology of the powders was also considered, powder samples from all seven boxes of ammunition could be correctly identified.

MILESTONES: Long-term goal is the development of an integrated approach to organic gunshot/explosives residue evaluation with effective sample collection, optimized analytical measurements, and rigorous graphical/statistical evaluation of the data. Manuscript has been presented to the Journal of Forensic Sciences for publication.

Evaluation of Saliva as an Alternate Drug Testing Specimen

Recent studies have shown that nearly two out of three of all suspects arrested for crimes admit to drug use and one out of three admit to use during the crime. Likewise, nearly two out of three drivers involved in fatal highway accidents test positive for drugs or alcohol. As a result, the American public has become considerably more sensitized to drug and alcohol abuse and has emphasized the need to evaluate the effects of drugs and alcohol on public safety and the environment. Therefore, the ability to rapidly determine drug concentrations is needed by the law enforcement community to support criminal and civil investigations.

The current methodology for analysis of drugs involves the use of blood, plasma, or urine as samples. However, obtaining these samples is either invasive or they can be adulterated. Saliva, on the other hand, can be obtained non-intrusively, allows protection of privacy, reduces the possibility of adulteration, and has the potential for estimating the actual circulating concentrations of drugs. Little is known about the mechanisms through which drugs are actually transferred from the blood into saliva. Therefore, an understanding of these mechanisms must be obtained to estimate the extent and rate of transport of the drugs into the saliva.

Saliva specimens from subjects will be collected by "spitting" into inert polyethylene tubes without stimulating saliva production.

It is known that drug disposition into saliva is affected by pH and collection techniques. Therefore, four additional common collection techniques/devices will be evaluated in the controlled clinical studies. These include: (1) citric acid (hard candy) used to stimulate saliva production; and (2) non-acid stimulation of saliva production (chewing on Teflon, rubber band, etc.). Two additional commercial collection devices will be chosen for evaluation.

To be useful as a testing specimen, a rapid drug screening method is needed for the matrix. This is a potential problem with saliva since the parent drug is often detected, whereas commercial immunoassay tests generally target urinary drug metabolites.

In order to evaluate the need for hydrolysis of codeine and morphine conjugates to improving the detection in saliva samples, glucuronide metabolites of codeine and morphine in saliva will be analyzed. A LC/MS/MS method for determining morphine and morphine glucuronide metabolites using solid phase extraction has already been validated and can easily be adapted for the detection of codeine and codeine glucuronide.

MILESTONES: In FY2001, to complete the analysis of all saliva, hair, plasma, and urine samples collected. Special emphasis will be placed on the relationships between dose and specimen concentration.

Use of Enantiomeric Composition to Study Incorporation of Drugs into Hair

The analysis of hair for drugs of abuse can provide a number of advantages when compared to the analysis of urine or other biological fluids. Hair provides a view of drug use over a greater period of time and is more difficult to evade than urinalysis. Several issues have slowed the acceptance of hair analysis, including a lack of understanding of mechanisms for drug incorporation, a lack of reference materials, and the possibility of false positives arising from passive (environmental) exposure.

Amphetamine and methamphetamine are commonly abused stimulants that can be prepared through a variety of synthetic pathways. Both compounds have been detected in hair samples of drug users. Because amphetamine and methamphetamine are chiral molecules, they can exist as pairs of enantiomers. The (R)-enantiomer of methamphetamine is found in legitimate pharmaceutical products, but clandestine synthesis often produces racemic amphetamine and methamphetamine. Metabolism of methamphetamine produces amphetamine, and stereoselective metabolism of both compounds has been reported. Therefore, proof of illicit use of these stimulants requires an examination of enantiomeric composition of the compound of interest. Current analytical methods for the measurement of enantiomers of these stimulants typically involve derivatization with enantiomerically pure derivatizing agents to form diastereomers that are separated by gas chromatography (GC). However, most chiral derivatizing agents are not enantiomerically pure, and impure reagents may perturb the initial enantiomeric composition of the sample, leading to erroneous or misleading results. Analytical methodology that does not require chiral derivatizing agents would likely improve the reliability of enantiomeric measurements. In addition, the availability of standards of known enantiomeric composition of

amphetamine/methamphetamine would aid validation of analytical techniques for measurement of amphetamine and methamphetamine in hair samples.

Currently, the derivatization scheme has been evaluated on standard solutions and seems to provide adequate sensitivity for the levels of amphetamine and methamphetamine likely to be found in hair. The separations between the enantiomers of both dugs have been achieved using liquid chromatography in conjunction with a chiral stationary phase. The long-term goal will be the development of a standard reference material for hair analysis.

MILESTONES: In FY2001, to apply the developed methodology to the detection of amphetamine and methamphetamine in hair.

Innovative Sweat-Based Drug Testing Technology Development

The current methodology for analysis of drugs involves the use of blood, plasma, or urine as samples. However, obtaining these samples is either invasive, or they can be adulterated. In addition, their matrices are relatively complex thus requiring more intensive and time-consuming sample preparation and/or determination. Sweat, on the other hand, can be obtained non-intrusively, allows protection of privacy, reduces the possibility of adulteration, and has the potential for estimating the actual circulating concentration of drugs. In addition, sweat is less complex and more easily prepared for analysis. This proposal focuses on the development of sweat-based drug testing techniques.

The objectives of the research project are to:

- Test the current commercially available equipment for use as sweat collection devices for adult subjects and modify them as needed to improve both performance and reliability of the devices.
- Adapt assay test kits for use in testing liquid perspiration.
- Assess the validity and utility of the liquid perspiration collection technique as a method for testing criminal populations.

The research will be performed over a period of three years. During the first year, a thorough literature review will be conducted specially targeting non-invasive techniques for collecting and testing sweat. Experts in the field will be contacted and consulted to select the most promising devices as well as to identify laboratory-based screening methods. Available liquid-perspiration collection devices will be examined and reviewed. The investigators will work closely with manufacturers of such devices to improve and modify, as necessary, for use in criminal justice populations. Pilot tests of selected devices will be conducted. The results of this first stage will be analyzed and documented in an interim report.

MILESTONES: Liquid perspiration devices will be tested and modified; and immunoassay screening methods will be evaluated.

Update of NBS Special Publication 480–17—Auto Headlight Glass Visible Features of Forensic Utility

The objective of this project is to develop a database of headlight characteristics that are current and usable for identifying headlights installed in the "Top-Selling Models" of current production passenger vehicles sold in the U.S. A 1978 special publication contained information that assisted investigators trying to identify vehicles from the fragments of headlights that were left at the scene of hit-and-run crimes. The present market and application of headlights in vehicles is larger; and a significant fraction of headlights is made in other countries. There are also additional complexities involving materials and design. Today's headlights are made of glass, plastic, or glass-plastic hybrids, for application in passenger cars and trucks [sport utility vehicles (SUVs), minivans, vans, and light trucks]. The headlights' purchasing and referencing system is very intricate.

The first priority is to collect and evaluate information for the development of a database on automotive headlights for forensic use. The database will include the identification and visual characteristics of headlights, such as patterns and markings of sealed-beam and plastic headlights installed in "Year 2001 Top-Selling Models" sold in the U.S. Further work will evolve around technical collaborations and developing essential key contacts with automakers, headlight suppliers and forensic examiners to identify auto headlight issues.

MILESTONES: In FY2001, collect and evaluate data for the development of a database of automobile headlights. Identify database structure, design, and applicable software. Establish technical collaborations to perform photography of headlight features and to carry out characterization studies.

Research in Deoxyribonucleic acid (DNA) Identification Methods and Standards

The Biotechnology Division of the CSTL at NIST has been the lead organization for DNA research for NIJ. At this time, five forensic projects targeting different aspects of DNA have received funding from NIJ and each is described below:

A Standard Reference Material for PCR-Based Profiling Standard

The Biotechnology Division has already developed SRM 2390 for use in calibrating DNA tests based on the restriction fragment length polymorphism (RFLP) method. However, with the change in technology and the burst of growth into the polymerase chain reaction (PCR) field, another SRM (SRM 2391) was developed for tests based on the PCR method. These SRMs have contributed immeasurably to the current accuracy of DNA measurements and the ability of laboratories to successfully defend the measurements in court. A major objective of this project is to provide fundamental research and development on all aspects of current DNA forensic testing with the goal of providing NIST traceability to all U.S. crime laboratory measurements on DNA for human identification.

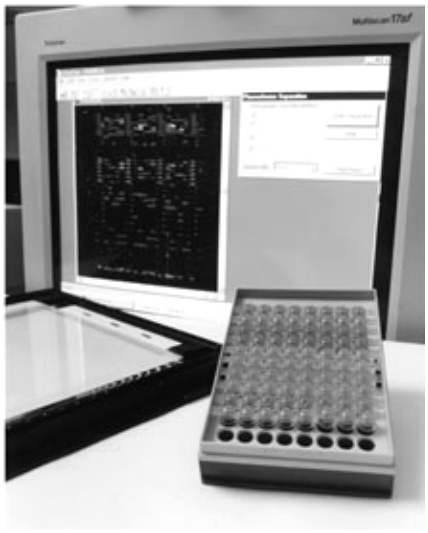
The large demand from the forensic science community for SRM 2391 has required revisions in the quantity produced and mandated continuous subsequent lot numbers.

MILESTONES: In FY2001, initiate manufacturing of the next SRM lot number to allow production completion prior to the depletion of the current SRM 2391a stock.

DNA Mixed-Stain Study 3 (NMSS3)

Laboratories utilizing multiplex kits for DNA analysis have found multiple-source DNA samples difficult to interpret. Various interactions between similar loci in a mixed run produce results that require astute interpretation and experience in the recognition of these situations. Variants present within the DNA molecule also add another source for difficulty in interpretation, yet when correctly recognized can provide a unique sample identifier. Laboratories should have a listing of identified variants, additive DNA effects, and amplification variables that may be encountered during the performance of short tandem repeat (STR) multiplex kits. A round-robin study designed to address a current number of these issues has been initiated between several volunteer forensic laboratories. Two sets of predominantly binary mixtures of extracts of DNA will be prepared at concentration ratios other than just 1:1. For the second set, all participants will be requested to quantify and type the DNA sources.

MILESTONES: In FY2001, prepare peer-reviewed manuscript or presentations to disseminate information.



Results from electrophoresis analysis of DNA sample.

Quantification of Human DNA

As STR multiplexes have increased in the number of genetic loci analyzed in one amplification, the need for controlling the input amount of DNA has increased. The results of the NIST Mixed Stain Study 2 indicated that there was a range of DNA concentration estimates that was on average 1.8. The DNA quantitation methods used were primarily two commercial kits as well as a few "in-house" methods. There was no clear measurement performance difference among the methods used. NIST is presently identifying sources of high quality and large quantity of human DNA and continuing to develop several scenarios to test federal, state, and local crime laboratories for their ability to accurately quantify nanogram to sub-nanogram levels of DNA.

MILESTONES: In FY2001, distribute evaluated materials to targeted laboratories and complete characterization of results.

Substrate Stability Studies for Convicted Offender Samples

Crime laboratories must maintain crime scene biological fluids and known blood samples at optimum conditions pending future analysis requests by investigative, prosecutorial, or defense personnel. The length of time a laboratory must accommodate these requests varies from state to state. Some states, such as California, have determined all samples must be retained indefinitely. In addition, the implementation of the federal database system, the Combined DNA Index System (CODIS), has increased the storage requirement for known blood samples. To cope with the increasing number of CODIS samples and crime-scene samples, crime laboratories must re-evaluate storage protocol. In 1994, a 10-year research study was initiated at NIST to determine the effects of temperature and substrate conditions on the quality of DNA in dried bloodstains. This study is comprehensive and will address issues absent in other published validation studies of this nature.

MILESTONES: In FY2001, prepare peer-reviewed manuscript or conduct presentations to disseminate information.

Human Mitochondrial DNA Research for Forensic Needs

Human mitochondrial DNA (mtDNA) is used by the forensic community for human identification, especially when the nuclear DNA is non-existent, degraded, or available in limited amounts. There are at least two main problems that investigators face when using mtDNA for human identification. First, laboratories need to ensure that their amplification and sequencing techniques are providing them with the correct results. NIST recently completed a human mtDNA sequencing Standard Reference Material (SRM 2392) for validation of mitochondrial sequencing procedures. The use of SRM 2392 provides an established basis by which to evaluate generated results from known and questioned evidentiary samples. Second, the mitochondrial DNA from an individual can be heteroplasmic; that is, the DNA within a single cell can differ at one or more base pairs. There are several options where these differences can exist within the human body. Heteroplasmy is a problem for forensic investigators since a sample from a crime scene can differ from a sample from a suspect by one base pair and this difference may be interpreted as sufficient evidence to eliminate that individual as the suspect. The NIST laboratory has shown that hair samples from a single individual can contain a hereoplasmy at vastly different concentrations and even the root and shaft of a single hair can differ.

MILESTONES: In FY2001, attempt to develop a human heteroplasmic mitochondrial DNA standard reference material for the detection of heteroplasmy and low frequency mutations.

On-Line Chemical Analysis of Human Hair Samples

Hair samples collected in connection with a crime are typically characterized for their morphology by microscopic techniques. These microscopic comparisons can only detail the strength or weakness of a "match" between a known and questioned hair. On occasions when the hair sample contains a root, genetic material can be extracted and characterized using PCR-based technology. Mitochondrial profiling is becoming the preferred DNA methodology for hair examinations due to its stability and presence even in the hair shaft. However, these techniques require specialized laboratory equipment, designated room allocations, and extensive laboratory analysis. In an effort to provide a simpler but still definitive method for hair characterization, NIST is evaluating a technique that will provide a statistical accounting of distinguishing features present in hair.

NIST has developed a method for determining the extractable components from hair using an on-line supercritical-fluid extraction-gas chromatography/mass spectrometric (SFE-GC/MS) technique. This technique allows for all of the organic extractable material from a small hair sample (30 g to 100 g, typically a single segment) to be introduced into the analytical system, compared with only a few percent of the total from a conventional liquid solvent extract. The added sensitivity of the on-line technique (50 to 100 times the conventional extraction technique) enables full-scan mass spectra to be obtained from any peak detected in the extract, aiding in any confirmatory identification of the component. A preliminary study suggests that hair from different individuals yields different chemical profiles, the sources of which include naturally deposited components (from sebaceous and sweat glands), artificially deposited species (from conditioners and treatment), and environmental contaminants (e.g., occupational exposure). To demonstrate the effect of

prolonged storage of physical evidence from a crime scene, hair samples have been retained at room temperature for a three-year period. These samples will be periodically removed and analyzed, comparing the results of analysis to two different groups: to chemical profiles obtained in the hair sample prior to storage, and to freshly removed hair samples from the same individuals.

MILESTONES: In FY2001, provide a laboratory procedure for the forensic science community that will provide statistical analysis of human non-DNA hair characteristics.

Development of an International Automotive Paint Database

The objective of this project is to develop an International Automotive Paint database, which has forensic science applications to both insurance and law enforcement investigations.

The Royal Canadian Mounted Police (RCMP) automotive paint database has, through a partnership with the FBI, become an important forensic trace evidence tool in North America. A Cooperative Agreement for Research and Development (CARD) between the RCMP and the FBI and funded by OLES has provided the resources needed to develop the database over a five-year period. The goals include: keeping Paint Data Queries (PDQ) current with the production year for the North American automotive industry, and training all North American law enforcement agencies in the use of the database. As it grows, PDQ will enable:

- Examiners to potentially identify make, model, and year of vehicles used in the commission of a crime or involved in a hit and run fatality.
- Examiners to develop court testimony to provide the court with alternatives to an "either/or" type conclusion. ("It is either the suspect vehicle or vehicles X as determined by PDQ.")
- Paint analysts to be on the cutting edge of automotive paint technology (PDQ as a learning tool).

MILESTONES: In FY2001, continue to add new samples to the PDQ making the database internationally viable, and make programming improvements to individualize submissions from each state laboratory so that queries to the database could be customized and thus carry more investigative and judicial impact.

DNA Mass Spectrometry and Multiplex Single Nucleotide Polymorphism/Short Tandem Repeats (SNP/STR) Research

Convicted offender blood samples are collected on a daily basis and stored throughout the United States' crime laboratories waiting for DNA analysis. To cope with the increasing backlog, a faster method of analysis is required. The time-of-flight mass spectrometry can address the backlog issue by eliminating manual sample preparation at the pre- and post-amplification steps and increasing the speed of analysis. The improved PCR assay should increase the number of markers that can be tested in a single amplification, thereby providing another means for the reduction in examiner preparation and analysis time.

Mixed crime scene samples have proven time consuming in a forensic laboratory, requiring additional extraction steps and a stringent interpretation protocol. The Y chromosome markers are targeted to offer new loci on the Y chromosome and mitochondrial DNA for potential use in improved separation of male-to-male fractions and to eliminate female cellular contamination. These steps would simplify the determination of multiple contributors to a body fluid sample.

The work accomplished on these projects in FY2000 was fast paced. The incorporation of the MWG Biotech RoboAmp 4200 sample preparation robot with the Bruker BIFLEX III Time-of-Flight Mass Spectrometer was completed. This combination was utilized to characterize and validate forensic multiplex STR kits. To accompany this work, development of a suite of Visual Basic computer programs to assist multiplex PCR primer design was also initiated. Several new Y STR multiplex sets have been started to aid characterization of a future Y chromosome SRM.

MILESTONES: In FY2001, conduct an inter-laboratory evaluation of the multiplex STR results from commercial kits and continue characterization and quality control work on these kits. Conduct an evaluation of various methods for measurement of single nucleotide polymorphisms (SNPs) using mass spectrometry and evaluate approximately 20 Y SNP markers using an optimal mass spectrometric method.

Revision of ASCLD/LAB Accreditation Manual to Conform with ISO Guidelines

The American Society of Crime Laboratory Directors/ Laboratory Accreditation Board (ASCLD/LAB) operates an accreditation

program for crime laboratories with members consisting of 139 domestic and 14 foreign laboratories. The board administers this program on a minimal budget from member dues and has only one part-time paid employee. The program has become a source of laboratory accreditation to meet federal and judicial requirements. The current criteria and the accreditation program procedures were prepared by the members of ASCLD/LAB based on their professional knowledge and experience in crime laboratory operations. However, several international organizations have prepared generic criteria for competence of laboratory operations and for operating accreditation programs to measure laboratory competence. The International Organization of Standardization (ISO) has prepared ISO Guide 25 General Requirements for the Competence of Calibration and Testing Laboratories and ISO Guide 58 General Requirements for Operation and Recognition of Calibration and Testing Laboratory Accreditation Programs. To maintain the highest level of criteria and to adopt a single international standard for measurement of laboratory competence, it is imperative that ASCLD/LAB considers conformation to the ISO guidelines.

The objective of this effort is to improve the quality of laboratory services provided to the criminal justice system by revising the policies and procedures of the board of the ASCLD/LAB to meet applicable international standards.

MILESTONES: In FY2001, review the suggested revisions to the current ASCLD/LAB Accreditation Manual and recommend changes to the bylaws of ASCLD/LAB so that they conform to the criteria in ISO Guides 25 and 58.

Accomplishments

- *Maintenance of a short tandem repeat DNA database commonly referred to as STRBase (http://www.cstl.nist.gov/biotech/strbase).* The STRBase has provided a venue for the collection of variant alleles, multiplex STR kit schematics, and downloadable PowerPoint presentations. More than 1300 publications on the use of STRs for DNA typing, including over 150 regarding Y-chromosome markers, have been catalogued within the STRBase. This database is a quick and impressive source of STR information.

Publications

NIJ Report 600–98, "Forensic Sciences: Status and Needs," February 1999.

"Survey Tool for the Measurement of Workload in Crime Laboratories," January 1999.

NIJ Report 600–99, "Trace Evidence Analysis of Human Hair by On-Line Supercritical Fluid Extraction—Gas Chromatography/Mass Spectrometry: A Feasibility Study," December 1999.

"Correlation of Saliva Codeine Concentrations with Plasma Concentrations," Journal of Analytical Toxicology, Vol. 23, October 1999.

"Associating Gunpowder and Residues from Commercial Ammunition Using Compositional Analysis with the Propellant to Stabilizer Ration (P/S)," accepted for publication in the Journal of Forensic Sciences.

NIJ Report 604–00, "Flammable and Combustible Liquid Spill/Burn Patterns," submitted for publication.

"Validation of Twelve Chemical Spot Tests for Detection of Drugs of Abuse," submitted for publication.

NIJ Standard–0604.01, "Color Test Reagents for Preliminary Identification of Drugs of Abuse," July 2000.

Technical Contact:
Kathleen Higgins
George Lieberman

Staff-Years:
15.0 professionals

Funding Sources:
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Project Champions:
- Institute for Telecommunication Sciences, the research and engineering branch of the National Telecommunications and Information Administration (NTIA), Boulder, CO

Public Safety Communication Standards

Project Goals

The primary objective of this project is to lead the development of wireless telecommunications and information technology standards, profiles, and guidelines for interoperability, and information sharing, among criminal justice (CJ) and public safety (PS) agencies at state, local, and federal levels. To achieve this it will be necessary to focus on enabling technologies and open architecture standards so that interoperability approaches can be designed and implemented. Proposed techniques and standardized configurations will be verified and validated through simulations and laboratory testing.

While standards are being developed, other interim interoperability solutions will be investigated. As a secondary goal, this project will conduct technical evaluations of current and emerging technologies aimed at providing immediate assistance to CJ and PS agencies.

Customer Needs

Law enforcement work requires effective coordination, communication, and sharing of information with numerous criminal justice and public safety agencies. Thousands of incidents that require mutual aid and coordinated response happen each and every day. High-profile incidents, such as bombings or plane crashes, test the ability of public safety service organizations to mount well-coordinated responses. In an era where technology can bring news, current events, and entertainment to the farthest reaches of the world, many police officers, firefighters, and emergency medical service personnel cannot communicate with each other during routine operations or major emergencies, such as the Oklahoma City bombing. New technologies are promoting the convergence of information and communication systems with the result that portable and mobile units are increasingly being viewed as merely wireless nodes within information networks. Interoperability, the ability of two or more organizations to communicate and share information (voice, data, images, and video), is therefore becoming more difficult.

To illustrate this point, one need only look at the existing environment of the public safety community. There are more than 17000 law enforcement agencies in the United States. Approximately 95 % of these agencies employ fewer than 100 sworn officers. Additionally, over 35000 fire and emergency medical agencies exist across the nation. Due to the fragmented nature of this community, most public safety communications systems are stovepipe systems that do not facilitate interoperability. To further complicate the situation, public safety radio frequencies are distributed across four isolated frequency bands from low band VHF (25 MHz to 50 MHz) to 800 MHz (806 MHz to 869 MHz), with no universally available or affordable radio being able to operate across the entire range.

Effective communication is a critical aspect of both law enforcement and corrections operations. Dispatch is the nerve center of the agency.

Technical Strategy

During FY2000, OLES concentrated most of its technical efforts toward a major program of the National Institute of Justice (NIJ) called "AGILE." At the same time, it continued its support to NIJ in other areas related to public safety needs.

NIJ and its AGILE Program

As the Department of Justice's science and technology arm for federal, state, and local agencies, the NIJ has been addressing interoperability technology issues for a number of years. This is because the Law Enforcement and Corrections Technology Advisory Council (LECTAC), which provides advice and guidance to NIJ and its National Law Enforcement and Corrections Technology Centers (NLECTC), has consistently identified information sharing and communications interoperability as top priorities. (LECTAC consists of representatives of federal, state, and local law enforcement and corrections practitioners.) It is natural, then, that the goal of NIJ's Advanced Generation of Interoperability for Law Enforcement (AGILE) program is to

assist the federal, state, and local criminal justice and public safety communities in achieving their interoperability technology needs.

The ability of an officer to communicate with other local agencies and emergency responders is critical to efficient and safe operations.

AGILE is a comprehensive program that addresses interoperability technology issues on several fronts while leveraging many other related efforts in a complementary manner. For example, NIJ is working closely with the Administration's National Partnership for Reinventing Government (NPRG) initiatives; specifically, the Office of Justice Program's (OJP's) Information Technology Executive Council Integration Initiative, which supports the Global Criminal Justice Information Network (GCJIN) and the Public Safety Wireless Network (PSWN). The OJP Executive Council has tasked NIJ with being the technical arm for its Integration Initiative. As such, NIJ through its AGILE Program is leading the development of wireless telecommunications and information technology standards, profiles, and guidelines for information sharing to facilitate interoperability at state, local, and federal levels.

The Integral Role of OLES in the NIJ/AGILE Standards Project

OLES plays a key and pivotal role in the AGILE Standards Project. The same formal processes that OLES has used in successfully bringing users, technologists, industry representatives, and members of the standards development organizations (SDOs) together for other standards efforts, have been used again for the AGILE Program. In some respects, the AGILE Program may present fewer difficulties for standards development since the vast majority of standards (perhaps 95 % or more) will be chosen from existing standards. That is, OLES will support and facilitate the work of CJ/PS users, who will identify desirable standards that have been developed by national and international SDOs. Those interoperability standards will then be recommended to NIJ for adoption as NIJ Standards. Only in very rare cases will the users (and OLES) need to develop technical specifications to create standards that do not already exist. Even in those cases, the actual standards activities may occur through the formal structures of the SDOs. That is, selected users and/or OLES will simply represent the needs of the CJ/PS users within the appropriate SDO committees, and ensure that the proper standards are developed correctly, and in a timely fashion.

The AGILE Standards Process

The AGILE standards process can be seen as having two distinct phases – the "Preparation Phase" and the "Implementation Phase." The Preparation Phase is that part of the project in which background material is accumulated and analyzed, and the Implementation Phase is planned. The Preparation Phase, which is necessarily tedious, does not involve the user community directly. It actually prepares for the users' involvement, by developing a set of documents that can provide a good starting point for the Implementation Phase.

Figure 1 illustrates the demarcation between the Preparation and Implementation phases of the standards process. The Implementation Phase starts to occur on the far-right side of the diagram, i.e., at the points where "Wireless Interoperability Standards Development" and "IT Information-Sharing Standards Development" begin, respectively. Activities to the left of those points are included within the Preparation Phase. That is, the development of the Strategic Plans is the last effort in the Preparation Phase, for these plans provide the rationale and general methodology for initiating the standards development actions. A closer look at Figure 1 will clarify this.

The Preparation Phase begins with the "*Outline of the Strategic Plan: Standards for Wireless Communication and Information Technologies for Public Safety Under NIJ's AGILE Program,"* shown on the extreme left side of the diagram. As noted above, this document (designated SP–00–0001) defines what needs to be accomplished during the Preparation Phase of the Standards Process. The blocks shown in the figure directly to the right of SP–00–0001 provide the information that is needed for the Strategic Plans to be completed.

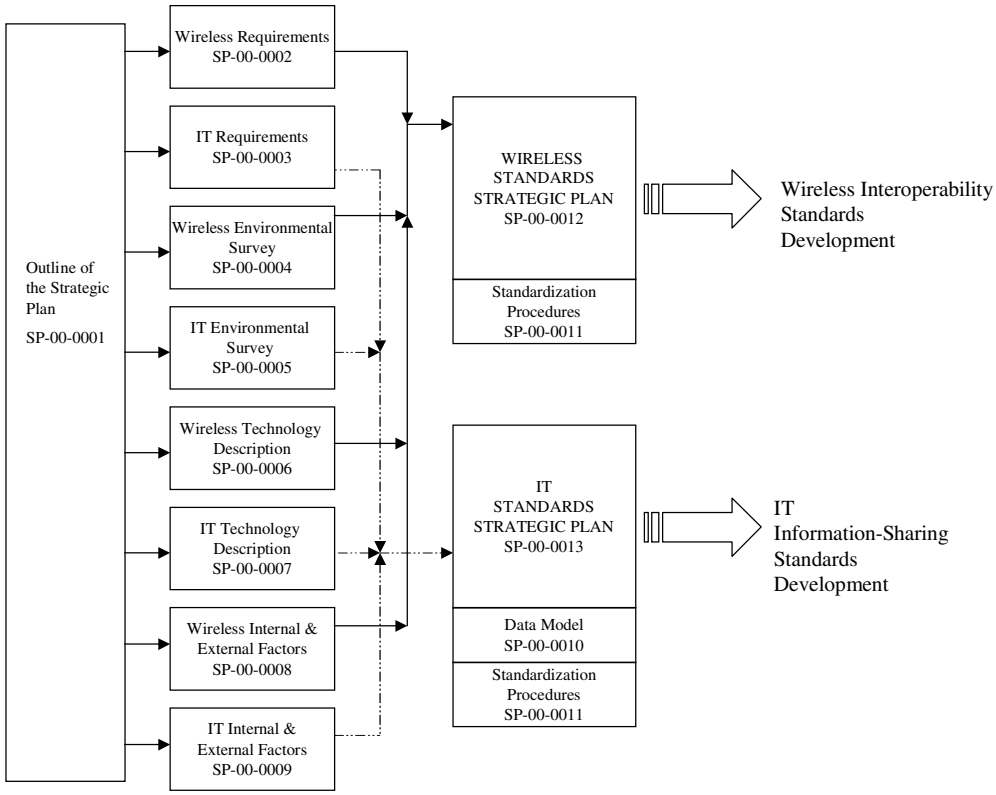

Figure 1. Overview of AGILE Standards Process and Associated Documents

The "Requirements" documents, SP–00–0002 and SP–00–0003, are really the cornerstones for the wireless telecommunications and IT (information-sharing) standards processes. All proposed standards adoption activities must be validated by referring to the users' requirements.

The Environmental Surveys, one for wireless and the other for IT, are snapshots of current and planned telecommunications and IT activities, organized state-by-state. That is, they present the current assets, and what is planned to upgrade or replace them. It is important to know what the state and local agencies presently have, so as to not offer interoperability approaches that will cause them unwarranted technical effort or excessive cost. These survey reports document the types of systems and networks used by each state for various governmental functions (law enforcement, corrections, judiciary/courts, fire, etc.) based on published or website data. No attempt is made to conduct personal interviews to fine-tune the gathered data, because users' representatives will thoroughly review (and validate) all Preparation Phase documents during the early stages of the Implementation Phase.

Technology Descriptions (contained in documents SP–00–0006 and SP–00–0007) provide an objective view of current and emerging wireless and information technologies, particularly those that have been standardized. The information in these documents will be considered in the two Strategic Plans as alternative technical approaches are addressed. Both large-scale (architectural) and individual (access/channel) techniques for wireless interoperability and information-sharing will need to consider the implications of evolving technologies, and how they can be efficiently accommodated.

Internal and external factors are those issues that can (or will) influence the selection of an approach for interoperability or information sharing. That is, they are political, legal/regulatory, or cultural conditions that can restrict the number of viable or practical choices. Internal factors are those that are imposed by those in the community, and may be able to be changed. External factors are derived by others, and normally cannot be altered or deleted. Documents SP–00–0008 and SP–00–0009 address such factors as state privacy laws (that restrict or closely control the access to, and exchange of, certain data on individuals) and radio frequency assignments of the Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA).

All of the documents summarized above provide input to their respective Strategic Plans and may actually be considered as components or "sections" of the Strategic Plans. As separate documents, these information sources can be revised or updated individually without requiring the others to be modified. That is, they are independent by design. However, the Strategic Plans, which consider (and use) the data from all these sources, probably would be affected by most significant changes in these documents. Strategic Plans, therefore, are re-examined when input data have changed, to determine if the approaches need to be refined.

The last documents that are developed as part of the Preparation Phase are shown in Figure 1 as residing within the Strategic Plans themselves. This is because they are not as independent as the other information sources, and in fact need to consider the other sources in their development. The Data Model (SP–00–0010) document (shown only in the *IT Standards Strategic Plan*) provides a framework for creating a common intermediate representation of key CJ/PS data elements to enable broader information sharing capability. The data model, which will be completed with the help of the user-experts in the Implementation Phase, will outline the actual scenario under which data will be accessed and transferred, and will include data format guidelines, communications protocol guidelines, and operational guidelines. The suite of IT Standards, then, will accommodate the data model; that is, make the concepts possible.

The NIJ/AGILE Standards Organization and Procedures document (SP–00–0011) is the general strawman for conducting formal "Implementation" business in both the Wireless Interoperability Standards Development and IT Information-Sharing Standards Development activities. The procedures document outlines the structure and operational functions of the organizations that will eventually present proposed standards to NIJ for adoption as NIJ Standards. Before standards can be proposed, however, the appropriate standards committees will identify standards candidates and evaluate their applicability and worth in satisfying users' requirements (within the context of certain architectural models).

In addition to the general strawman found in SP–00–0011, two other documents will be used by the respective Standards Committees to more specifically describe their organization and operations. The Standards Committee related to IT information sharing will use SP–00–0014 to fashion an effective approach. A similar document will outline the design and workings of the Wireless Interoperability Standards Committee.

FY2001 Implementation Phase Activities

In order to begin the Implementation Phase of the AGILE Standards process, formal standards committees will need to be established and convened. Recognized officials from the criminal justice and public safety communities will be sought to represent the users in the highest-level committees. At the same time, working groups of technical experts will be organized and convened to confront detailed technical issues that arise during higher-level discussions. OLES will develop agendas, discussion points, white papers, and other aids that can be used to structure and advance the work of the committees and working groups.

OLES will present the standards committees with the Preparation Phase documents (described above) as draft documents to be validated, and then used by the committees.

After the standards committees have all relevant background material, and approved procedures to conduct business, OLES will begin providing standards to them in a structured fashion. The identification and compilation of formal documents that are associated with standards activities is a huge task. It is estimated that telecommunications and IT standards may already number between 5000 and 10000 documents. In addition, there are some 1200 active SDO specifications/agreements that may find their way to becoming formal standards. The Internet Engineering Task Force (IETF) alone has some 450 documents that specify the Internet and its operations.

The IETF documents will be reviewed and analyzed as a good starting point to expedite standardization of IT interoperability (and IT mobility, i.e., wireless access to the IT network framework). Even with 450 documents, however, it is fairly certain that they will not provide the necessary characterization of virtual private networks (VPNs), multi-level security techniques, and transfer mechanisms required for criminal justice or public safety operations. New documents will need to be developed and offered to the IETF and the SDOs for review and adoption.

In conjunction with standards "discovery," it will be necessary to analyze the available (and emerging) IT and telecommunications standards and SDO specifications and agreements for applicability to satisfying the needs of the criminal justice and public safety communities. The salient characteristics of the standards and agreements, and the results of the analysis for each, will then be documented. Furthermore, it will be necessary to harmonize the diversified requirements of the (wireless) telecommunications users with those of the (wireline) information technology users to ensure that all end-to-end system interoperability issues are adequately addressed, including performance. As potential interoperability approaches are derived, simulations and/or laboratory testing may be needed to assess the viability and effectiveness of the schemes.

OLES will act as the secretariat for the standards organization during its initial operation, and as NIJ standards are adopted. Where necessary, standard profiles will be developed and adopted to further define the particular technical specifications of the standards that are implemented. Therefore, it will be required to construct and maintain a relational database containing lists of adopted standards and their profiles, as well as the actual documents.

Accomplishments

- *Completed the AGILE Strategic Plan for developing IT Information-Sharing Standards, as well as all of its accompanying documents*. This finished the Preparation Phase for IT standards development. All background documents for the Wireless Standards Strategic Plan were also developed; however, the Strategic Plan associated with wireless telecommunications interoperability requires additional information related to the members of the standards committees and working groups.

- *Performed a formal technical evaluation of an audio gateway device.* This was accomplished as part of the technology evaluation function for the AGILE Program. Labeled a "cross-banding technology," the equipment allows the interoperation of dissimilar wireless telecommunication systems, e.g., between very high frequency (VHF) radios and ultra-high frequency radios. An evaluation report was provided to NIJ for dissemination to public safety agencies.

- *Provided a presentation at the 2000 International Symposium on Advanced Radio Technologies (ISART).* The presentation, entitled "The Effect of Evolving IT Applications on Broadband Wireless Requirements," characterized (AGILE) public safety needs in terms of required broadband wireless system design specifications.

- *Published NIJ Guide 201–99, "Video Surveillance Equipment Selection and Application Guide."* This guide educates law enforcement and corrections agencies in the cost-effective and application-specific selection of video surveillance equipment. The guide pays particular attention to delineating the technical parameters that most influence operational performance of video gear used by police to collect evidence or provide safety.

- *Submitted NIJ Guide 202–99, "Antenna System Guide," to NIJ sponsor for approval.* In this guide, the reader is provided with sufficient understanding of the fundamentals, characteristics, and functions of antennas to enable him or her to develop requirements and discuss antennas with vendors, installers, repair shops, and others. This information is generally restricted to the kind of antenna systems used by law enforcement agencies.

Publications

NIJ Guide 201–99, "Video Surveillance Equipment Selection and Application Guide," October 1999.

NIJ Guide 202–99, "Antenna System Guide," under NIJ review.

Office of Law Enforcement Standards Organization (810.02)

For additional information about the Office of Law Enforcement Standards, please visit our Web sites at http://www.eeel.nist.gov/oles or http://www.nlectc.org. Staff may be contacted at the following telephone extensions (301–975–XXXX):

Name	Title	Extension
Kathleen Higgins	Director, OLES	2754
Thomas Russell	Special Assistant to the Director	2665
Sharon Lyles	Administrative Support Assistant	2757
Marilyn Leach	Secretary	2756
Susan Ballou	Program Manager, Forensic Sciences	8750
Alim Fatah	Program Manager, Chemical Systems and Materials	2753
George Lieberman	Program Manager, Detection, Inspection and Enforcement Technologies	4258
Kirk Rice	Program Manager, Weapons and Protective Systems	8071
Nathaniel Waters	Engineering Technician	5128

January 2001

For additional information contact:
Telephone: (301) 975-2757
Facsimile: (301) 948-0978
On the Web: http://www.eeel.nist.gov/810.02