NATIONAL LAW ENFORCEMENT AND CORRECTIONS TECHNOLOGY CENTER
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New at NIST

On the surface it seems a quiet place. Ordinary looking offices are filled with desks, computers, and bookshelves. People go about their business at a focused, measured pace. Windows look out on trees, ponds, and grassy fields. Deer and geese make their home here. It is about as far removed from city streets and cellblocks as you can get.

But within this quiet, unassuming place, research and analysis take place to increase the safety and efficiency of police, corrections, and public safety personnel throughout the Nation. Located in the Maryland suburbs, 25 miles from downtown Washington, D.C., is a complex of buildings and laboratories situated on a 578-acre campus. This is the headquarters of the National Institute of Standards and Technology (NIST) and home to the Office of Law Enforcement Standards (OLES), which is funded by the National Institute of Justice (NIJ).

Every day at OLES, work proceeds on a number of technology-related projects and programs, including the following, to benefit the public safety community.

Matching Bullets

When people need a quick, all-encompassing solution, they speak of searching for a magic bullet. At OLES, they do not yet have a magic bullet, but they do have a matching one.

Just as no two fingerprints are alike, each firearm has its own set of unique characteristics that leaves a signature on the bullets and casings it fires. Forensic examiners analyze these ballistics signatures to connect a firearm to bullets or casings found at crime scenes. Susan Ballou, program manager for forensic sciences at OLES, explains that most ballistics laboratories use the Integrated Ballistics Identification System (IBIS) to match bullets. IBIS uses image capture, image analysis, and nationwide databases to match bullets to firearms. High-quality measurement standards for bullets and casings are necessary to maintain the system's reliability. To help laboratories maintain these high standards, NIST developed the Research Material 8240 Standard Reference Material (SRM) bullet. An SRM has had specific values verified and is certified by NIST.

"The bottom line is to see it from a forensics point of view," Ballou says. "I usually bring in DNA as an example, since it is such a hot topic. When we started forensically using DNA around 1987, every lab began incorporating it to the best of its ability. When different pieces of evidence from the O.J. Simpson case were sent to different labs, it brought to light that we had this highly sensitive type of evidence and we needed to make sure that everybody was following the same procedures. If you tested something in one lab, you needed to be able to substantiate how you got the same result in another. They decided they needed to put standard operating procedures in place."

Matching bullet signatures has the potential for the same types of problems, Ballou says. Forensic labs are encouraged to submit images of bullets they test to IBIS's national database. This database enables a lab to match the signature of a bullet recovered from a crime scene in Mississippi with that of a bullet found at a crime scene in Kansas. If Kansas law enforcement officials have the gun, it might help solve the Mississippi crime. However, slight differences in the calibration of equipment make matching bullet signatures harder. "It seemed that nobody was doing the exact same thing to their bullet images, so the success rate of the database search wasn't as high as it should have been," Ballou says.

Recognizing the need for nationwide calibration, then-Attorney General Janet Reno backed a 1998 initiative for NIJ that provided startup funds to create the SRM bullet. "If you buy a box of ammunition off the shelf, there can be so many differences," Ballou says. "They're microscopic and won't be visible to the naked eye, but they may make a big difference in testing."

A standard, computer-generated bullet will soon be available from NIST at a cost of approximately $2,000. (The price may be reduced depending on demand. NIST, which does not make a profit from the sales, recycles the funds into creating additional bullets.) This standard bullet is reproduced through a numerically controlled diamond-turning technique from master bullet signatures stored in a computer. A forensic laboratory can use this reproduction to calibrate its equipment settings. This

will reinforce consistency both within IBIS and among laboratories, leading to greater success in finding matches.

At first, Ballou says, the IBIS developer did not see the need for an SRM. A company representative told her that if a lab examiner followed directions for setting up the equipment, it would be properly calibrated. However, Ballou says, those directions do not allow for such variables as differences in light selection and an examiner's individual preferences, which might lower a lab's match success rate. The database might offer too many bullet images as possible matches, requiring the examiner to spend time doing visual searches. A lab might have time to follow up on only five, and the sixth might be the match, she says.

NIST's first run produced 40 SRM bullet reproductions. Of these, 20 will be available to forensic laboratories and 20 will remain at NIST for teaching purposes. OLES plans a workshop and a series of presentations on how to use the standard bullet. Because production is labor intensive and costly, NIST will not keep a large inventory of the bullets, but it will produce more if labs request them. The Bureau of Alcohol, Tobacco and Firearms and the Federal Bureau of Investigation (FBI) have taken part in the testing and other phases of this project. A final report is being prepared.

Standardizing Bomb Suits

In contrast to the standard bullet project, which is wrapping up, the bomb suit standards project is just starting, according to Kirk Rice, program manager for weapons and protective systems at OLES. The objective of this study is to establish minimum performance requirements and testing methods for bomb suits that are used by explosive ordnance disposal (EOD) personnel. Rice recalls his initial surprise that the military did not have such a standard, although the U.S. Army has preliminary performance requirements that can be used as a starting point.

Rice says purchasing agents typically rely on advice from others in the field and on manufacturers' literature; therefore, the EOD community has identified development of a standard as a top priority. The project will involve consulting with explosives experts to identify essential features of bomb suits, devising rating categories, proposing a standard, validating it through testing, and submitting the standard for comment and review.

The Technical Support Working Group (TSWG), an interagency government organization, helps provide overall coordination and access to resources from other countries. At this point, Rice says, the parties involved are considering the scope of the study and which suits to analyze, defining typical threat levels, and ensuring consistent testing standards. OLES also will seek input from the medical community about the human body's ability to withstand blast pressure.

"All these State and local police are dealing with pipe bombs, with things that show up at city hall and at abortion clinics. They don't have the resources to go out and test suits and make an educated decision," Rice says. "Sometimes they're not even sure what a bomb suit is. The FBI says they get calls from local police who ask if they put on body armor and a protective helmet, is that a bomb suit, and if so, can they wear that to come take disarmament training? That's why NIJ is taking it under its wing."

A bomb suit is designed to deflect much of the force from a blast around the body instead of the body's taking it all at one point. If someone is wearing the wrong equipment or wearing it incorrectly, he says, the blast force could hit the officer under the chin and break his or her neck.

"In generic terms, a bomb suit is a protective suit designed to shield the wearer from blast and fragment damage from explosive devices," Rice says. The goal of the project is to determine the extent to which a specific suit shields its wearer and rate it on a standard threat scale. Although this sounds similar to existing NIJ body armor standards, Rice thinks the need is not as widespread.

Rice and the rest of the group working on the project will have a lot of data to go through, but they can draw comfort from the knowledge that most manufacturers already produce good bomb suits. "It isn't that officers are wearing bomb suits and they're not working; they are," Rice says. "The idea is just to make it easier for law enforcement agencies to pick what's right for them. Manufacturers welcome this research. Right now, they make a product, and they make what they think is needed. A standard will give them a benchmark to shoot for."

Rice says OLES has met with a group that included representatives from the National Bomb Squad Commanders' Advisory Board, the FBI Bomb Data Center, the U.S. Army, TSWG, and the Navy EOD school to discuss the scope of the project. TSWG plans to convene a working group of professionals later in 2002. The project is expected to take approximately 2 years to complete.

Testing Saliva

The bomb suit standard will better protect law enforcement personnel. But Dr. Alim Fatah, OLES program manager for chemical systems and materials, is heading a study that may lead to more accurate drug testing results while protecting arrestees' and inmates' civil rights.

In recent years, many have felt that watching a subject produce a urine specimen for drug testing invades

his or her privacy. But if someone is left alone to produce the sample, samples can be swapped or otherwise contaminated. Saliva, however, can be collected under full observation without invading a subject's privacy. Research has shown that saliva appears to reflect blood-drug concentrations accurately. According to Fatah, studies have shown that many therapeutic drugs and drugs of abuse (e.g., amphetamines, marijuana, cocaine, opiates, LSD, and PCP) can be detected in saliva.

Under OLES's direction, researchers at the University of Utah's Center for Human Toxicology compared the presence of codeine in blood to that in saliva. Fatah says results showed that saliva concentrations were higher, easier to detect, and present longer. Saliva used in this study was acquired through spitting.

In a related study, the researchers looked at devices that collect saliva samples from inside the cheek. They also looked at the results when saliva production is stimulated by sucking on a lemon drop or chewing paraffin wax. Spitting produced uniformly higher results, Fatah says. He notes that one drawback to using saliva is the potential for contamination when the person being tested took a drug by mouth, inhalation, or smoke and then ate, drank, or smoked other substances.

Analyzing Pepper Spray

Fatah also is studying human reaction to pepper sprays. Oleoresin capsicum (OC), the oil extracted from the cayenne pepper plant, is the active ingredient used in most self-defense sprays. Although pepper sprays are a useful and purported nonlethal form of defense, commercially available products vary widely in their strength and potential effectiveness.

Law enforcement, corrections, and the public have concerns about product performance, legal issues, and medical safety surrounding the use of pepper sprays. OLES has undertaken a study to produce data for use in developing minimum pepper spray performance standards. Manufacturers' standards and product performance vary widely, sometimes even from batch to batch of the same product produced by the same manufacturer, Fatah says. Some pepper spray products have been shown to vary by 10 to 20 times in the amount of OC used.

The first phase of the study, conducted by researchers at the University of Utah's Center for Human Toxicology under the direction of OLES, analyzed several products made by different manufacturers. Some sprays contain only synthetic capsaicin (nonivamide), others contain natural substances from a variety of peppers, and others mix synthetic and natural capsaicins. (Capsaicin is the active ingredient in capsicum.) An analysis of 10 sprays showed wide variations in the amounts of OC used. The spray with the strongest concentration had about 40 times the amount contained in the weakest spray. Several samples appeared to be the same product but had different lot numbers. Fatah says that the next step is to determine the effectiveness of these various concentrations and to recommend standards.

To learn more about standard bullets, contact Susan Ballou at 301–975–8750, susan.ballou@nist.gov; about bomb suit standards, contact Kirk Rice at 301–975–8071, kirk.rice@nist.gov; and about saliva and pepper spray testing, contact Alim Fatah at 301–975–2753, alim.fatah@nist.gov. For information about the National Institute of Standards and Technology, log on to www.nist.gov; for the Office of Law Enforcement Standards, go to www.eeel.nist.gov/oles.

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