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Homeland Security

Terrorism: How vulnerable are we?

Conventional explosives: Unconventional solutions

Sandia National Laboratories

What is LDRD?

Sandia's world-class science, technology, and engineering work define the Labs' value to the nation. These capabilities must remain on the cutting edge, because the security of the U.S. depends directly upon them. Sandia's Laboratory Directed Research and Development (LDRD) Program provides the flexibility to invest in long-term, high-risk, and potentially high-payoff research and development that stretch the Labs' science and technology capabilities.

LDRD supports Sandia's four primary strategic business objectives: nuclear weapons; nonproliferation and materials assessment; energy and infrastructure assurance; and military technologies and applications; and an emerging strategic objective in homeland security. LDRD also promotes creative and innovative research and development by funding projects that are discretionary, short term, and often high risk, attracting exceptional research talent from across many disciplines.

When the LDRD symbol appears in this issue, it indicates that at some state in the history of the technology or program, LDRD funding played a critical role.

On the Cover:

Sandia National Laboratories is involved in the development of many technologies that may prove helpful to homeland defense. In this photo, researcher Doug Adkins works on a wind-tunnel test of "SnifferStar™," a device used to detect harmful agents from an airborne platform. Snifferstar™ is one of a series of tools that have spun off of early Sandia "laboratory-on-a-chip" research and are now finding useful niches in the war against terrorism.
(Sandia Photo by Randy Montoya)

Sandia Technology is a quarterly journal published by Sandia National Laboratories. Sandia is a multiprogram engineering and science laboratory operated by Sandia Corporation, a Lockheed Martin company, for the Department of Energy. With main facilities in Albuquerque, New Mexico, and Livermore, California, Sandia has broad-based research and development responsibilities for nuclear weapons, arms control, energy, the environment, economic competitiveness, and other areas of importance to the needs of the nation. The Laboratories' principal mission is to support national defense policies, by ensuring that the nuclear weapon stockpile meets the highest standards of safety, reliability, security, use control, and military performance. For more information on Sandia, see our Web site at *http://www.sandia.gov.*

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FROM THE Editor

Dear Readers,

This issue of *Sandia Technology* explores a timely, yet worrisome topic — our homeland security. Images of September 11, 2001, will stir terrible memories in many of us for years to come. At the same time, the reaction of Americans to this tragic day speaks volumes about our national spirit. Sandia's reactions have reflected this national trend. As you will learn in this issue, Sandia researchers were quick to help in a number of short-term projects, including search-and-rescue efforts at the World Trade Center.

But it is in the long-term, systematic approach to issues of national importance that Sandia and the network of Department of Energy national laboratories excel. This issue details some of our continuing efforts.

John German, a member of the Media Relations and Communications staff at Sandia, was a major contributor to this issue. So too were Mike Janes and Nancy Garcia of our California site. Many others also helped, working with a dedicated technical staff in pursuit of answers to the troubling questions posed in defending our homeland.

Finally, new assistant secretary Penrose Albright looks at how the Department of Homeland Security and the national laboratories can be the most productive in this long-term effort — truly a war on terrorism — that has only just begun.

Will Keener
Editor

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Trial by FIRE

Sandia is fully engaged in the antiterrorism fight. Even as the World Trade Center towers tumbled down, Americans were finding new levels of resolve on both personal and professional levels. Sandia's response was no different.

"Like most Americans, the people of Sandia National Laboratories responded," Sandia president and director C. Paul Robinson told a Congressional committee of the Labs' reaction to September 11, 2001. "As a result of strategic planning and the prior investment of resources for emerging threats, Sandia was in a position to immediately address some urgent needs," he added.

As the nation approaches the second anniversary of that horrible day, the response from Sandia's senior managers, researchers, and supporting staff has become more organized, more focused on key areas, but is certainly no less passionate.

Robinson outlined for Congress a number of short-term responses by Sandia to terrorist warfare. They included:

- Dispatch of emergency personnel to New York's "Ground Zero." Among those helping were a small team providing instruments for K-9 rescue units. These instruments allowed dogs

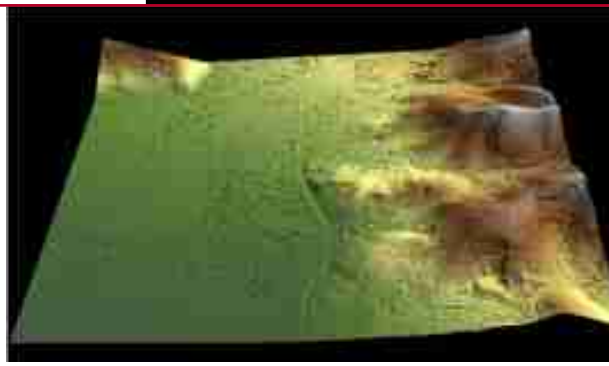
Sandia's contributions to the war against terror were possible because of early investment in capabilities needed to respond to emerging threats.

entering spaces in the World Trade Center wreckage inaccessible to humans to transmit live video and audio to rescuers.

- Supplying decontamination foam, developed by Sandia chemists, to help eliminate anthrax in the Hart, Dirksen and Ford buildings on Capitol Hill and at other impacted sites.
- Assistance with real-time synthetic aperture radar (SAR) systems for U.S. troops dispatched to trouble spots around the world. SAR systems have operated under every U.S. military command, enabling our forces to detect and track targets day or night and through inclement weather, as well as giving them a real-time topographical mapping capability.
- Deployment of an array of devices invented for disarming terrorist bombs. Law enforcement officials used one such Sandia-developed device to disable shoe bombs recovered from accused terrorist Richard Reid. He tried to detonate the bombs onboard a trans-Atlantic flight. (See story on page 18.)

These and other contributions to the war against terror were possible because of early investment in capabilities needed to respond to emerging threats, Robinson reported.

Sandia' s Richard Sparks demonstrates K-9 collar and camera.



Sandia used SAR to produce this digital, accurate terrain map of Park City, Utah, for the 2002 Winter Olympic Games security.

LDRD

Researchers also recognized that a long-term approach to these issues is needed. They assessed relevant work under way even before September 11, 2001, and began to develop such an approach last year.

While much of this issue of *Sandia Technologies* and a significant amount of current work at the Labs is devoted to homeland security technologies, attention also is being paid to an overarching framework for the conduct of this new war. The framework comes as a result of efforts by Sandia's Advanced Concepts Group, under the direction of vice president and principal scientist Gerry Yonas.

Fear of fire

"At the turn of the 19th century," explains Yonas, "people lived in fear of fire. Loss of life was enormous." But society learned to live with fire by investing in technology, he continues. Today, water sprinklers, heat detection sensors and fire alarms are routinely installed in public buildings.

Advanced Concepts Group member John Whitley notes that while technological advances have led to major improvements in firefighting, the threat of fire has become more complex.

"Like fire, terrorism will not be a static threat. We can count on terrorists using our very defensive responses to create new threats," says Whitley.

The Advanced Concepts Group has suggested that an effective response to terrorism involves "a dynamic system that can

Demonstrating Sandia' s decontamination foam.

re-evaluate and update both the threat and our vulnerabilities and respond accordingly."

Examples of the Group's ideas include approaches to friendly, secure borders and to better understanding the terrorists themselves.

Friendly, secure borders: Borders should permit the flow of legitimate trade and travel, while stopping the passage of harmful materials and agents. To do this a different approach may be needed with more cooperation from other nations. Tracking the flow of goods worldwide can expedite the cross-boundary flow for some items and improve probabilities for identifying actual contraband.

Locating the root causes: While technology can help minimize damage, they don't change the intent of others to harm. Knowledge of what motivates terrorists and what can change their behavior is valuable. This calls for an integration of sociology, group theory, biology and bioscience, among other disciplines. One possible product from this approach could be a software tool for pattern recognition to identify and track suspicious behavior.

From the immediate work of supporting U.S. defenders at home and abroad to the long-term need to change the environments where terrorism breeds, Sandia is making progress. The articles in this issue outline some of these efforts.

For more information, links to a number of Sandia capabilities for homeland security may be found at this site: *http://www.sandia.gov/capabilities/homeland-security/*

From the immediate work of supporting U.S. defenders at home and abroad to the long-term need to change the environments where terrorism breeds, Sandia is making progress.

Sandia bomb disablement expert Chris Cherry shows news media a replica of Richard Reid' s shoe bomb.

Organizing for the Challenge

"The U.S. government has no mission more important than securing the American homeland."

President George W. Bush

T. J. Allard

Mim John

By the time President Bush announced plans to form a Department of Homeland Security (DHS) and pronounced its role as a pre-eminent responsibility of federal government, Sandia researchers had the message. And they were busy.

At the executive level, Sandia Vice President Mim John was named to head a Homeland Security strategic initiative at the Labs. "The initiative will focus on establishing our ties with the DHS and assure coordination of efforts within Sandia," she says.

She sees development of a robust sponsorship arrangement between DHS and the Department of Energy, including an effective model for partnering with industry and academia, as an important next step. This will be done in part through the Homeland Security Tri-Lab Council. This group presently includes Sandia, Lawrence Livermore and Los Alamos national laboratories.

Assisting Mim John as Sandia's lead for the Homeland Security Office is T. J. Allard. He is coordinating a full-fledged effort to address security issues. "Sandia started work in anti-terrorism following the 1972 Munich Olympics," says Allard. "As ever, the Labs today are focused on tomorrow's problems. Now, the problems are even more challenging than those of the past."

"Our primary mission always has been to ensure the safety, security and reliability of the nation's nuclear weapon stockpile. Now many of the technologies and capabilities we developed for weapons and nonproliferation programs can support our mission of defending against terrorist threats," he says. "Sandia is prepared to support the Department of Homeland Security as a core mission at the same time it continues to support existing missions and commitments."

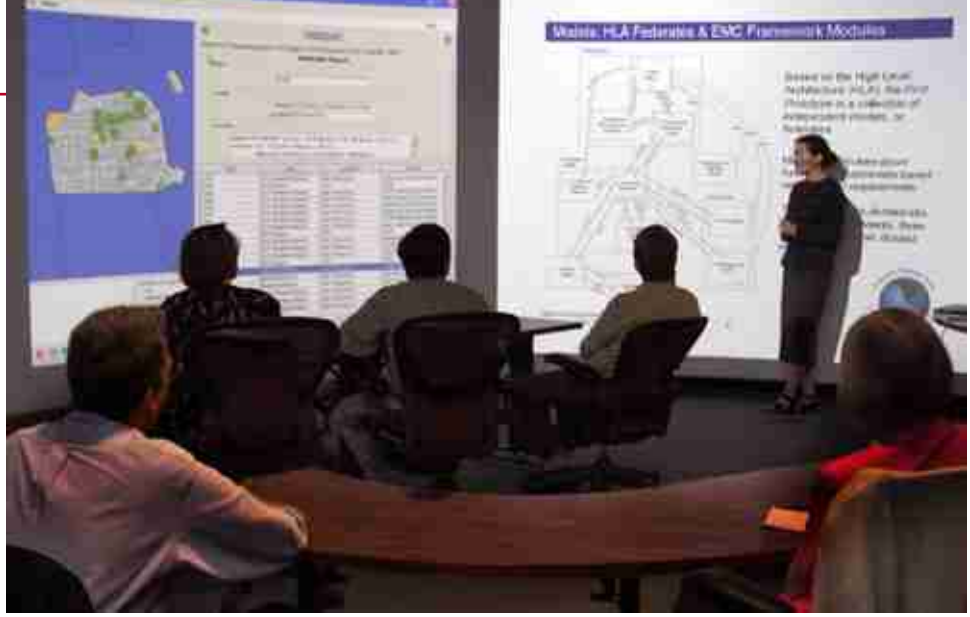
Galvanizing Sandia

Another key to addressing the new threats posed by terrorism has been the Laboratory Directed Research and Development LDRD program. "The events of September 11, 2001, galvanized Sandia," says Labs' Deputy Director Joan Woodard. "Sandians responded with an astonishing outpouring of ideas that could help the country counter terrorist threats, now and in the future."

Based on the outpouring of ideas, the Sandia Mission Council in the spring of 2002 selected five "Grand Challenge" projects to represent Sandia's strategic response to terrorism. The LDRD Grand Challenge projects allow Sandia researchers to take on critical problems that are much bigger than any one individual or group could attempt.

This year, Sandia leadership agreed to keep the focus on Homeland Security. In May, Woodard announced a senior management decision to defer new Grand Challenge proposals until 2005, instead continuing work on the projects under way. "Our collective experiences at home and in the Persian Gulf confirm that Sandia's Grand Challenge focus on homeland security and the war against terrorism is the best strategic investment for FY2004," she announced.

READY OR NOT



Systems analyst Dawn Manley (standing) describes the Weapons of Mass Destruction Decision Analysis Center computer program to a group of observers. The center uses medical data and sophisticated computer simulations to provide a realistic response tool for a terrorist event.

Imagine the unimaginable: Terrorists have released a biological agent throughout the San Francisco Bay Area that threatens local residents. The speed and effectiveness of key decision-makers may mean life or death for dozens — or thousands — of citizens.

by Mike Janes

Key decision-makers and government entities — including public health officials, hospital administrators, a regional FBI Weapons of Mass Destruction expert, emergency management personnel, and media representatives — gathered in June at Sandia's Weapons of Mass Destruction Decision Analysis Center (WMD-DAC) at Livermore, California. They were facing a simulated crisis: Highly infectious, weapons-grade anthrax had been released in the marina area near Berkeley, California.

Two dozen officials with responsibilities for Alameda County and neighboring Contra Costa County actively addressed the problem. They discussed and developed a strategy to apply effective countermeasures to reduce the destructive impact of the hypothetical anthrax attack. In the background, Sandia researchers watched, learned and provided information and news of developments at the marina and elsewhere.

It was just an exercise this time, although it could have been the real thing, notes Dr. Tony Iton, who participated in the exercise. "The scenario, while vast in scale, was quite realistic," he says. Dr. Iton is the Alameda County Public Health Officer.

"This is the first exercise I've been in that actually feels like the real thing to me, because we were forced to make some decisions without knowing what the outcome would be," adds Dr. Poki Namkung, City of Berkeley Public Health Officer.

Sandia's Howard Hirano, manager of the Labs' Advanced Technologies department, and his staff have been developing the sophisticated analysis center tools meant to assist decision-makers involved in emergency response. Commissioned by Vice President Mim John three years ago, researchers began with the idea that it was only a matter of time until the U.S. suffered a terrorist attack. "The Department of Defense was coming to the same conclusion and scenarios began to emerge recognizing the likelihood of a big U.S. event," says Hirano.

Multiple-view concept

Beginning with a broad scope and many, often disconnected, ideas, the late Rich Palmer, a Sandian who worked on the project in its early stages, suggested a war game tool to mix historical data, real action and virtual play into an interactive format. In this concept, outcomes could change as events moved along. Later, other Sandia researchers added a multiple-view concept. "We wanted to show the same thing from many perspectives," says Hirano.

"If an event like this one were to occur, decision-makers would have to act quickly and efficiently, but without the luxury of having all of the information at their fingertips immediately," says Hirano. "What we're doing is creating the situation ahead of time so that — by playing through various scenarios — the involved decision-makers can examine

Public health workers from Alameda County participate in an exercise at Sandia simulating release of anthrax.

The researchers then determined that a more integrated approach was necessary, one that brought together the perspectives of the many decision-makers…

various protection and reaction schemes and figure out what works best under different conditions."

The WMD-DAC program will help answer some of the more pressing questions facing decision-makers at all levels, from city officials all the way up to the White House:

- How much of an emphasis should we place on building up stockpiles of anthrax prophylaxis?
- What portion of our investment should go into developing a stronger information network among physicians?
- How important are early warning sensor technologies?

The hub of the program is Sandia's Visualization Design Center that allows users to comprehend complex issues and situations more easily. The program utilizes advanced display systems and software that simulate an attack based on real and projected data.

For the original Bay area model, researchers integrated historical information on illnesses and deaths that was obtained from local hospital reports. Designers used this information to accurately simulate the impact of medical trends. Decision-makers examined and tested response strategies using this and other data, such as air measurements and physicians' reports. "The idea is that a public health director or other key official can take the information they learn from the simulated event and integrate it into their own emergency plans," says Hirano.

Dr. Iton agrees. "The benefits of the planning process are in establishing relationships and understanding what our various roles are."

This simulation capability began with a six-month "program definition study" — completed in June 2001. Researchers analyzed new threats and the site's unique capabilities in combating those threats. The researchers then determined that a more integrated approach was necessary, one that brought together the perspectives of the many decision-makers as they sought to deal with an event that unfolds over days and weeks, having to make decisions along the way with information that is often incomplete.

Many dimensions

While Sandia researchers were examining the many dimensions and decisions that are fundamental during a biological attack, the events of September 2001 — and the subsequent anthrax deaths — added a sense of urgency to the work. Officials with the Department of Energy and Department of Defense, anticipating the next wave of attacks, sought new strategies to protect citizens.

First prototyped for the San Francisco Bay area, scenarios are now being considered for addressing other threats and applications. Following a demonstration, Alameda County officials inquired about using the prototype in an exercise.

"Even though the capabilities of the current WMD-DAC prototype are somewhat limited, the simulation has really resonated with the physicians and other decision-makers we've worked with to date," says Hirano. "It's clear they've thought about the problems and decisions they'd be faced with during an attack, and consequently they've helped us to focus on key details and information they will need."

"I feel this was a tremendous opportunity to not only test out the Sandia system," says Jim Morrissey, "but also to try our combined skills and expertise in a particular type of simulated event." Morrissey is a disaster coordinator with the Emergency Medical Services division of the Alameda County Public Health Department.

Editor's Note: Sandia's Nancy Garcia and Brooke Kuhn, Alameda County Public Health Department, contributed to this article.

Terrorism:
How vulnerable are we?

Sandia is addressing the protection of systems for water resources, gas and electric distribution, public transportation, national defense, chemical plants, power generation, and a host of other critical infrastructures with systematic, risk-based assessment processes.

A risk assessment of U.S. Mint facilities in the mid-1990s may have been Sandia's first project of its kind. Government officials wanted a thorough study of all federal circulation and commemorative coin manufacturing facilities and the bullion depositories to understand the potential threat to them from terrorism. They came to Sandia. "They wanted more than a vulnerability assessment," recalls Betty Biringer, a Sandia risk analysis expert. "We had good physical protection effectiveness tools, but they wanted to examine threats and consequences as well — a full risk assessment."

Shortly after work began on the U.S. Mint risk analysis, Sandia's architectural surety program leaders embarked on an analysis of U.S. dams. Other projects in drinking water infrastructure and power transmission systems followed. "Sandia has been recognized as the physical security research and development lab for the Department of Energy complex for a long time," explains Sandia's Jeffrey Danneels, manager of the Labs' Civilian Surety Programs department. He became involved in developing a risk assessment methodology for the drinking water infrastructure several years ago.

The methodologies are based on formal risk-assessment tools and techniques originally used by Sandia to protect nuclear weapons facilities, explains Gordon Smith, manager of the Labs' Public Safety Technologies department.

Congressional and presidential requests for various infrastructure groups to look at vulnerabilities and risks resulted in several Sandia projects. These, in turn, led to the creation of a number of valuable assessment products.

Uniqueness a key

Sandia's reputation for thoroughness and its willingness to go to the field and address the uniqueness of a given infrastructure have brought industry and government leaders to Sandia, Danneels adds. "While the core methodology is the same and some modules of these tools are similar, there is a lot of uniqueness in each infrastructure," he notes. "You have to tailor the assessment tool to the industry to make it useful."

Sandia's systems approach to the interlacing web of infrastructure systems involves three steps:

Many of the nation's primary water supply systems are more than 60 years old and were built without concern for security. Further, their different configurations result in different security issues for many utilities.

Jeff Danneels assesses drinking water systems.

- Analysis to understand the potential threats, including characterizing the site to understand security operations and effectiveness, developing a list of critical assets, and understanding potential consequences (pre-event)
- Addressing the vulnerabilities of the prioritized critical assets identified (event)
- Proposals for dealing with the consequences of an attack (post-event.)

Each of these steps reduces the likelihood of a successful attack on a U.S. asset. In the pre-event phase, analysts must understand the types of threats. This depends on a vigorous intelligence program to gather information and work cooperatively with U.S. agencies to anticipate where and how terrorists might strike. As an example, one key effort in preventing a catastrophic attack is to keep weapons of mass destruction — biological, chemical, and nuclear — out of the United States. Programs under way with the independent states of the former Soviet Union (FSU) focus on preventing the theft of nuclear materials there. Other efforts focus on monitoring borders and checkpoints and FSU chemical and biological facilities.

In the next step, analysts study the layout, security and operations of a given asset. They look at potential targets in terms of the possible threats determined from step one. Knowing the most likely forms of attack, they assess vulnerabilities and suggest ways to strengthen protection systems. These evaluations can be done by walk-through inspections or in simulated attacks. Evaluations also can be done using a numerical approach, plotting potential paths using adversary sequence diagrams and data on the effectiveness of protection systems. The latter method is a risk-management approach and results in a more complete analysis.

If a facility is attacked, responders must manage the consequences. In step three, analysts look at actions that can reduce the consequences of an attack, such as evacuations and emergency response. From these actions, managers can create a contingency plan.

Drinking water

Jeff Danneels has some answers about how drinking water systems in this country can remain secure. And he knows how important these systems are. According to a National Intelligence Council report, half of the world's population will lack access to fresh water by 2015, causing geopolitical tension in many regions in the world.

Working with the Environmental Protection Agency, the American Water Works Association Research Foundation, and a host of others, Danneels led the effort to develop a program to train water utility employees to assess the vulnerabilities of their systems and develop measures to reduce the risks and mitigate the consequences of a terrorist or criminal attack.

Many of the nation's primary water supply systems are more than 60 years old and were built without concern for security, explains Danneels. Further, their different configurations result in different security issues for many utilities.

"We started to explore the possibility of working to enhance the security of America's water infrastructure — supply, treatment and distribution — well before the attacks on the World Trade Center and the Pentagon," says Danneels. "We put a program in place that involves on-site assessments and training sessions for utility personnel."

Risk Assessment Methodology for Dams and Risk Assessment Methodology for Transmission take owners, operators and security managers through a detailed examination of their facilities.

To date, hundreds of water utilities have used the assessment method to analyze potential threats and plan accordingly.

Dams and power transmission

Operators of dams, hydroelectric facilities and power transmission systems in this country can make their sites less attractive to terrorists by using a step-by-step security assessment developed by the Interagency Forum on Infrastructure Protection. The Forum is a team of government dam owners, transmission operators and anti-terrorism experts.

Two processes, Risk Assessment Methodology for Dams and Risk Assessment Methodology for Transmission, take owners, operators and security managers through a detailed examination of their facilities. They look at potential adversaries, vulnerabilities, consequences of attack and existing security to provide analyses that could lead to security upgrades.

"These processes are much more than checklists," says Rudy Matalucci, former Sandia project leader and currently a consultant. "They begin with an event you don't want to happen, identify who might want to do it and what their resources are, and quantify how much risk reduction you get with a given security upgrade. In this way, the processes help owners make decisions about how to balance security needs with cost and other considerations."

The two methodologies are based on formal risk-assessment tools and insights gained in other Sandia security work at nuclear weapons facilities. The Forum conducted trial assessments on four actual U.S. dams and a regional transmission system to verify the process.

Hundreds of high-risk dams in the U.S. have been assessed using the methodology, which has been adopted for use by the Bureau of Reclamation and the U.S. Army Corps of Engineers.

Assessing building risks

Sandia has created a software program to rate the risks to buildings from natural hazards, crime and terrorism. The tool, called Risk Assessment Method – Property Analysis and Ranking Tool, was originally designed to help the General Services Administration assess risk to nearly 8,000 federal buildings. The software earned high praise from a group of industry advisors, who found it highly effective in determining facility risk. "This tool is unique because it lets the property manager

Richard Griffith studies building blueprints.

determine and manage his building's risk without having to consult an expert in risk analysis," says Regina Hunter, the principal investigator. "All the expertise and data are built in. If the property manager determines that a risk is high, the software tells him what steps to take next, often to get expert advice."

Modeling and simulation tools also are available for assessing specific chemical and biological attacks on buildings. The tools look at how lethal agents — such as anthrax, smallpox, or poison gases — might move through a building. They then help develop strategies to guide detection, emergency response, and effective cleanup and decontamination. Sandia manager Richard Griffith began working on simulation tools for airborne attacks in the wake of the 1995 sarin gas release in a Tokyo subway system.

Using sophisticated Sandia computer modeling and visualization capabilities, researchers map out a building using blueprints with information on air-handling systems. The computer model, known by the acronym KCNBC©, then predicts where a lethal agent will move over time. It produces a movie to show researchers the transport and concentration information. Tracer experiments and selected pressure and flow measurements are used to validate the model and ensure that researchers have an accurate understanding of lethal agent transport and deposition inside the facility.

KCNBC© modeling has been applied to a number of facilities, including an eight-story federal courthouse, a military command center and two large airport terminals. (See story on page 23.)

"The information from the simulations helps determine cost-effective strategies for figuring out where to put detectors, developing requirements for sensors, developing emergency response strategies, and deciding on cleanup tactics," says Griffith.

The process requires community leaders to identify 10 to 20 facilities they feel are potential security targets, either because of their symbolic value or because of the possibility of severe consequences if an attack were successful.

Community assessments

Last fall, Sandia's security experts added to their list of risk-assessment tools a scientific methodology for making entire communities more resistant to terrorism.

The Community Risk Assessment Methodology was in the works for more than two years, says former project leader Gloria Chavez. Funded by the National Institute of Justice's Office of Science and Technology, the approach was developed as part of an agreement between Sandia and Public Technologies, Inc., a nonprofit technology organization of the National League of Cities, the National Association of Counties, and the International City/County Management Association.

Several metro areas have tested the new methodology, says Chavez, including Sterling Heights, Michigan (north of Detroit); Bismarck, North Dakota; Dade County (Miami), Florida; Hennepin County, Minnesota (the Minneapolis-St. Paul area); Tucson, Arizona; Norfolk, Virginia; and Rochester, New York. Other communities are becoming involved.

The process requires community leaders to identify 10 to 20 facilities they feel are potential targets, either because of their symbolic value or because of the possibility of severe consequences if an attack were successful. Then, a step-by-step, scientific risk-assessment process helps leaders define threats, analyze consequences and evaluate the effectiveness of current security measures.

Sandia is working with homeland security officials in Kentucky on assessments for a number of communities. Sandia just completed training 25 instructors from Kentucky's Department of Criminal Justice Training and other senior law enforcement officials from the state. This cadre is ready to conduct risk assessments, focusing on security for smaller communities.

"Our lessons learned from these pilot assessments will eventually help us guide a self-assessment program for the state," says Clay Bailey, Kentucky special projects coordinator for the Criminal Justice Training

The Risk Assessment Methodology for Chemical Facilities helps plant owners and security managers to assess their facilities for a wide range of potential threats.

Department. "The training we received from Sandia was absolutely first rate, right on target with our program goals."

Chemical plant security

Another Sandia product is helping shore up anti-terrorism defenses at the nation's chemical plants. As a part of a project initially sponsored by the Department of Justice, Labs experts developed a vulnerability assessment approach (Risk Assessment Methodology for Chemical Facilities) to improve security at more than 10,000 U.S. facilities that store, manufacture and use hazardous chemicals.

Sandia's Cal Jaeger managed the project and visited several facilities with colleagues to review security practices and develop a methodology that can be used to assess chemical plant security. After development and review, the methodology was made available to interested users. The approach is recommended by the American Chemical Council, a trade group representing the major chemical manufacturers, and is one of the primary security risk assessment tools being used within the chemical/petrochemical industry. Support also has been provided by the U.S. Environmental Protection Agency.

"We ask, if I am a bad guy, what could I do?" says Jaeger, who also leads the community assessment project. (See page 11.) "Then we evaluate the effectiveness of current protection measures and the likelihood and consequences of each threat scenario." The methodology allows plant owners and security managers to assess their facilities for a wide range of potential threats, he says.

Screening DOI sites

Sandia is also working with the Department of Interior (DOI) on a security screening assessment tool to help that agency set priorities for security resource management among its many assets. These include such national icons as Mount Rushmore and the Jefferson Memorial Arch, a large number of dams, and many thousands of public sites, buildings, and other property, according to Tommy Woodall, manager of the Labs' Security Systems and Vulnerability Analysis department.

DOI is moving ahead on the assessment of some obvious potential targets. Sandia will continue to work with DOI to establish a ranking system for other assets and develop appropriate assessment methods.

NISAC improves predictive resources

The events of September 11, 2001, led to the enactment of the USA Patriot Act, which established NISAC "to serve as a source of national competence to address critical infrastructure protection and continuity through support for activities related to counter-terrorism, threat assessment and risk mitigation."

The National Infrastructure Simulation and Analysis Center (NISAC) was established in 2000 by Sandia and Los Alamos National Laboratory. The Center builds on a foundation of modeling, simulation and analysis activities at the two national laboratories.

The events of September 11, 2001, led to the enactment of the USA Patriot Act, which established NISAC " to serve as a source of national competence to address critical infrastructure protection and continuity through support for activities related to counter-terrorism, threat assessment and risk mitigation." The Act defines the need for extensive modeling and simulation to evaluate " appropriate mechanisms to ensure the stability of these complex and interdependent systems,..."

Today, NISAC is a program under the Department of Homeland Security, providing science-based information and analysis and working to expand its capabilities to address the full spectrum of consequences of disruptions to the nation' s infrastructure. These include:

- direct consequences, such as lives lost, property destruction and contamination;
- secondary consequences, including economic, commodity disruptions and national defense threats; and
- cascading consequences, based on regional or infrastructure interdependencies.

NISAC has developed an initial suite of modeling, simulation and analysis capabilities that address urban, regional and national interdependent infrastructures and their complexities. These capabilities, which are not available in private industry, can be used or adapted to address new issues, new regions and new infrastructures.

NISAC offers a growing capability in micro-economic simulation, telecommunications, agriculture, and national-international transportation. The center also offers extensive capabilities in the energy field, including electric power, oil, natural gas, and fuels. Another capability simulates the activities and movements of a large population in several major urban areas for detailed assessment of transportation and public health problems.

Modeling information and telecommunications systems is important because of the link between these systems and actual hardware. Systems connected to the internet, called Supervisory Control and Data Acquisition, or SCADA, systems can control valves, move power from one wire to another, and monitor the health of various operations remotely. The pervasiveness of internet use by American businesses and government entities means efforts to protect information systems are more and more important.

NISAC's technical program is building along several lines:

- Architecture development. NISAC is coordinating different infrastructure models, simulations and databases in a seamless, secure way.
- Data. NISAC is working to collect, correctly identify, validate, store and retrieve large volumes of data for analysis. The system must permit secure sharing and protection of the data.
- Model development. NISAC is building on its broad technology base to develop analytical capabilities on local, regional and national levels.

In two recent projects, NISAC has:

- Conducted a port security analysis with stakeholder workshops to analyze the balance between security investments and port throughput and economics.
- Developed a Port Simulator for Seattle and Portland users. With the input of operating conditions and the status of infrastructures supporting the port operations, the simulator analyzes consequences of proposed security measures.

Unchecked cargo:
Assessing the threat

Several Sandians are working with port authorities and companies that operate and utilize the country's two busiest ports to reduce the potential threats to homeland security posed by sea cargo.

Forty percent of all goods entering the United States by sea in containers come through the Port of Los Angeles or the Port of Long Beach.

The Merchandise arrives in truck-sized metal boxes, called transportainers. The two ports process some 15,000 transportainers during a typical day. They are often packed in the Far East or the Middle East.

Although the U.S. Customs Service inspects a small percentage of the containers for contraband, relatively few of the incoming containers are opened until they arrive at their manifested destinations within the country.

From a security standpoint, the picture isn' t pretty. So, after consulting with security vendors and other experts, officials at the ports of Los Angeles and Long Beach asked Sandia to conduct a threat assessment and offer recommendations to improve the security of the ports and their supply chains.

"Everybody has a device that will solve the security problem," says Sandia port security program manager Charles Massey of the Labs' International Physical Protection group and a former U.S. Merchant Mariner. "But rather than simply having vendors tell them they must put some gizmos on a pier, the ports wanted someone to understand the threats and ask, ' What is the combination of procedural and technical solutions that would cost-effectively address those threats?' "

The Sandia team includes nonproliferation experts from the International Security Programs center, whose specialties include detecting and preventing smuggling of materials needed to create weapons of mass destruction.

It also includes experts from the Security Systems and Technology center, where programs to protect valuable assets by assessing security threats and correcting vulnerabilities have been under development for several years.

The team began conducting the security assessments last fall with private funding from the ports of Los Angeles and Long Beach through a work-for-others agreement. An $8.2 million grant proposal recently approved by the Transportation Security Administration will provide additional support.

One of the team's first questions was, " How could a ship or cargo or persons aboard a ship be used to cause substantial loss of life or long-term denial of usage of the port?" Working backwards from each set of undesirable consequences, the team identified threats that could bring about those consequences and security vulnerabilities that could allow the threats to be realized.

Sandia security experts and system analysts are working with the ports to identify the most cost-effective means of dealing with the most significant vulnerabilities. The team is looking at port security from a systems perspective, although technology could be part of the overall solution, adds Massey. " Procedural improvements, as well as training, are likely to be as important as technology improvements."

Ultimately, Sandia's recommendations to improve security at Long Beach and Los Angeles could be shared with ports around the world. "What the ports and carriers hope is that improved security doesn't solely occur through expensive new government mandates," Massey says, "but rather through an industry-driven effort with independent recommendations adopted as best management practices."

Conventional explosives:

Unconventional solutions

Sandia researchers are busy on two fronts in the war against terrorist explosives. First, they are working to detect explosives before they can be used. In the event that a terrorist bomb is discovered, Sandia's experts are bringing state-of-the-art "render safe" technologies to bear.

Bomb tech in protective gear uses PAN® disrupter on mock briefcase bomb.

Conventional explosives have proven to be a major weapon of terrorists worldwide.

A critical factor in the fight against the use of explosives is detection: finding the explosives before they can be brought into a target building or complex, military base, embassy or special event. To be successful, detection technologies must be able to identify a telltale trace of explosives so authorities can stop a shipment before it crosses a border or a checkpoint or is loaded on to a truck, ship or aircraft.

A second key factor is disablement. In a scenario where detection technology or other intelligence leads officials to a terrorist bomb, experts must be equipped to disable it safely. Mitigating foams, robots and an array of technologies and techniques can help in this effort.

Sandia researchers are successful in both these areas.

The Sentinel, a commercial version of a Sandia-designed personnel portal, is now in use.

Screening devices

LDRD

A walkthrough personnel portal, now in operation in several countries, uses Sandia technology to screen individuals for the presence of explosives. The Sandia effort began in the 1990s, after the crash of Pan Am Flight 103 over Lockerbie, Scotland, when Sandia explored innovative concepts with sponsors from the Federal Aviation Administration, now the Transportation Security Administration (TSA).

The portal uses Sandia-patented airflow design and preconcentration technologies to detect explosives residues at trace levels previously considered impossible to analyze, says Kevin Linker of Sandia's Entry Control and Contraband Detection department. Trace explosives are collected using Sandia's air sampling and preconcentration technology and identified with a commercial chemical detector.

The air sampling and preconcentration technologies have been licensed to Smiths Detection for application. The Sentinel personnel portal, developed by Smiths, is in use at the Canadian National Tower in Toronto, Canada, and a U.S. facility. The Sentinel portal also is undergoing field testing at London Heathrow Airport. In the U.S., acceptance testing for the Sentinel is underway at the Transportation Security Laboratory.

Sandia has adapted this air sampling and preconcentrator technology to develop a prototype to screen vehicles for explosives. The vehicle portal prototype can screen vehicles of various sizes and detect several common explosives compounds.

The system uses engineered airflows to remove vapor or trace particle explosives contamination from the exterior and interior of the vehicle. The sample is then

"We are proud to work with some of the country's best bomb squads to discuss and practice the art and science of disabling increasingly complex terrorist bombs, while protecting the lives of the public and our first responders."

preconcentrated and analyzed with a commercial ion mobility spectrometer. In contrast to other screening technologies, the vehicle portal screening times are less four minutes per vehicle and require the passengers to exit the vehicle.

The Department of Energy's Office of Security and the Technical Support Working Group funded the vehicle portal prototype development. Sandia is exploring commercialization opportunities.

Kevin Linker, one of the developers of Sandia's MicroHound™, displays a unit similar to those now being evaluated by federal emergency first responders.

Releasing the hounds

"Preconcentration and sampling are a very important part of trace detection of explosives, and it's an area where Sandia has made a real gain," says Linker, who has been principal investigator of the personnel portal since 1995. Sandia's next step was to take that technology and integrate it with a commercial handheld detector.

The Hound II™ can operate in either vapor or swipe collection mode. In swipe mode, a sampling substrate is swiped across a suspect surface and then inserted into the device for analysis.

The collection and preconcentration device can be combined with a variety of commercial detectors. The Hound II™ is undergoing field trials and Sandia hopes to commercialize this technology as well.

Finally, researchers worked to integrate the sample collection and preconcentration technology with Sandia's own microsensor technology. Dubbed the MicroHound™, the completely integrated package weighs about 12 pounds, reports Linker. Designed to be fast, inexpensive, and easy to use, the handheld MicroHound™ is intended for use by first responders and can be used to check people, packages, or vehicles for the presence of trace explosives. Engineers continue to refine the MicroHound™.

Sandia bomb experts demonstrate the PAN® disrupter.

Disrupting the bomb

When Gov. Tom Ridge, now Secretary of Homeland Security, visited Sandia in early 2002, he saw technologies that can make a difference in the war on terrorism. For example, Sandia researchers demonstrated the Percussion-Actuated Non-electric (PAN®) disrupter. This device uses echnology developed at Sandia to disable bombs and at the same time preserve their parts as evidence. (See story on page 18.)

"Our goal is to give bomb techs the training they'll need to deal with the kinds of terrorist devices we think they'll encounter in the next 10 to 20 years."

The PAN® disrupter was already on the front lines with bomb squads nationwide by the time of Ridge's visit. In fact, Sandia has been considered at the forefront in bomb disablement technology since 1992, when the Labs began development of some of the most technically advanced and widely used "render-safe" technologies. In 1994, Sandia began hosting bomb-squad training conferences in Albuquerque. These conferences have evolved into "Operation America," a regional training program held in communities around the country.

"This is the honors program for bomb techs," says Sandia's Chris Cherry, principal investigator for the Labs' explosives disablement work. "We are proud to work with some of the country's best bomb squads to discuss and practice the art and science of disabling increasingly complex terrorist bombs, while protecting the lives of the public and our first responders."

"These are not your run-of-the-mill pipe bombs," says Cherry. "Our goal is to give bomb techs the training they'll need to deal with the kinds of terrorist devices we think they'll encounter in the next 10 to 20 years."

Regional conferences have been held in Riverside and San Diego, California; Astoria, Oregon; Orlando, Florida; and Portsmouth, Virginia. Specialists from state and local bomb squads, federal law enforcement agencies and all branches of the U.S. armed forces attend the five-day conferences.

An "Operation America" regional training program is scheduled to be held in Forsyth, Georgia later this year.

Robots to the rescue

Sandia-designed software makes it easier to control robots.

When possible, robots and not human members of the bomb squad will relocate and disable bombs or suspect articles. But steering a police robot under emergency conditions can be frustrating for officers. To help, researchers have developed the Sandia Modular Architecture for Robotics and Tele-operation (SMART) software and sensors. Licensed to a commercial robot manufacturer, this software makes it much easier to design and control the robots, as well as integrate specialized sensors for characterization of the suspect device.

The Wolverine police robot, shown here, is a commercial product of REMOTEC, Inc., a subsidiary of Northrop Grumman. Sandia modified it from a remote-controlled vehicle to a robot by using SMART software. It can move a briefcase or bomb-containing package to a safe location for bomb-squad technicians. The software also can help experts operate bomb disablement equipment, such as Sandia's PAN® disrupter, remotely. (See story on page 16.)

LDRD

The Wolverine robot with SMART software handles a simulated briefcase bomb.

‘Souping up’ detection hardware

Current approaches use signals that take less than one percent of a sample and rely on averaging results over many cycles to achieve an adequate signal-to-noise ratio for the chemical signature.

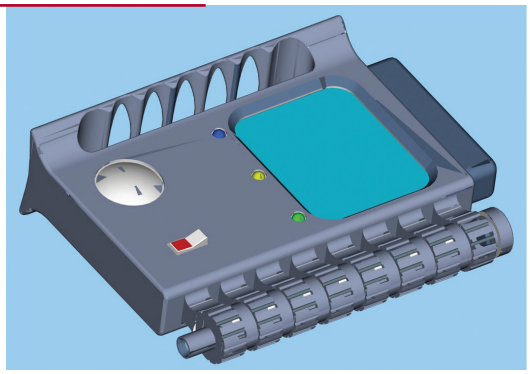
Sandia’ s Ed Tarver, of the Analytical Materials Science department, is working on a way to make the faint signals fed to ion mobility spectrometers (IMS) stronger and cleaner, reducing the number of false alarms for important detection equipment. He describes it as comparable to a fuel injection replacement for carburetors.

Working on a number of approaches for funding his research during recent years, Tarver now believes a contract with the Department of Defense to develop and manufacture the contraband-detector devices will bring them into use within the next 18 months.

Tarver’ s technological solution involves providing a better signal to any ion mobility spectrometer device and adding a computer chip that makes use of a sophisticated mathematical approach to deconstruct the resulting information and identify contaminants. Current approaches use signals that take less than one percent of a sample (the rest is exhausted) and rely on averaging results over many cycles to achieve an adequate signal-to-noise ratio for the chemical signature. The result of averaging is a blurred signature and potentially inaccurate identification.

Hardware he’ s developing captures about fifty percent of the ions formed from a sample, but varies the sampling rate to accommodate the different speeds at which they travel. By varying the amount of time allowed for each of the ions to move through a gate, all of the ion velocities are monitored during a single sample cycle. “There is no blurring of the chemical signature,” Tarver says. He makes an analogy between pedestrians lined up single file behind one another to cross a street (conventional IMS technology) and another group of pedestrians crossing the street shoulder-to-shoulder (his IMS detector technology.)

The latter approach allows more pedestrians (or ions) of different sizes and speeds to cross the street at the time best suited for their speed. This offers the potential for more accurate estimates of the ion population.



Artist’ s drawing of gated sampling device to improve signals for detectors.

LDRD

Shoe bombs disabled

Sandia bomb-disablement expert Chris Cherry.

The story of Richard Reid, who tried to detonate his explosives-packed shoes on a flight from Paris to Miami, is well known. Reid was arrested in Boston, where Massachusetts state bomb squad members and FBI agents subsequently disabled the shoe bombs using the Sandia-developed Percussion-Actuated Nonelectric (PAN®) disrupter.

The PAN® disrupter enabled bomb technicians to disarm Reid’ s shoe bombs without detonating them so the FBI could use the deactivated bombs during its criminal investigation. The device interrupts a bomb’ s internal electronics before the bomb can detonate. Bomb specialists initiate PAN® remotely, waiting a safe distance away.

Sandia bomb-disablement expert Chris Cherry and a team of Labs’ researchers developed the PAN® disrupter in the early 1990s as a way to keep technicians safe and retain valuable evidence. It is one of several advanced bomb-disablement tools developed at Sandia. In 1995, PAN® was licensed to Ideal Products of Lexington, Kentucky. It has become the primary tool used by bomb squads nationwide for disabling conventional, hand-made bombs remotely.

In April 1996, Cherry and his team were called to Montana by the FBI to disarm a bomb found in a remote cabin following the arrest of Theodore Kazcynski, known as the Unabomber. The PAN® disrupter was used to disable the bomb, Unabomber Device #17.

The PAN® disrupter also was instrumental in safely disabling suspect bombs in Atlanta during the 1996 Summer Olympic Games and was deployed by bomb squads in Salt Lake City during the 2002 Winter Olympic Games.

Detecting new weapons of Terror

Sandia and other research institutions are adapting the motto "faster, better, cheaper" in their efforts to detect biological, chemical and radioactive weapons. Add smaller, too.

µChemLab™ systems provide a fast, portable means for first responders to detect harmful chemical and biological agents.

LDRD

We want fast, accurate, simple, small and cheap. But "the perfect system to detect the new weapons of terrorism does not yet exist," says Duane Lindner, Sandia's deputy director for Chemical and Biological Programs. Because no current technologies fit the ideal, "people are forced to make compromises," he continues.

Accurate detectors tend to be slow, bulky, complex and expensive. On the other hand, faster detectors continue to be inaccurate — prone to "false positive" readings, or readings where dangerous substances appear to be present when they aren't.

Although there are no simple answers, researchers at Sandia realize that many different approaches are likely to be needed to recognize the variety of conceivable threats. At Sandia, these approaches include airborne and portable point detection units to detect lethal agents, laser beam scanners for harmful airborne particles, and a detection system that detects radioactive materials as they move past.

The µChemLab™ provides a fast, portable means of detecting harmful environments on a battlefield, at the scene of a terrorist attack or in a host of civilian applications where extreme sensitivity and specificity are required.

µChemLab™ LDRD

µChemLab™ units are portable, hand-held analysis systems incorporating "lab-on-a-chip" technologies for detection of chemical or biological agents. µChemLab™ devices are now being developed for detection of a broad range of biological and chemical threat agents including chemical warfare agents, industrial chemicals, biotoxins and pathogens.

These systems provide a fast, portable means of detecting harmful agents on a battlefield, at the scene of a terrorist attack, or in a host of civilian applications where extreme sensitivity and specificity are required.

Chem detector

The µChemLab™ Chem Detector System identifies chemical warfare agents and toxic industrial chemicals. The Chem Detector System detects gas contaminants in a three-stage process. First, samples are collected from an air stream passing across a film layer that selectively absorbs substances of interest. The layer is heated to release the concentrated analytes.

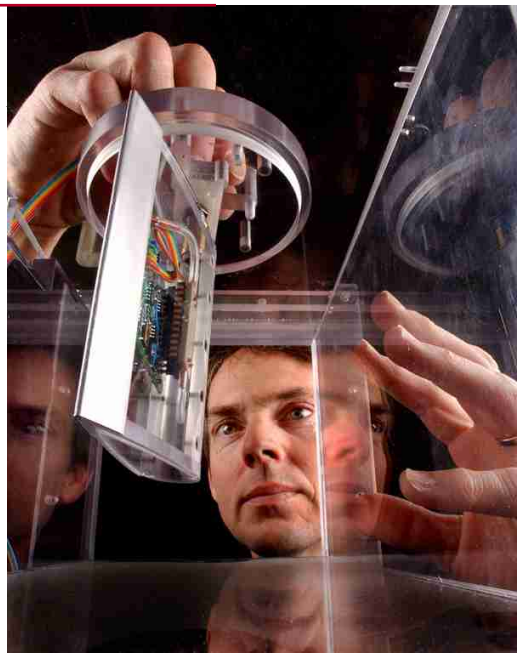
In the next 30 seconds, gas flows from the film layer through a chromatography column. Coatings in the column briefly retain compounds of interest and an image, called a chromatogram, is produced for identification.

Finally, as each analyte exits the chromatograph, film coatings on an array briefly absorb it. The absorption changes vibrations in the array, which help identify the substance of interest.

Bio detector

The µChemLab™ Bio Detector System is a laboratory demonstration unit designed for rapid detection of proteins in a liquid medium. The Bio Detector system uses fabricated microchannels for performing chemical separations with high sensitivity and rapid response in a compact, low-power device. Many different separations can be run simultaneously, and identification of compounds of interest is determined from unique patterns of retention times.

Designed for the rapid detection of proteins, the current laboratory demonstration unit has



Sandia researcher Doug Adkins checks wind tunnel performance for SnifferStar™.

staphylococcal enterotoxin B, and botulinum toxin. The unit's capability is being extended to enable identification of viruses and bacteria using protein signatures.

Parallel analysis channels provide highly accurate detection at nanomolar sensitivities. Portable, stand-alone devices for the analysis of bio agents have been developed and tested at the research prototype stage. Current research is focused on improving the performance and expanding the capability of these and related devices.

SnifferStar™ flies high LDRD

A half-ounce "sniffer," intended to ride on small aerial drones for the protection of military forces, can detect nerve gases and blister agents and operates on only a half watt of electrical power. Sandia, in partnership with Lockheed Martin Corporation, has patented the device which is based on µChemLab™ technology.

While other gas monitors exist, "this is small, lightweight, low power and offers rapid analysis," says Sandia researcher Doug Adkins. "Rapid analysis currently is not possible with any other package near this size."

The invention, smaller than a deck of cards, consists of a series of tiny sensors on a platform the size of a pat of butter, atop a credit-card-

"A terrorist with a nuclear weapon and the knowledge and skill to use it, will use it if he is not stopped."

sized microprocessor board. Forward motion of the vehicle carrying SnifferStar™ forces air through the device. Air samples are absorbed and concentrated, then heated. The heated sample passes over thin stripes of coated materials, to which it temporarily sticks. The polymer stripes are fixed to a quartz surface that vibrates. The mass of incoming "stuck" particles changes the frequency of vibration for each stripe.

Data from these frequency changes is passed to a processing unit on the SnifferStar™ module, then relayed to a processor on the drone or radio-linked to processors on the ground. There it is compared to a library of patterns created by a range of known gases.

"SnifferStar™ ignores most common interferents (likely to cause false positives)," says Adkins. Sampling is repeated every 20 seconds: 15 seconds for intake and 5 seconds for analysis. Expertise in microsensors, microelectromechanical systems, or MEMS, and application-specific integrated circuits helped Sandia pack a lot of analytical power into this small package.

Chemiresistor sensors

LDRD

Chemiresistor sensor housing and cable.

Hazardous chemicals that could pollute underground water resources are getting easier to detect thanks to Sandia's work with a kind of detector called a "chemiresistor." Sensor probes can be installed underground or underwater to detect a variety of chemicals from leaks, deliberate contamination, or other pollution sources.

Chemiresistors take advantage of Sandia's microfabrication technologies to create small, robust sensor probes.

These probes can be linked so that real-time information reaches a data collection station and immediate action can be taken. The chemiresistor system offers advantages over current systems, which require manual collection of samples and days of waiting for laboratory analysis.

RAID system

In addition to addressing chemical and biological threats, Sandia researchers are developing detectors for radioactive materials. With the potential for terrorists to explode so-called "dirty bombs," radioactive materials detection has become even more of an issue in the new war on terrorism.

"A terrorist with a nuclear weapon and the knowledge and skill to use it, will use it if he is not stopped," one Sandia executive told a Congressional committee last year.

"A nuclear bomb is a product of science and technology and it is this same technology that must be used to protect against its use by terrorists."

Sandia's Radiation Assessment Identification and Detection (RAID) system is able to detect and identify radioactive materials moving past the detection unit. The unit can be placed at control points such as facility entrances, passenger terminals, border crossings, mail centers and maritime ports.

The system makes use of a number of detectors and links information with video images of persons or containers present at the time of detection. Knowing what characteristics to look for, how to sense emissions, and how to interpret what is detected are key aspects of the RAID system.

Sandia researchers are working to see that RAID technology is quickly transferred to the commercial sector and rapidly deployed.

Sandia sky scanner

Someday soon the skies over U.S. cities may be scanned for airborne biological agents using Sandia's "Ares" technology. Named after the Greek god of war, the first Ares prototype scanner is mounted inside the back of a large

Sandia's Randy Schmitt and Mark Johnson (right) examine the Ares standoff detection system.

passenger van for mobility. This biological weapons standoff detection system can be taken anywhere that concern for a terrorist attack exists. It can be used to detect biological agents in the air, such as anthrax, smallpox, tularemia, plague, botulinum toxin or other deadly germs.

Ares works by scanning a 90-degree wedge of the sky once every 30 seconds with between 600 and 1,000 ultraviolet (UV) laser pulses. A camera mounted on the end of a telescope and wired to a computer-based location system follows the beam. The camera looks for bright spots that could indicate the presence of smoke, diesel fumes, dust clouds or something more sinister.

Sandia project leader Phil Hargis explains that the beam uniformly illuminates floating dust and other contaminants in the atmosphere. Because biological materials react to UV light by emitting characteristic colors (a phenomenon known as fluorescence), the Ares system can tell if a coud contains biological aerosols by looking for these characteristic wavelengths. The entire process of detection, location and analysis takes about 10 seconds.

Sandia continues to test and develop Ares. The system works to a range of about three miles currently, says Al Lang, program manager for Ares. “Right now, it’s a ‘detect and warn’ system. It can’t identify a particular bug, but it can tell you if a cloud has bio-content, so you can get out of the way.”

The technical challenge for this detector is to distinguish between normal airborne contaminants, such a pollen or diesel exhaust, and deadly bio-warfare agents, quickly and with few false alarms. The problem is made more difficult by the added number of particulates found in urban and battlefield environments, Lang says.

Spraying the threat away

Sandia has developed a versatile decontamination foam that can neutralize many chemical and biological agents, including anthrax.

Sandia is developing technologies and systems that can be used to rapidly and effectively assess and decontaminate facilities contaminated with chemical and biological agents. Rapid restoration of operations is critical to minimize the social and economic impacts of a chemical or biological attack.

- Initial responders to a contaminated scene must be able to decontaminate the area quickly to a safe level so that casualties can be treated and evacuated.
- Rapid, safe, and complete restoration of the affected facilities is necessary, so that the facilities can be readied for re-use in a timely manner without loss of critical services and expensive equipment.

Sandia has developed a non-toxic, non-corrosive aqueous formulation for rapid decontamination and mitigation of chemical and biological agents to protect and restore civilian and military targets. The Sandia Decon Formulation can be deployed as a foam, liquid spray, or fog. Nontoxic to humans, the foam can be sprayed quickly over wide areas. When deployed as a foam, the formulation can be designed to remain stable and reactive for long or short periods, depending on user needs.

The Sandia Foam has already assumed an important role in the nation’ s counter-terrorism toolkit. It was used successfully to help decontaminate anthrax in portions of congressional office buildings in Washington and buildings in New York in late 2001.

Sandia has licensed the foam technology to commercial manufacturers. Small systems that look like a twin canister fire extinguisher are already on the market and could well become standard issue for police, fire and emergency vehicles.

Airport Tests Bio/Chem Technologies

Sandia conducted smoke tests like this to help model airflows in the new SFO International Terminal.

Sandia is developing a unique set of counterterrorism tools at the San Francisco International Airport in a technology demonstration that may become a national model for transit facilities.

by Nancy Garcia

Funded by the Department of Homeland Security's Protective and Responsive Options for Airport Counter-Terrorism (PROACT), Sandia's work with the San Francisco International Airport (SFO) was unveiled to the general public for the first time this spring.

"We're really pleased and excited to be Sandia's testbed for some of their latest and greatest technology," SFO's community affairs director, Mike McCarron, told news media gathered at the terminal. "Hopefully, we'll be a less attractive target because of it."

In collaboration with the airport, PROACT researchers are exploring issues and options to protect facilities from chemical or biological attack. The program also is demonstrating key elements of a protective system such as detection and information technologies and is in the process of developing guidance that is broadly useful for the nation's airports.

Sandia systems analysts first began looking into bioweapon defense and domestic preparedness in 1995, after the cult Aum Shinrikyo launched a deadly sarin gas attack on a Tokyo subway.

Sandia's John Hinton, of the Labs' Systems Studies department, was an early participant in the Bay Area Terrorism Working Group with regional representatives of the FBI, local law enforcement and other agencies. While there, he met the emergency preparedness manager of the airport. In June 1998, the two developed a proposal to collaborate.

Testing an empty terminal

Taking advantage of construction underway in the new billion-dollar SFO international terminal in 2000, Sandians teamed up with airport personnel to test possible dispersal of an agent in the unoccupied facility, using theatrical smoke and harmless tracer gas to trace airflow, and suggest operational strategies to minimize exposure and contamination, including evacuation routes and air-handling operation and responses. The group also fielded commercial or prototype detectors, which could act as a sort of "smoke alarm" for biological or chemical agents. They evaluated monitor networks that potentially could serve as an early warning system to prompt evacuation, switch air handling and indicate escape routes that should minimize exposure.

"The real learning has been in understanding how to put together systems that can be used in an end-to-end defensive capability," says Chem and Biological Program deputy director Duane Lindner. Chemical detectors and more experimental biological detectors were fielded and are considered prototypes for components of future integrated detection systems.

The research team leveraged tests and evaluation to provide operational guidance. "Over the past several years," Duane elaborated, "we have developed an ability to assess vulnerabilities in facilities, to understand the

Sandia researcher Susanna Gordon and Deputy Director Duane Lindner with the SFO bus customized to administer decon foam.

Research is expected to continue through 2005. Activities will include a simulated emergency exercise involving a mock biological attack.

implications of a chemical or biological attack on them and to establish procedures, technologies, and decision support systems tailored to minimize the impact of such attacks."

After examining potential facility vulnerabilities, the researchers recommended passive protection measures to reduce the consequences of a potential attack and suggested improvements to physical security measures in place. They also developed processes to characterize facilities and system design and models to analyze trade-offs of protective systems.

Dale Dunham, the airport' s head of emergency preparedness, also developed an interest in acquiring decontamination formulations as part of a response strategy. He plans to use a Sandia foam. (See page 22.) Harmless to people, it neutralizes chemical or biological agents using a combination of compounds found in such common household items as toothpaste and hair conditioner. The foam currently can be used on clothing and other applications while awaiting FDA approval for use on humans.

Custom response vehicles

After he learned about the Sandia formulation, Dunham acquired a bus from the local transit district and had it modified to administer the foam to as many as 1,800 people an hour. It is equipped to spray foam from four turrets mounted above the windshield, while a 100-foot hose attached near the grill can deliver the decon formula to a specific location, as well as to anyone who may be immobilized by an injury. Once potentially contaminated people have lathered up, they would move forward to shower heads that extend from either side of the bus and rinse there under a spray of warm water. At the end of the line, towels and modesty ponchos or blankets would be dispensed.

The airport is unique in having custom vehicles to respond to a potential chem/bio attack. At the same time this 40-foot bus was purchased and reconfigured, Dunham also had two buses modified to provide mobile medical care. The emergency fleet is rounded out by a mobile command post and a fourth modified bus that provides repeaters for tactical communications.

The airport' s public announcement comes at a time when the Washington, D.C. Metro is putting into operation a chemical early warning system developed earlier by Sandia and Argonne National Laboratory under a related program. Work on protection of subways from chemical attacks began in 1995, and chemical detectors have been tested in Washington since 2000. The labs have since expanded their investigation of subway protection to Boston.

A simulated attack

PROACT facility protection research is expected to continue through 2005. Activities will include a simulated emergency training exercise involving a mock biological attack at the airport. An interactive simulation is under development that will allow decisions made during the tabletop exercise to influence the outcome, in contrast to standard tabletops, where the scenarios and outcomes are pre-scripted. "The exercise will explore the question, ' If you had a detection system, how would you use it?' " said PROACT principal investigator Susanna Gordon, of Sandia' s Systems Research department.

"This is a huge work in progress," SFO' s McCarron commented about the ongoing research with Sandia. He noted that SFO has become a laboratory serving as a national model for protecting airports and other large, indoor public sites. "We' ve both benefited greatly from the relationship."

The program, which requires 36 credit hours, will provide students with an understanding of the fundamental principles of the legal charter, presidential executive orders, and the framework that guides the operation of national security agencies.

Master's degree in National Security

The University of New Haven (UNH) graduate program for a Master of Science degree in National Security has completed its first two trimesters. The program, with weekend and evening classes, began in January. Sandia National Laboratories' California site is the "host facility" for the program.

The program is open to U.S. citizens holding a bachelor's degree from an accredited institution. It attracted about 30 full-time students and more than a dozen part-time enrollees during its first semester, according to Jason Reicks, who administers the program for Sandia.

Unique opportunity

"Our University feels quite privileged to be affiliated with one of our nation's premiere laboratories, as it provides a unique opportunity to work with scientists who share our interest in national security," said Dr. Thomas Johnson, Dean and Director of the University's School of Public Safety and Professional Studies. "Our graduate concentration in Information Protection and Security, with research issues related to cyber-terrorism and issues related to cyber-intelligence, will be enhanced by our ability to work with Sandia scientists. They are among the best in the world."

The strategic collaboration between the Connecticut-based UNH and Sandia will permit greater attention to issues directly related to the nation's homeland security focus," Dr. Johnson added.

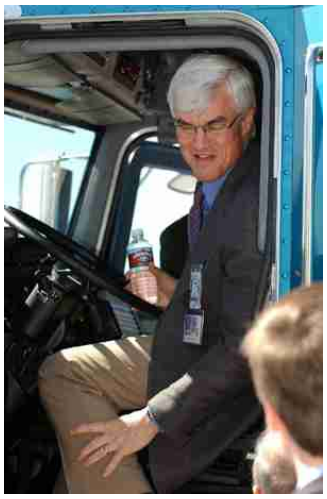
The plan of the program is to create a structure for teamwork between the UNH faculty, Sandia scientists, and members of the corporate community for exchange of ideas and the critical assessment of theories fundamental to the study of national security and public safety.

The pool of potential students for the program may include current government workers, who may already be involved in homeland security issues; those in the commercial sector, including government contractors or those who do business with the government; and college graduates, who may be looking for guidance and learning opportunities that will lead to national service.

The program, which requires 36 credit hours, will provide students with an understanding of the fundamental principles of the legal charter, presidential executive orders and the framework that guides the operation of national security agencies. Students also will analyze the role and function of the U.S. agencies in the intelligence community, focusing largely on information protection and security.

Those interested in learning more about the program should visit *http://www.newhaven.edu/psps/nationalsecurity.html*

By Penrose C. Albright **INSIGHTS**



DHS Assistant Secretary Penrose "Parney" Albright checks out a SafeGuards Transport unit while visiting Sandia.

"Homeland security is fundamentally a systems engineering task. The particular assets of Sandia National Laboratories, including their well-regarded systems engineering capability, are of particular relevance to our mission."

DOE's National Laboratories and Homeland Security

The Department of Homeland Security (DHS), including its Science and Technology Directorate, is drawing upon the expertise and capabilities of the national laboratories to address some of our nation's greatest threats. These threats include biological, chemical, radiological and nuclear, high explosives, and cyber threats.

The Department of Energy's (DOE) national laboratories have long been a resource for solving difficult problems associated with national security. Over the past few years, through LDRD, some DOE funding, as well as some work for other agencies, these labs began investing in the homeland security mission — anticipating and responding to threats well before much of the Nation's research and development enterprise had engaged on the issue.

Thus, when the President asked Congress to create the DHS, it was natural and logical to provide that Department with access to the talent housed in the laboratories. The idea was (and is) to provide the DHS with a capability for conducting sensitive research and development activities with scientists and engineers of the highest caliber. An intellectually stimulating environment would attract them to places where they could have rewarding careers dedicated to the DHS mission.

Note the use of the words "careers" and "dedicated" — the DHS is now by statute a primary customer for the labs, which are now truly national labs engaged in an enduring effort to protect the homeland in the same manner that they conduct their missions for the DOE. The DHS's laboratory complex will continue to be essential to meeting the challenges and requirements of the Department. The particular assets of Sandia National Laboratories, including their well-regarded systems engineering capability, are of particular relevance to our mission.

Homeland security is fundamentally a systems engineering task. At all levels there are concerns about efficiencies, costs, maintainability, and performance. The President has said that we must not just make the Nation safer, we must also render our commonplace tasks more efficient where it is possible to do so. If the investments we make now to better secure our borders can also improve the flow of legitimate traffic, and if the communications systems we build to better respond to a terrorist event improve our ability to respond to a natural disaster, then the Nation is enriched

Conversely, if in securing cyberspace we restrict flexibilities and reduce the productivities associated with the digital age, or if the installation of portal monitors at the borders serves to restrict commerce, the Nation will be the poorer. Everyone engaged in research and development for homeland security must thus become a little bit of an operations analyst. They must carefully consider how the system will be deployed, who will operate it, and what the consequences of its operation will be. Cost-benefit trades must be made between the various technical and operational concepts in play, and, at the overall systems level, between the investments we make in detection and warning, mitigation, and recovery.

INSIGHTS

"Homeland security also requires a deep understanding of the fundamental aspects of physical, biological, and social sciences, and cutting edge technology. Putting all this together has been a historical strength of the laboratories, and we are excited about engaging these capabilities in securing our nation."

With this set of imperatives in mind, we are asking our laboratories to engage state and local public safety entities; federal agencies at our borders and airports; operators and protectors of our ports and airports and critical infrastructures; in order to better understand the operational environment, and develop systems that can fit well with their practices and procedures. However, the discipline of systems engineering is only part of the story. Homeland security also requires a deep understanding of the fundamental aspects of physical, biological, and social sciences, and cutting edge technology. Putting all this together has been a historical strength of the laboratories, and we are excited about engaging these capabilities in securing our nation.

The Department of Homeland Security Act emphasizes the important role of industry in performing research and developing technologies. The national laboratories have well-established and recognized collaborative, cooperative relationships with private industry and the academic community that are important for developing and then commercializing solutions. Finally, and importantly, the national laboratories are members of the Intelligence Community, allowing them to play a significant analytic role for the Department in assessing the current and emerging threats.

Existing programs totaling about $118 million dollars to counter homeland security threats were transferred from the DOE and the National Nuclear Security Administration to the DHS. Many of these programs were already being executed by the national laboratories and continue today. National laboratory personnel played a key role as the Department was being "stood-up," and continue today in the development of the science-based technology roadmaps that guide our investments to thwart these threats.

The Science and Technology Directorate has developed these roadmaps in response to our key missions: to serve as the principal Departmental component for countering the threat of weapons of mass destruction; to perform research and development aimed at enhancing the capabilities of the other components of the Department; and to provide systems engineering expertise for the Department. Thus, we are focused on the development of countermeasures to the threat of biological, chemical, radiological, and nuclear threats, and also on improvements to our border operations, to our ability to analyze and process information, and to respond to natural and man-made catastrophes.

The Department of Homeland Security's laboratories are a crucial, and integral, part of our strategy to accomplish those missions.

Sandia researchers briefed DHS Undersecretary Charles McQueary on a number of Sandia programs during a May 2003 visit.

The author is President Bush's recently confirmed nominee for Assistant Secretary of Homeland Security - Science and Technology, for Plans, Programs and Budgets.

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"Sandia started work in antiterrorism following the 1972 Munich Olympics. As ever, the Labs today are focused on tomorrow's problems. Now, the problems are even more challenging than those of the past."

T. J. Allard
Sandia Office of Homeland Security

Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

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