The Los Alamos Center for Homeland Security

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On November 25, 2002, the president of the United States signed a bill creating the Department of Homeland Security (DHS), thus initiating the most significant transformation of the U.S. government since 1947, when Harry S. Truman merged the various branches of the U.S. armed forces into the Department of Defense. Planning for the DHS began in the aftermath of September 11, 2001, and was first codified in the July 2002 National Strategy for Homeland Security released by the White House. When it came into existence on January 24, 2003, the DHS consisted of 170,000 employees from 22 agencies and had an annual budget of $38 billion.

The DHS has three primary missions: prevent terrorist attacks within the United States, reduce America's vulnerability to terrorism, and minimize the damage from potential attacks and natural disasters. Los Alamos National Laboratory has a rich history in developing technologies that can be brought to bear on these DHS mission areas and over the past few years has pursued activities that paralleled the evolution of the new department. As the national strategy for homeland security was evolving, Los Alamos had already decided to create the Center for Homeland Security (CHS), which was formally established in September 2002.

The CHS is responsible and accountable for all Los Alamos programs for the DHS. It applies the Laboratory's science and technology capabilities toward homeland security and seeks to provide solutions. It also helps streamline operations, since it is the sole point of contact to the DHS and other agencies involved in homeland security. In addition, the CHS provides the opportunity to leverage institutional relationships within New Mexico at the state, regional, and local levels.

The CHS was established as a small program office that would oversee three critical focus areas: chemical and biological; nuclear and radiological; and systems analysis, integration, and infrastructure. Technologies that Los Alamos had been developing for decades under sponsorship of the Department of Energy (DOE), the Department of Defense, and other government agencies were evaluated and their associated programs transferred into one of the three focus areas. This action was taken in anticipation of the transfer that was mandated by the creation of the DHS. Although each focus area encompasses many research efforts that can address the challenges of homeland security, we highlight only a few in the sections that follow.

Technology against Bioterrorism: BASIS

A bioterrorist attack with aerosolized biological threat agents could have a catastrophic impact in an urban environment. In collaboration with scientists and engineers at Lawrence Livermore National Laboratory, we have developed a wide-area environmental monitoring system called the Biological Aerosol Sentry and Information System, or BASIS, which will provide early warning of biological attack. Early detection and rapid response is crucial because the identification, treatment, and possible isolation of exposed individuals are most effective if they occur within the first few hours following a biological attack. Unfortunately, awareness of an attack typically comes only after individuals begin displaying symptoms, when it is too late to save a large percentage of those exposed. BASIS can determine the time and place of a bioattack within 12 hours, well before the onset of most symptoms and in sufficient time to warn public health and safety organizations.

Figure 1 provides an overview of BASIS. Distributed sampling units (DSUs) that sample the air are located at specific sites in a city or in a mobile unit. A suction pump in the DSU draws outside air through filters

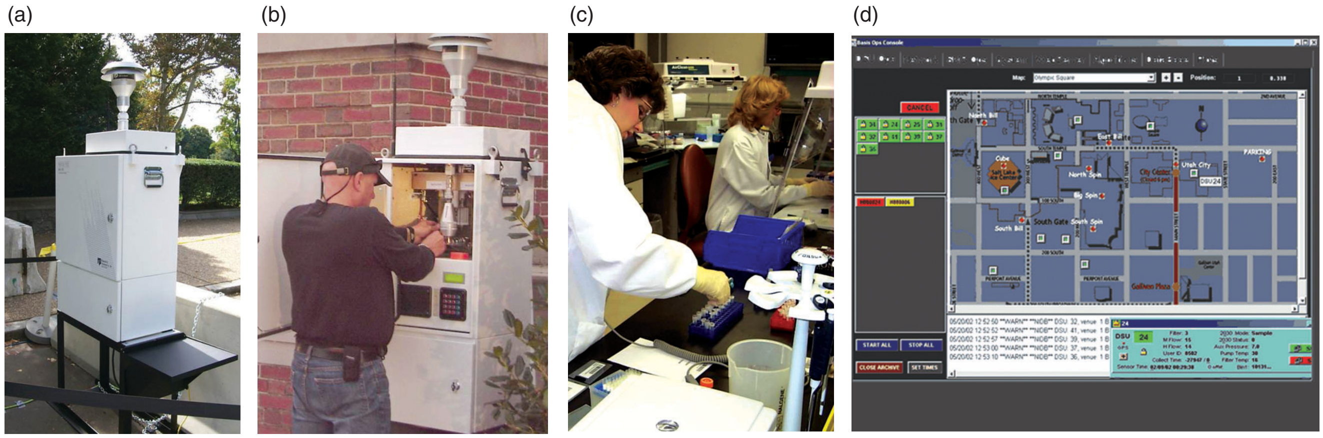

Figure 1. The Biological Aerosol Sentry and Information System

BASIS is a suite of integrated technologies developed to provide timely detection, identification, and characterization of bioagent aerosol releases. (a) DSUs continuously collect aerosol samples in and around selected sites. (b) The Sample Management System helps to coordinate the periodic retrieval and delivery of the samples and is responsible for maintaining and archiving information. Here, a support team member scans an aerosol filter holder with a laser barcode reader. (c) Samples are analyzed at the RFL (or possibly at existing local laboratories), where high-sensitivity, high-specificity bioassays provide bioagent detection and identification. Samples are saved and inventoried to provide opportunities to confirm and reanalyze the findings. (d) All operations, including sample management and testing in the laboratory, are monitored at the command console of the BASIS Operations Center. The operations center has links to external agencies, and in the event of an attack, it can initiate and help coordinate a rapid response.

that capture any aerosolized threat agents. Two filter systems operate simultaneously: a "holder," which typically collects samples for four hours, and the "magazine." The latter contains several filters, each of which typically collects samples for one hour. The filters from the DSU are periodically retrieved and delivered to a relocatable laboratory, where they are analyzed for multiple biothreat agents by identification assays based on polymerase chain reactions. (Similar assays are described in the article "Reducing the Biological Threat" on page 168.) Only if a holder filter tests positive for an agent are the magazine filters tested, a procedure that enables prompt biothreat detection while minimizing the number of assays.

A command and control center oversees the collection and analysis of the samples and maintains communication links to federal, state, and local agencies. In the event a biothreat agent is detected, appropriate public health and safety organizations can be alerted in time to initiate effective medical treatment and other responses.

Successful Demonstrations. BASIS proved its operational capabilities at the 2002 Winter Olympic Games in Salt Lake City. The system went into full operation on January 21 and ran continuously until February 26, when it was shut down. Sixteen DSUs were deployed at key indoor and outdoor locations in Salt Lake City and Park City. The sampling was performed 24 hours a day, except at ice skating venues when the coverage started one hour before the beginning and finished one hour after the end of an event. Each sample run lasted four hours, except during the night when the run was extended to eight hours. During the Winter Olympics, the Sample Management System coordinated the loading, replenishing, and tracking of approximately 10,000 filter cassettes.

A relocatable field laboratory (RFL) was set up at the Utah Department of Health. The RFL ran two production lines that analyzed samples for threat agents and operated 20 hours a day, processing approximately 2100 samples during the five weeks of operation.

The BASIS Operations Center operated continuously. Each DSU was in constant contact with the Operations Center, which monitored the airflow rates and particulate concentrations. The replenishment operations were confirmed, and the barcodes on samples were recorded. If a sampling unit had problems, service teams were sent out immediately. The Operations Center was also in contact with the Sample Management System and the laboratory. All sample transactions were recorded in a master database for forensic purposes.

By all measures, the performance of BASIS was superb. During the Winter Olympics the overall time to detect was a minimum of two hours and a maximum of eight hours. For overnight sampling, the time to detect was increased by four hours because of the extended sampling time. The level of detection has been studied in field tests with surrogate agents and with live agents at Dugway Proving Ground. The system is proving to be both sensitive and specific.

In collaboration with the

Department of Defense, Lawrence Livermore and Sandia National Laboratories, and the New Mexico State Department of Health, we established an operational systems-level test bed in Albuquerque, New Mexico. BASIS was deployed in the test bed and expanded to include autonomous sampling units at the Albuquerque airport, and in December 2002 a demonstration was conducted. Again, BASIS performed successfully. After this demonstration—in collaboration with the DHS, the Environmental Protection Agency, and the Centers for Disease Control and Prevention Laboratory Response Network—we deployed BASIS to numerous urban centers in the United States as part of Project BioWatch.

Systems Analysis: Modeling the Nation's Energy Infrastructure

Since the middle of the 1980s, researchers at Los Alamos have modeled and simulated energy transmission networks, with a long-standing focus on electric power systems. During this period, we have developed an extensive set of databases, analysis tools, and science and engineering expertise to answer a broad range of questions that are important to decision makers; various local, state, and federal agencies; and the nation as a whole. Our work is typically done in collaboration and coordination with other national laboratories, industry organizations, and government agencies.

Electric Power Grid Modeling. Much of our analysis of the electric power industry has focused on possible outage events that could interrupt the reliable supply of electric power. Inherent attributes of the electric supply system, in addition to natural or man-made breakdowns, are possible sources of disturbances in the power system. We typically construct detailed models of the utilities of interest and then analyze the models using state-of-the-art power-flow simulation tools. Thus, we are able to identify the service and outage areas, estimate how long the outage lasts, identify critical system components, and recommend restoration strategies or mitigation options. In general, our goal is to evaluate the performance of the system and determine the electric industry's ability to supply sufficient electric power to its customers, given all the demands and energy requirements and taking into account the breakdown of system elements.

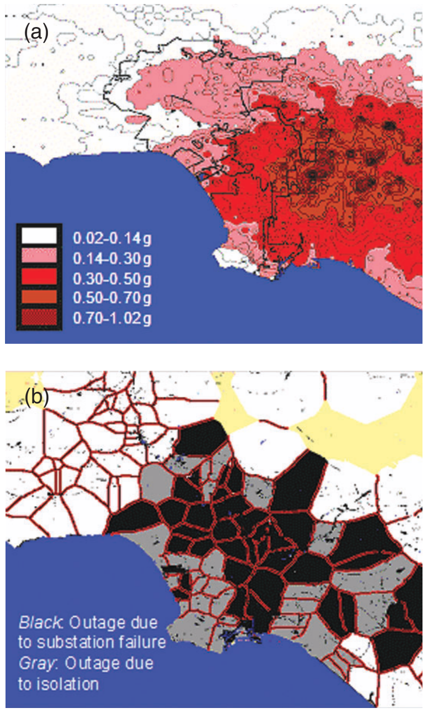

Figure 2. Simulating the Effects of an Earthquake
(a) The figure shows the calculated peak ground acceleration for an earthquake of magnitude 6.75 on the Richter scale, occurring at the Elysian Park fault under downtown Los Angeles. (b) The quake damages equipment in some areas (black), creating power outages. Neighboring areas (gray) subsequently become disconnected from the grid and also lose power.

For example, Figure 2 illustrates the effect a large earthquake under downtown Los Angeles might have on the electric power grid. The analysis starts with the evaluation of ground motion and acceleration. We then estimate the damage to electric power substations using "fragility curves" that approximate the probability of a certain level of damage to the equipment, based on the previously estimated ground motion. Those estimates of equipment damage provide a basis for simulations of the earthquake's effect on the overall operation of the power system. Using a Los Alamos–developed cellular automaton algorithm that calculates the area that an electric power substation can serve, we predict the geographic extent of the power outages that might occur.

We have also examined how deregulation and mergers in the electric power industry have affected the reliability of the power grid and performed simulations to understand how the structure of a deregulated energy market influences the day-to-day operation of the power system. Aside from the technical challenges, this problem is politically complex because it involves differences in state and federal guidelines or policies, differences among state deregulation policies within the same geographic region, planned new regional transmission organizations, and new independent system operators. In another project, we have undertaken an extensive series of case studies to document the robustness of the energy supply to important government facilities.

Interdependent Infrastructures. Over the past five years, Los Alamos work on the electric power grid has expanded into the broader area of energy transmission infrastructures in general. We now model natural gas pipeline networks and petroleum liquid networks and have plans to model the coal infrastructure within the United States. These energy networks typically

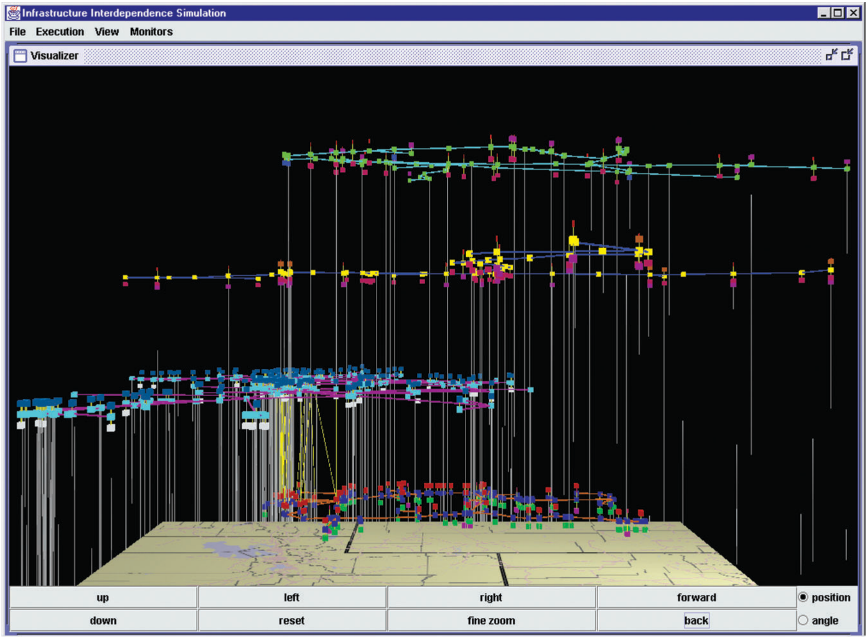

Figure 3. Analysis of Interdependent Energy Networks
The IEISS is a set of software tools that helps us analyze interdependent energy networks. This screen capture shows an abstract three-dimensional visualization of major energy networks laid over a map of Utah. The network of crude oil pipelines is displayed in the upper layer, then the petroleum product pipelines, the electric power transmission lines, and finally the natural gas pipelines. The vertical lines identify interdependencies between the systems.

depend on each other to deliver their product. A gas-fired electric generating plant, for instance, requires a steady supply of natural gas, and the natural gas pipelines may possess electrically powered compressors to maintain sufficient pressure. Because traditional tools that modeled single infrastructures were severely limited when applied to such interdependent networks, we have developed new tools to address the earlier shortcomings.

The Interdependent Energy Infrastructure Simulation System (IEISS) is a suite of analysis software tools developed by Los Alamos in collaboration with Argonne National Laboratory. We intend to develop a comprehensive simulation of the nation's interdependent energy infrastructures that will include all components and couplings, in a manner far beyond what could be done previously. The IEISS will help us understand in depth the normal operations of the infrastructures and help us develop insight into disrupted operations. In addition, it allows us to assess the technical, economic, and national security implications of the interdependencies. Figure 3 is a screen capture from a prototype of the IEISS analysis tool that was used in preparation for the 2002 Winter Olympic Games in Salt Lake City.

In addition to identifying critical components and vulnerabilities in coupled infrastructures, we hope to use the IEISS to assess how future investments in the systems might affect quality of service and to perform integrated cost-benefit studies, evaluate the effect of regulatory policies, and aid in decision making during crises. Additionally, IEISS is a research tool for investigating fundamental issues related to real-life, complex networks.

Countering Nuclear and Radiological Threats

Nuclear and radiological threats exist now, and there is concern that more will occur over the coming decades. The quantity of nuclear material is increasing. Worldwide weapons information is available in the public forum, and terrorist organizations—some of which are well funded—have stated their interest in obtaining nuclear and radiological devices. (The United Nations reports that 130 terrorists groups may be capable of developing a homemade atomic bomb.) Although preventing threats is optimal, we must also be prepared to detect and respond to threats that develop and evolve to crises.

The CHS works with customers and end-users to develop and implement technologies and approaches that affect all aspects of nuclear and radiological terrorist threats. (See Figure 4 for an overview of our focused efforts.) Overviews of five of our thrust areas follow.

Prevention. Safeguarding fissile and radioactive materials is important in preventing nuclear terrorism. The Laboratory's current safeguards mission is in part to assist with the global control of nuclear material and expertise that is accomplished through several venues: the implementation of treaties and agreements, worldwide export control, research and development, and a new effort to counter nuclear terrorism. Since 1966, Los Alamos has had active programs to develop methods to track, secure, and account for fissile material, including the Material Protection, Control, and Accounting (MPC&A) Program, and the nuclear safeguards programs. We also provide technical support for actively monitoring the export of sensitive equipment and raw materials and deploying capabilities for detecting the clandestine production of nuclear materials. Additionally, in the mid-to-late 1990s, the safeguards program assisted in the down-blending of large amounts of Russian weapons-grade uranium, wherein the highly enriched material was diluted to produce a mixture that could not be used in nuclear weapons. More recently, the international safeguards program, motivated by experience in Iraq in the early 1990s, has developed technologies that support additional protocols for detecting undeclared nuclear activity.

Our nuclear safeguards programs also have an extensive training component. All IAEA inspectors have been trained by Los Alamos, as have personnel from the National Nuclear Security Administration and the Nuclear Regulatory Commission. We have similarly trained state authorities in effective management of state systems for nuclear material accounting. In the near future, the program will expand to include the development of threat analysis methodologies for subnational units, the development of new "proliferation resistant" fuel cycles, new safeguards approaches for future large-scale nuclear facilities, and the creation of new technologies for mitigation and detection of nuclear noncompliance.

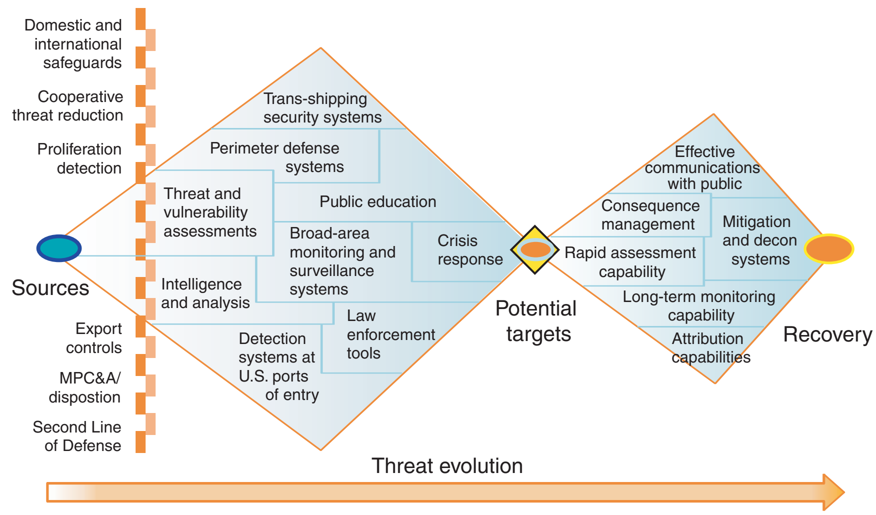

Figure 4. The Los Alamos Nuclear and Radiological Systems Strategy
We contribute to multiple programs (left) that are geared towards monitoring and controlling nuclear and radiological materials and technology. Protection at the source is one key to preventing nuclear and radiological threats. If a threat were to develop, then a different set of capabilities would address the problem, initially with a broad range of potential responses, but focusing to more specific actions when a specific threat is identified. Should an incident occur, responsibility evolves to programs that are concerned with immediate postevent mitigation and with decontamination, attribution, and recovery.

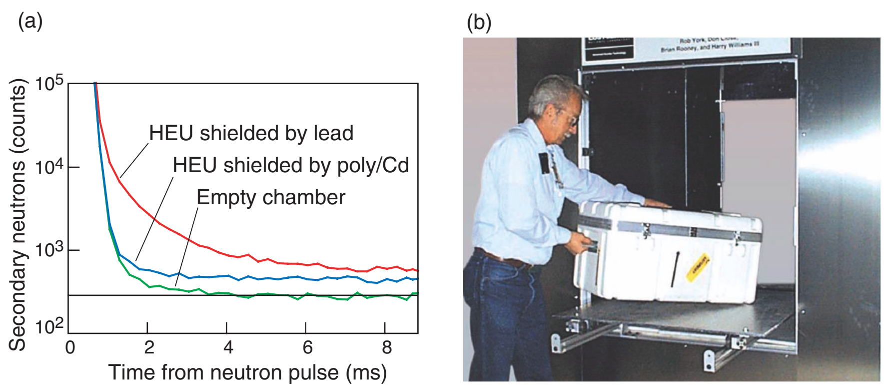

Figure 5. Active Interrogation of Packages
(a) Pulses of electromagnetic or neutron radiation induce highly enriched uranium (HEU) or plutonium to produce characteristic emissions. This graph shows that even shielded material is discernable. (b) Los Alamos has developed and demonstrated this active detection system for monitoring luggage and packages; it could readily be extended to monitor air cargo containers. Gram quantities of shielded HEU can be detected within seconds.

Monitoring and Assessing. We spend considerable time at Los Alamos monitoring nuclear programs worldwide. After the disintegration of the Soviet Union in 1991, we became very concerned about the fate of their nuclear weapons, especially those that were left within the borders of the newly formed nations of Kazakhstan, Belarus, and the Ukraine. Over the course of several years, and with the cooperation of the countries involved, we participated in an unprecedented reversal of nuclear proliferation and helped denuclearize the three new nations. Their weapons were destroyed or returned to Russia. We then assisted Russia in securing these and other weapons. To the best of our knowledge, all nuclear weapons in the Russian stockpile are accounted for and secure.

We also monitor worldwide nuclear smuggling on a continuing basis. With ties to the intelligence community and to national and foreign law enforcement communities, we combine information as it is made available with our own understanding of smugglers. Our immediate goal is to assess current terrorist capabilities so that the United States can take immediate action, but we also try to estimate future capabilities. In addition, working with other government agencies, we field equipment and protective measures and help establish security measures and procedures to keep ahead of the terrorists.

Detection. The United Nations reported that attempts to smuggle radioactive material have doubled over the past five years. Since 1993, IAEA's database has recorded 550 incidents of illicit trafficking in nuclear materials. (More than 370 of those incidents have been confirmed.) For these and other reasons, Los Alamos has been developing and installing radiation monitors at Russian and U.S. border crossings.

The technology to monitor for radioactive materials is either passive or active. In passive monitoring, one looks for neutron or gamma radiations that are emitted naturally from the radioactive material. This is a mature technology that began at the Laboratory 25 years ago under the direction of Paul Fehlau. Passive monitors have been installed in many airports to scan baggage and people, and whole-vehicle and train monitors have been placed in strategic positions around the world, including the Russian–North Korean border.

The downside of a passive monitoring system is that fissile materials can be shielded, reducing the emissions reaching the detectors. Active detectors emit pulses of electromagnetic waves or neutrons that induce detectable electromagnetic and neutron emissions from highly enriched uranium and plutonium, even when the materials are shielded (see Figure 5). Active detectors are more capable of detecting small amounts of shielded weapons-grade uranium. The Laboratory has already developed and fielded prototypes of these next-generation portal monitors.

Response. Los Alamos plays an essential role in responding to nuclear and radiological threats. We are active participants in the Nuclear Emergency Support Team (NEST), a DOE–National Nuclear Security Administration umbrella program that includes the Joint Technical Operations Team, which provides advice on how to "render safe" terrorist nuclear devices and provides nuclear safety assessments for the safe disposition of devices; the Accident Response Group, which is responsible for incidents involving U.S. nuclear weapons; and the Radiological Assistance Program (RAP), which upon request, provides assistance to local, state, tribal, and federal government officials or to private individuals. The RAP would respond, for example, to a radiation alarm at a landfill, an abandoned radiation source, or a transportation accident involving radiological materials. Another NEST program in which we participate is TRIAGE, which provides technical assistance to front-line personnel (such as customs officers) should they need help in evaluating data from fielded radiation monitors.

Recovery. Consequence management (CM) focuses on rapid and prepared responses to the tragic reality of an executed terrorist attack. CM preparedness provides direct support to first responders; playbooks for directing response activities; readily available public education information; rapid postevent simulation capabilities; and triage, mitigation, and decontamination technologies. Los Alamos emergency response and science experts are making significant contributions to increase our nation's CM preparedness. Advanced mitigation and decontamination technologies are required to prevent or minimize resuspension of radionuclides, to protect people and the environment, and to provide risk-based strategies for postevent cleanup. The Laboratory is addressing development challenges, including understanding the molecular-based interactions between radionuclides and building materials; establishing performance criteria; developing test and evaluation protocols; and creating new technologies to clean buildings, ground coverings, water supplies, and runoff from first responder activities.

Concluding Remarks

Since September 11, 2001, there has been a tremendous need to confront the international problem of terrorism. In line with our Manhattan Project roots, the Laboratory and the CHS are accepting that responsibility by again creating new technologies that aid in the nation's defense. For additional information about the CHS and our ongoing programs, please visit www.lanl.gov/orgs/chs/. ■

Authors (from left): Thomas W. Meyer, director of CHS; Sara Scott, associate center director for nuclear and radiological programs; Brian Bush, technical staff member; and J. Wiley Davidson, acting director of CHS. Other authors, missing from photograph are the following: (BASIS) I. Gary Resnick, associate center director for chemical and biological programs; and Ray Gordon, technical staff member; (Energy Systems Modeling) Cetin Unal, Loren Toole, and Jonathan Dowell, technical staff members.