Global Threats and Security

The distinction between national security and global security has blurred to the point that, in reality, there is just "security." The threat posed by the proliferation, terrorist acquisition, or use of weapons of mass destruction (WMD) knows no boundaries.

Protecting the United States against this threat requires a broad range of activities, at home and abroad. Livermore participates in international cooperative activities aimed at preventing the proliferation of nuclear weapons. Researchers also play an active role in national efforts to develop countermeasures against nuclear or radiological threats and bioterrorism.

A distinguishing feature of Lawrence Livermore's work for this vital security mission is its integrated, end-to-end approach. To tackle the challenges of WMD proliferation and terrorism, the Laboratory draws on more than 50 years of experience in all aspects of nuclear weapons as well as extensive resources in biology, chemistry, engineering, and computations. Livermore provides technologies, analysis, expertise, and operational capabilities to confront all aspects of the threat.

Cooperation to Prevent Proliferation

As part of the National Nuclear Security Administration (NNSA) Material Protection, Control, and Accounting (MPC&A) program, Livermore researchers oversaw the completion of the Kola Technical Center in Russia. This unique complex offers courses and hands-on training for Russian Navy nuclear security and MPC&A professionals. It will play a critical role in enabling Russia to sustain an effective MPC&A culture.

Building on experience and lessons learned in Russia, MPC&A cooperation has been extended to other countries, including China. Livermore led the project teams that installed nuclear material protection upgrades at several facilities at the Beijing-based China Institute of Atomic Energy, including the Fast Neutron Critical Facility, the Materials Storage Facility, and the Safeguards Laboratory. Livermore personnel also gave workshops and lectures for Chinese safeguards engineers and analysts and civilian nuclear industry officials on such topics as vulnerability assessment, nondestructive analysis, and national-level nuclear material accounting. In June 2006, Livermore also coordinated logistics and led the Regulatory Infrastructure Section of a visit by Chinese experts on nuclear security and safeguards to a number of NNSA facilities and laboratories.

Laboratory scientists have also developed a plutonium gamma-ray simulator for the International Atomic Energy Agency in support of its efforts to safeguard nuclear technology and prevent nuclear proliferation. Hardware and software work together to simulate the pulses that come from a high-purity germanium detector when it interacts with plutonium gamma rays.

The simulator eliminates the need for actual plutonium samples to test the instrumentation and analysis software used in international safeguards activities. Its use significantly reduces testing and training costs and cuts the development time for new monitoring instruments. Large plutonium samples can be simulated in an office environment by a single employee, without incurring any of the safety and security costs and risks associated with Livermore's Plutonium Facility or other comparable facility.

At the joint China-U.S. integrated nuclear materials management technology demonstration in Beijing in fiscal year 2006, then NNSA director Linton Brooks (center, seated), participates in opening ceremonies.

Laboratory researchers have also developed the Livermore Safeguards Systems Analysis Tool (LISSAT) to systematically assess the efficiency and effectiveness of alternative approaches and technologies for nuclear safeguards monitoring. LISSAT has been applied to a generic enrichment facility and to assess the use of antineutrino detectors in reactor safeguards strategies.

In areas where proliferation is a concern, scientific collaboration helps to promote understanding and cooperation. These collaborative efforts also are an aid in defusing regional tensions that might otherwise lead to conflict. For example, Laboratory scientists organized seismic workshops (with the U.S. Geological Survey and the United Nations Educational, Scientific and Cultural Organization) on the December 2004 Great Sumatran earthquake and its aftershocks. Participants from across South Asia attended the conferences in China in 2005 and in Bhutan in 2006. Livermore also leads North African Sister Laboratory projects in Egypt, Libya, Algeria, and Morocco and is developing an integrated safeguards strategy for the region.

Countering the Nuclear Threat

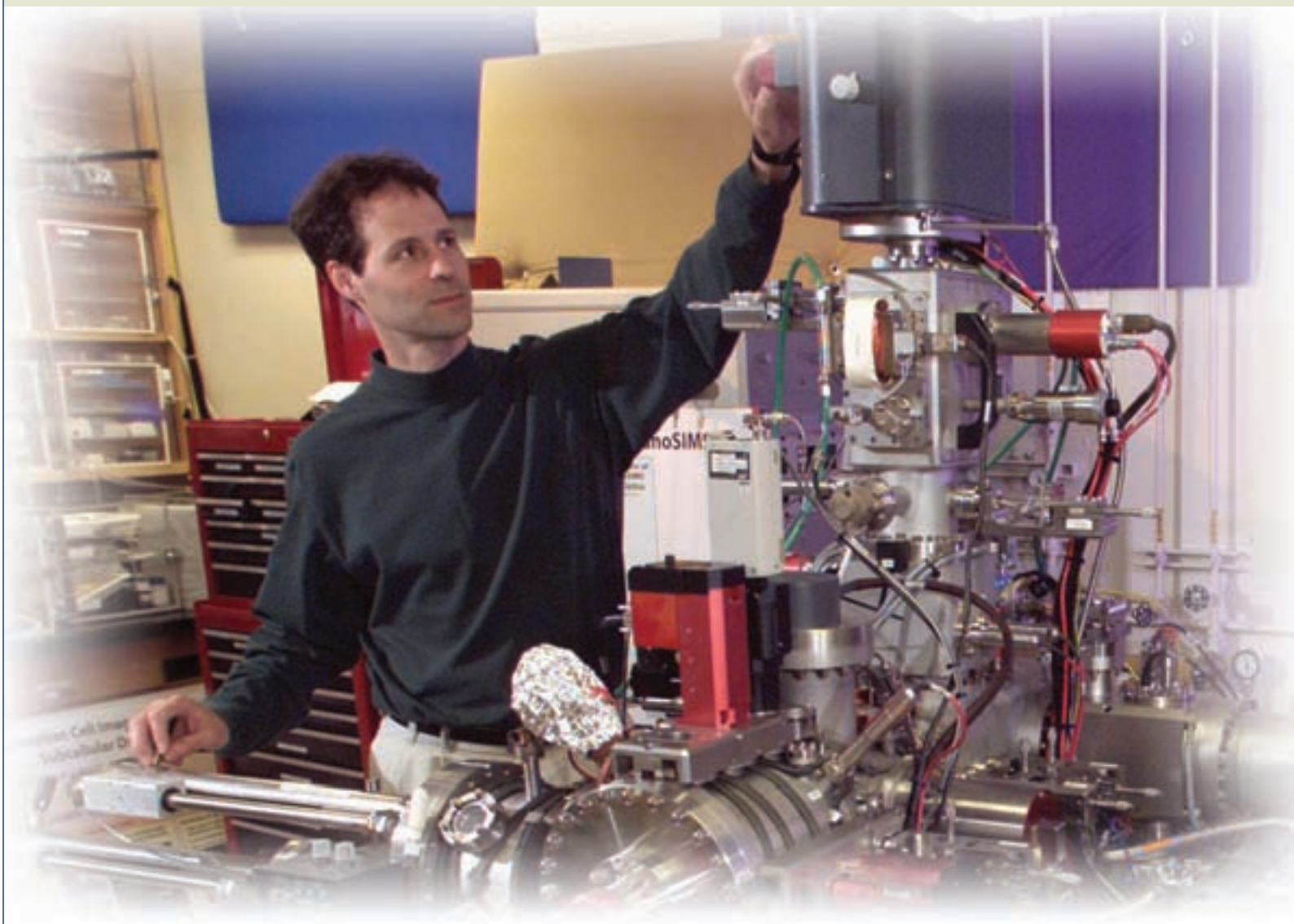
Lawrence Livermore leads the Nuclear Assessment Program (NAP), the national capability for the evaluation of communicated nuclear threats. This program also assesses cases of illicit trafficking of alleged radiological and nuclear materials. Each year, NAP provides dozens of nuclear-related threat assessments and evaluates roughly 100 nuclear trafficking incidents. In addition, NAP analysts provide subject matter expertise, in formal training venues and real-time assistance, to assist first responders and law enforcement officials, at home and abroad, in their efforts to thwart nuclear terrorism.

On the technology side, the Laboratory is developing novel detection approaches for monitoring for radioactive materials at choke points, searching for nuclear materials inside cargo containers, and other activities aimed at countering nuclear or radiological terrorism. A new, large-area, coded-aperture gamma-ray imager has demonstrated its ability to detect small quantities of nuclear materials from distances of more than 80 meters—quite possibly the most significant achievement in radiation detection systems in the past decade. In 2006, a more rugged and compact version of this detector system was assembled that fits in a 15-foot trailer pulled by a pickup truck. This version is suitable for nuclear search operations and can detect threats on both sides of the vehicle simultaneously.

Sonoma Wins R&D 100 Award

The Laboratory develops advanced technologies for detecting and monitoring proliferation-related activities such as the Sonoma persistent surveillance system, which won an R&D 100 Award in 2006 (see p. 44). Sonoma provides continuous, real-time video imagery of an area the size of a city, with resolution fine enough to track 8,000 or more moving objects continuously within its field of view. The system incorporates a novel sensor design that can view wide areas at high resolution and real-time, on-board, automated image and data processing. In addition to its proliferation detection mission, Sonoma could also be used for environmental monitoring, disaster response, border security, and more.

The Sonoma surveillance system offers the resolution shown on the right, covering the area outlined in red, from a single airplane-mounted camera. The satellite image is of Washington D.C.



Peter Weber adjusts the nano secondary-ion mass spectrometer (NanoSIMS), a versatile tool for characterizing not only nuclear materials but also cell function for biological research (see p. 29).

Another priority is to develop new radiation detection materials that offer energy resolution close to that of high-purity germanium yet do not need to be cooled to liquid nitrogen temperatures. To this end, scientists from Lawrence Livermore and Lawrence Berkeley national laboratories are working on the development of high-purity aluminum-antimonide (AlSb) for radiation detection. In 2006, they successfully demonstrated the first-ever detection of gamma rays using an AlSb device. This achievement represents a significant step in the development of AlSb as a next-generation semiconductor material for ambient-temperature gamma detection.

A major deterrent to nuclear terrorism is the ability to identify the origin of interdicted radiological or nuclear materials, which can provide clues to the identity of the perpetrators. The nuclear fuel cycle that supports worldwide use of nuclear power is complex, and there are many points at which materials might be diverted for nefarious purposes. This past year,

Livermore scientists applied their forensic analysis capabilities to characterize real-world samples, including uranium ore concentrates, sediment samples, and several samples of unknown origin. Laboratory researchers are also working with representatives in the republics of the former Soviet Union and other countries to develop co-operative frameworks for the sampling and analysis of uranium ore concentrates and nuclear fuels of significance.

Defending against Biological Terrorism

The Laboratory is home to the Biodefense Knowledge Center (BKC) for the Department of Homeland Security (DHS). This national resource provides rapid-turnaround and in-depth analyses of biodefense issues. BKC assessments and knowledge-discovery tools help the homeland security community understand scientific trends that may be exploited by adversaries to develop biological weapons. Assessments also assist in the development of an integrated national effort to respond to emerging threats and help guide the prioritization of national investments in biodefense-related R&D, planning, and preparedness.

Laboratory scientists continue to provide technical support to BioWatch (the national system for detecting large-scale bioattack against key U.S. cities), furnishing reachback expertise by on-call subject matter experts as well as supplementary sample analysis and consequence management capabilities. In 2006, the team supported several exercises and confirmed several positive environmental detections. At the request of DHS and the Centers for Disease Control and Prevention, they also coordinated a pilot program to begin the use of Livermore-developed multiplex assays by the Laboratory Response Network (LRN) laboratories. The effort included developing a training manual for assay use, providing on-site training at ten LRN laboratories, and conducting proficiency testing of those laboratories.

Multiplexed assays are also being developed for human respiratory viruses, including influenza. Hospital

Restoration after a Biological Attack

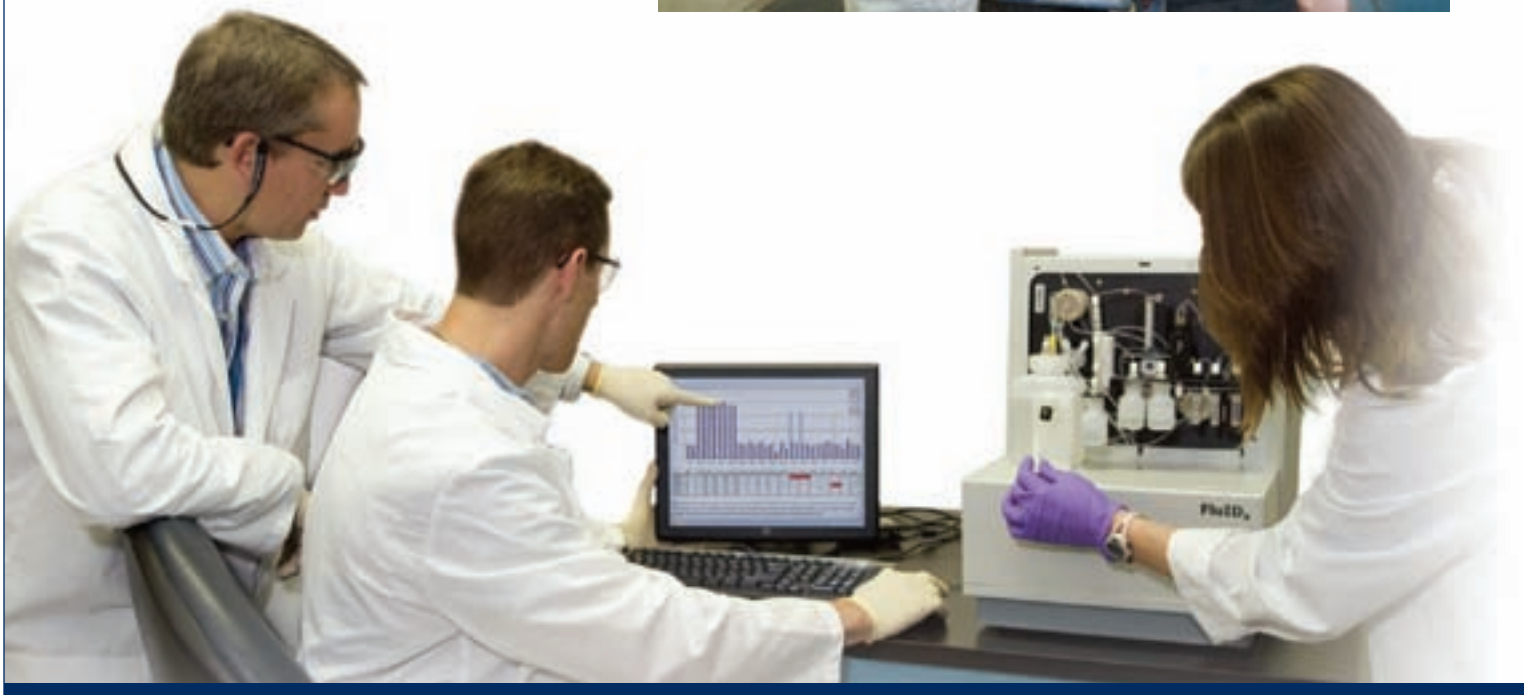
In January 2006, a two-day demonstration held at the San Francisco International Airport (SFO) laid out the response and restoration protocols that would be undertaken if a biological attack occurred. This demonstration was the culmination of the three-year, $10 million DHS Bio Restoration Demonstration Project. In this project, researchers from Lawrence Livermore and Sandia national laboratories developed restoration plans that integrated technologies and procedures so that airports hit by a biological terrorist attack could be quickly decontaminated and reopened. As part of this effort, scientists developed a test for determining within a few hours the viability of the biological agent (e.g., anthrax spores). The restoration plan demonstrated at SFO is being documented in a joint DHS/Environmental Protection Agency report for adaptation and use by other airports and transit facilities.

A cleanup team confers during a demonstration at San Francisco International Airport of response and restoration protocols following a biological attack.

emergency rooms, clinics, and doctors' offices have a pressing need to rapidly diagnose and differentiate influenza and other respiratory diseases, both to prescribe the appropriate treatment and to promptly identifya disease outbreak. Livermore researchers developed the FluID$_X$ diagnostic system to meet this need. FluID$_X$ is an integrated system that performs multiplexed nucleic-acid-based assays in real time. It autono-mously processes a sample (typically a nasal swab), analyzes the data, reports the results, and decontaminates itself. This past year, the FluID$_X$ system was tested at the University of California (UC), Davis, Medical Center Emergency Department. In October 2006 the system was submitted to the U.S. Food and Drug Administration for approval as a medical device, a process that typically take about a year.

In an effort to protect against agro-terrorism, Laboratory scientists have partnered with researchers from DHS, the U.S. Department of Agriculture, UC Davis, and Canada's National Center for Foreign Animal Diseases. Together they have developed a rapid multiplexed assay that simultaneously tests for foot-and-mouth disease (FMD) and six other look-alike diseases in livestock. Early detection of FMD or other foreign livestock disease is critical to reducing the spread and mitigating the economic impact of an outbreak (one estimate is that the U.S. would lose up to $3 million in direct costs for every hour's delay in diagnosing FMD). The research team has also developed a high-throughput, semi-automated system that can analyze 1,000 animal specimen samples in a 10-hour period using two robotic workstations and two technicians, a ten-fold increase over current capabilities. This system can be readily adapted for use with other

Jim Birch, Jack Regan, and Kristl Adams (below, left to right) view results from FluID$_X$, a system that can diagnose influenza and other respiratory viruses in about two hours. Laboratory veterinarian Pam Hullinger (right) prepares to demonstrate how swab samples are taken from cattle to check for foot-and-mouth disease.



assays, including those that test for human diseases, making it directly applicable to public health monitoring and emergency response.

Infrastructure Protection and Emergency Preparedness

To protect infrastructure and enhance preparedness against WMD threats, Laboratory scientists work closely with infrastructure owners and with local, state, and federal response entities. Together these teams identify and evaluate risks, vulnerabilities, and mitigation options. Laboratory researchers then provide essential capabilities to prepare for and respond to WMD emergencies. Many of these tools can be applied to planning for and responding to natural disasters as well.

The National Atmospheric Release Advisory Center (NARAC), located at Livermore, is the premier capability in the U.S. for real-time assessments of the dispersion and potential impact of hazardous materials released into the atmosphere. NARAC provides the technical, scientific, and operational capabilities for the DHS-led Interagency Modeling and Atmospheric Assessment Center (IMAAC), which serves as the coordinating center and single source of federal plume-modeling predictions in the event of a nationally significant incident.

NARAC/IMAAC annually supports thousands of requests for information and hundreds of drills, exercises, and events. In June 2006, NARAC/IMAAC participated in the national TOPOFF4 Command Post/Marble Challenge/ Forward Challenge exercise, conducted respectively by DHS, the Federal Emergency Management Agency, and the Federal Bureau of Investigation. Livermore scientists played a key role in developing the exercise scenarios and participated as exercise controllers.

Also in June, the Laboratory was assigned a lead role in the DHS Air Cargo Explosives Detection Pilot Program, which is taking place at San Francisco International Airport, Seattle–Tacoma International Airport, and Cincinnati–Northern Kentucky International Airport. The goal is to thoroughly understand the technological and operational issues involved in

As part of a pilot program to screen aircraft cargo for explosives, Dave Weirup examines the cargo screening area at San Francisco International Airport.

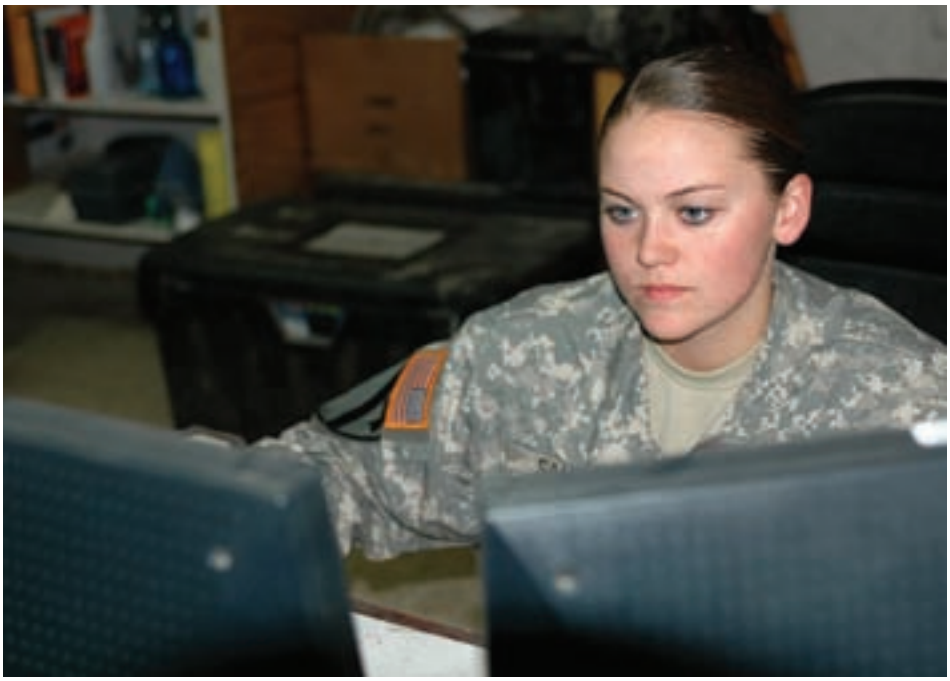
A Pocket-Sized Explosives Detector

A decade of effort culminated in the Easy Livermore Inspection Test for Explosives, or E.L.I.T.E., a credit card-sized device that is self-contained, easy to use, tests for more than 30 different explosives, and yields results within minutes. E.L.I.T.E. won an R&D 100 Award (see p. 44) as well as an award for excellence in technology transfer from the Federal Laboratory Consortium. The E.L.I.T.E. technology has been licensed to Field Forensics Inc., of St. Petersburg, Florida, and E.L.I.T.E. cards are now commercially available.

detecting explosives in air cargo. At San Francisco, cargo inspection lines with x-ray machines have been set up separate from the airport's passenger baggage screening system. Commercially available explosives detection systems are also being used. Different screening approaches are being evaluated at the other two airports in the program. The data collected will be used to develop, test, and optimize concepts of operations and operating procedures and to identify promising technological approaches for improving explosives detection.

Thirty years of Laboratory experience in developing interactive tactical simulation models for the defense community is being applied to enhance infrastructure protection, civil defense, and emergency response. Advanced Conflict and Tactical Simulation (ACATS) is a tool for analyzing tactical vulnerabilities and determining tactical responses to a chemical, biological, or other terrorist attack in an urban environment. ACATS is gaining widespread use at the state and local level to train emergency response personnel in dealing with a terrorist attack.

In a related effort, Lawrence Livermore scientists worked with counterparts at Sandia National Laboratories to produce a Training, Exercise, and Lessons Learned system for DHS. This system supports the National Incident Management System and Incident Command System for multi-level and multi-jurisdictional exercises. A proof-of-concept prototype was successfully demonstrated to senior DHS officials this past year and will be applied in regional exercises in 2007.



A member of the California National Guard uses HOPS during the Vigilant Guard exercise.

Another Livermore-developed tool for infrastructure protection is the Homeland Defense Operational Planning System (HOPS). HOPS provides detailed vulnerability and engineering assessments of critical infrastructures and facilities associated with industry, agriculture, transportation, government/military installations, and important public structures. HOPS is being incorporated into many agencies' response, training, and planning efforts. For example, the California National Guard and the California Office of Homeland Security are using HOPS to analyze the vulnerabilities of critical California infrastructure and then devise measures to protect against and mitigation damage from WMD threats. This past year, a number of major emergency-planning exercises used HOPS, including the seven-state Vigilant Guard exercise, run by the Utah National Guard, the U.S. Northern Command, and the Federal Emergency Management Agency Region 7.