Army Issues and Technology Impact
Chemical, biological, radiological, and nuclear (CBRN) threats to the United States constitute an issue of highest concern for the Office of Homeland Security. Since September 11, preventing and detecting CBRN events has been the focus of much legislation, including the Bioterrorism Preparedness Act of 2001, and of other measures. If prevention fails, the capability to dispatch informed first responders within minutes following a CBRN event will save lives.

ORNL and the American Tower Corporation (ATC) are working to combine their assets, both technical and physical, to immediately build a nationwide system for the real-time detection, identification, and assessment of CBRN threats. The system, which has been tested successfully in the field, joins three elements:

- ATC’s already existing infrastructure of 10,000 communications towers;
- ORNL’s new Block II Chemical-Biological Mass Spectrometer (CBMS), developed for the U.S. Army Soldier Biological-Chemical Command to provide rapid identification of chemical and biological agents; and
- ORNL’s Hazard Prediction and Assessment Capability (HPAC) software, developed for the Defense Threat Reduction Agency, which produces in real time a plume model, determines the number of exposed persons, and predicts immediate and latent effects on the population.

Technical Concept
ATM communications towers. Strategically located to create a nationwide wireless communications infrastructure, the ATC towers are ideal for SensorNet. Moreover, ATC has a nationwide technical field services group to rapidly install, maintain, and upgrade on-site systems. Through ATC’s FTM 5000 remote telemetry technology, each site will communicate the detection, identification, and assessment of a CBRN threat to a national or regional operations center via LAN, wireless, or satellite in real time. The FTM 5000 can be quickly upgraded either remotely or on-site for technology enhancements.

The CBMS system. The CBMS system can detect known and unknown chemical agents in less than 45 seconds and a classified list of biological agents in 4 minutes. No other device in the world has this capability. The heart of the CBMS is a direct sampling ion trap mass spectrometer. Technology to rapidly detect the presence of a nuclear release is also available and would be incorporated into the system. The instrument resists nuclear radiation, temperature extremes, and vibration and shocks.

HPAC software architecture. HPAC is an integrated system of codes and data that provide detailed information on the dispersal of hazardous atmospheric releases of nuclear, biological, and chemical materials. HPAC includes detailed, 3D information on sources, atmospheric transport and dispersion,
and ground deposition, all linked to worldwide population information at a one-kilometer resolution to predict the consequences of various releases. The system provides estimates of acute and long-term radiological, chemical, or biological population doses.

**Development Approach**

The ATC communications network is already in place. The CBMS system, developed in a $45 million program, won an R&D 100 award in 2000 as one of the most significant technological advances during the year. CBMS has been successfully tested by an independent government contractor and is currently in tests at Dugway Proving Ground. HPAC is already in use by the military throughout the world.

The integrated SensorNet system underwent field testing at ATC communications towers in Tennessee on March 11–12, 2002. The SensorNet field test included:

- a Block II CBMS for detection of airborne chemical agents in the mail room of the City-County Building in Knoxville,
- a direct-sampling ion trap mass spectrometer for detection of chemical agents in air and compounds in water in Chattanooga, and
- a Block II CBMS for detection of airborne chemical and biological agents in Nashville.

All sensors were networked to a command center at the State of Tennessee Office of Homeland Security in Nashville, where detection information and local meteorological data were input to HPAC for plume prediction. The results of this successful field test are shown below.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Detection and identification time</th>
<th>Total elapsed time of test (^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarin simulant (methyl salicylate)</td>
<td>4–25 sec</td>
<td>39–96 sec</td>
</tr>
<tr>
<td>Anthrax simulant (bacillus globigi [GB])</td>
<td>29–40 sec</td>
<td>64–77 sec</td>
</tr>
<tr>
<td>Water tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloroform</td>
<td>1.7–2.0 sec</td>
<td>(b)</td>
</tr>
</tbody>
</table>

\(a\) Total elapsed time from injection in the sensor to detection, identification, and hazard plume prediction at the command center.

\(b\) HPAC water plume dispersion modeling was not performed for chloroform in water.

During the passive response mode test, the Command Center successfully received sensor data, without loss of information, from simultaneous alerts from the three dispersed sensor locations.

Future field tests will include meteorological instruments at the sensor locations and automatic data transfer from the Command Center sensor monitoring station to the HPAC system.

**ORNL Facilities**

ORNL has exceedingly strong capabilities in instrumentation design, development, production, testing, and support. Major facilities available are the Environmental Effects Laboratory, the Radiation Effects Laboratory, the Large Scale Climate Simulator, and the Harsh Environmental Test Facility. The $45 million CBMS program has involved close coordination of all of ORNL’s scientific directorates, in order to research and develop new hardware, control electronics and software, integration of sampling systems from other vendors, identification algorithms and software, interfaces for both advanced users and the soldier, performance testing, verification, and field trials, and commercial production (through a commercial partner).

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