

CBRN Detection & Defense

Chemical Biological Mass Spectrometer (CBMS) Block II

Army Issues and Technology Impact

The events of September 11, the subsequent anthrax releases through the U.S. mail system, and the ongoing U.S. military campaign against terrorism have made even more imperative the need for reliable, fast, compact detectors of nuclear, biological, and chemical agents. Such instruments can save lives in both the civilian and the military sectors.

The ORNL-developed Block II Chemical-Biological Mass Spectrometer (CBMS) is the first integrated system capable of detecting and identifying both chemical and biological warfare agents. It provides reconnaissance, point detection and stand-alone deployment and, beyond its designed military mission, has obvious applications for counter-terrorism, civil defense, and health care.

The CBMS system combines a high-sensitivity mass spectrometer, integrated electronics, and an expert system to provide rapid identification of chemical and biological agents. The device detects known and unknown chemical agents in less than 45 seconds and a classified list of biological agents in less than 4 minutes. No other device in the world has this capability. The system won an R&D 100 award in 2000 as one of the most significant technological advances during the year.

Technical Concept

The heart of the CBMS is an ion trap mass spectrometer that can be operated in either ethanol chemical ionization or electron ionization in full scan and tandem mass spectrometry modes. The mass spectrometer is connected to three sampling systems via the sample interface module. Respirable particulate airborne biological agents are isolated, concentrated and delivered to a pyrotube by the bioconcentrator module. The bioparticles are heated in the presence of an esterifying agent, and the derivatized phospholipid membrane fatty acids and other biomarkers are transferred to the mass spectrometer by a mode select valve, transfer line, and capillary interface.

Chemical agent (nerve, blister, riot agent, and other military chemicals) vapors are sampled via a heated Silicosteel™ capillary line and are directed to the mass spectrometer via the mode select valve. Liquid chemical warfare agents on the ground are sampled by the reconnaissance vehicle ground wheel/heated probe system, which connects with the Block II CBMS.

Modular in design, the instrument is soldier-friendly in operation and self-diagnosing in fault location. It resists nuclear radiation, temperature extremes, and vibration and shocks from wheeled vehicle transport.



The soldier operates the instrument using the soldier display unit, which also sounds and displays the alarms and transfers them to a central computer. Coupled to remote telemetry, such as when mounted on wireless communications towers (a system concept currently being tested), CBMS could serve as an ever-alert sentinel.

Development Approach

The Block II CBMS Program, for the U.S. Army Soldier Biological-Chemical Command, is in its sixth year of development. The objective of this \$46 million program has been to design, build, and demonstrate prototypes and pre-production units with improved capabilities for rapid biological warfare/chemical warfare agent detection and identification on the battlefield. Tests performed at ORNL and observed by Dugway Proving Ground staff have shown that ORNL is on track for meeting this objective. Government testing of chemical agent performance will begin next month at Dugway. Additional biosampling optimization and biodata generation are needed before biodetection is fully ready.

Follow-on work to complete the biodetection work and add capabilities to meet additional requirements is planned for the next two fiscal years. The CBMS is being evaluated for the JSLNBCRS and the IAV/NBCRV platforms.

The project team includes ORNL, Hamilton Sundstrand Sensor Systems (formerly Orbital Sciences Corp.), MSP Corp., and the Colorado School of Mines. Collaborators include Dugway Proving Ground, White Sands Missile Range, and the Armed Forces Institute of Pathology.

Future

Technology under development at ORNL could underlie the Block II CBMS. The microtoroid, an advanced mass analyzer design, would greatly reduce mass, volume, and power consumption. An electrospray interface with unique ion-ion chemistry promises a priori identification of biological warfare agents by drawing upon vast proteomics databases. Investment in these technologies now would ensure their readiness when needed for the next generation of chem-bio detectors.

ORNL Facilities

ORNL's staff, equipment, and capabilities in mass spectrometry are recognized worldwide. In addition, the Laboratory has a small dilute solution chemical agent laboratory and a Bio Lab equipped to Biosafety Level 3 to facilitate development and testing with actual agents.

Related Programs

The CBMS is currently being tested for use in a homeland security system, SensorNet, which places these instruments on existing wireless communication towers. This system will combine the existing infrastructure of American Tower Corporation's 10,000 communication towers; the CBMS for rapid detection and identification of chemical and biological agents; and ORNL's Hazard Prediction and Assessment Capability software (a real-time plume and population impact modeling program) to provide first responders with fast, accurate information on evolving chemical, biological, radiological, and nuclear threats.

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