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Sensor Systems for Biological Agent Attacks: Protecting Buildings and Military Bases—*Summary*

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Introduction

Over the last ten years, there has been growing concern about potential biological attacks on the nation's population and its military facilities. At the same time, there has been significant investment in developing technology to detect and respond to such attacks, and it is now possible to do so quickly enough to permit treatment of potential victims prior to the onset of symptoms. The capability to "detect to warn", that is in time to take action to minimize human exposure, however, is still lacking. To help achieve such a capability, the Defense Threat Reduction Agency (DTRA) asked the National Research Council (NRC) to assess the development path for "detect to warn" sensors systems. This report presents the results of this assessment including analysis of scenarios for protecting facilities, sensor requirements, and detection technologies and systems.

Implementation Strategy

Future systems to protect against biological attacks need to have a "detect to warn" capability that permits alterations of building air movement or air treatment, or protection of personnel before the hazard reaches occupants. Such capability requires sample collection and analysis and initiation of protective measures within 3 to 5 minutes, and preferably one minute, of initial detection. To examine such detection strategies, two scenarios are considered: an indoor release in a building and an outdoor release against a military installation. There is growing consensus that such detection systems could be deployed by 2010. In both cases, a phased implementation strategy is desirable.

Buildings. Within one to two years, relatively simple and rapid detection systems that would not need to identify specific biological agents (nonspecific) could be deployed to provide baseline detect-to-warn capability. Over the next five years, the system's capabilities could be upgraded by the addition of sensors in air handling systems to detect still lower levels of attack. At lower thresholds, however, false alarms become more likely, and the development of detectors that can rapidly identify specific agents becomes important. The resulting arrangement would be a system of sensors that could detect large or small attacks on the order of one to two minutes.

Extended Military Installations. Nonspecific detectors can also be placed at the perimeter of a military installation—Phase I—to provide baseline, detect-to-warn protection as the first phase of an implementation strategy for these facilities. Lower

agent concentrations, due to the larger area covered, combined with the higher ambient background, however, will likely produce a higher rate of false alarms than for buildings. Confirmation capabilities—fast, specific detectors—will likely be needed to expand the protected space. A phase I system alone, however, can provide a detect-to-warn capability that can enhance overall protection. In addition, if phase I is skipped, it will be at least five years before rapid identifier detectors become available.

Technical Findings and Recommendations

The phased strategy is most likely to lead to a successful detect-to-warn capability given the current state of technology. The emergence of other technologies, however, might change this picture. To capture this observation, the recommendations and findings are divided into two categories; most probable path and technology watch list.

Most Probable Path

- Careful integration of detection capabilities with response options and procedures is required. A systems approach should be adopted by planners.
- Local aerosol backgrounds need to be well understood and should be characterized by the same methods to be used by the detection system.
- Due to the potentially high false alarm rate at very low detection levels, that rate should be characterized in relevant environments.
- Research should be supported to improve structure-based detectors which have the greatest potential for rapid, sensitive, and specific detect-to-warn applications.
- Research needs to be continued on integrated, fully automated polymerase chain reaction (PCR) systems for attack confirmation and organism identification.
- A clear concept of operations needs to be developed for standoff detection in support of military base protection.

Technology Watch List

- The use of mass spectrometry should be investigated to improve understanding of the biofingerprint method in complex agent mixtures and other background contaminants.
- Research is needed on developing low-cost arrays of semi-selective sensors that can be used as a biological ‘smoke alarm’ for triggering low level response actions.
- Ribosomal RNA analysis might be capable of rapid—one to several minutes—agent identification, and its potential and limitations should be explored.
- Function-based sensors are promising candidates for detecting unknown agents, and studies are needed to understand better their role in biodetection architectures.

Detection systems that could provide rapid warning for buildings or military installations could be deployed by 2010. The most promising approach would use a combination of advanced detectors including nonspecific devices for detecting all agents in a large attack; rapid, structure-based devices for identifying 10 to 20 leading agents in low-level attacks; and an autonomous PCR capability for rapid confirmation. Use of such a system would result in a very low false alarm rate and be very robust to countermeasures.

For further information;

Copies of *Sensor Systems for Biological Agent Attacks: Protecting Buildings and Military Bases* can be obtained from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20418, 201-334-3313, < http://books.nap.edu/ >.

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