

**CHEMICAL AND BIOLOGICAL DEFENSE PROGRAM**  
**SBIR 07.1 Proposal Submission**

***General Information***

In response to Congressional interest in the readiness and effectiveness of U.S. Nuclear, Biological and Chemical (NBC) warfare defenses, Title XVII of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) required the Department of Defense (DoD) to consolidate management and oversight of the Chemical and Biological Defense (CBD) Program into a single office – the Deputy Assistant Secretary of Defense, Chemical and Biological Defense Programs, DATSD (CBD). The Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD), Defense Threat Reduction Agency (DTRA) provides the management for the Science and Technology component of the Chemical and Biological Defense Program. Technologies developed under the SBIR program have the potential to transition to the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) if the appropriate level of technology maturity has been demonstrated. The JSTO-CBD Science & Technology programs and initiatives are improving defensive capabilities against Chemical and Biological Weapons. The executive agent for the Small Business Innovation Research (SBIR) portion of the CBD Program is the Army SBIR Program Management Office (PM, SBIR) ([www.armysbir.com](http://www.armysbir.com)).

The mission of the Chemical and Biological Defense Program is to ensure that the U.S. military has the capability to operate effectively and decisively in the face of biological or chemical warfare threats at home or abroad. Numerous rapidly-changing factors continually influence the program and its management, including planning for war-fighting support to asymmetrical threats, the evolving geopolitical environment, U.S. participation in the Chemical Weapons Convention, the threat of global proliferation of chemical and biological weapons, and DoD resources available. Improved defensive capabilities are essential in order to minimize the impact of such weapons. U.S. forces require aggressive, realistic training and the finest equipment available that allows them to avoid contamination, if possible, and to protect, decontaminate and sustain operations. Further information about the DoD CBD Program (and related programs) is available at the DoD Counter proliferation and Chemical Biological Defense Homepage at <http://www.acq.osd.mil/cp>.

The overall objective of the CBD SBIR Program is to improve the transition or transfer of innovative CBD technologies between DoD and the private sector for mutual benefit. The CBD SBIR Program targets those technology efforts that maximize a strong defensive posture in a biological or chemical environment using passive and active means as deterrents. These technologies include chemical and biological detection; individual and collective protection; decontamination; modeling & simulation; threat agent science; and medical pre-treatments, diagnostics, and therapeutics.

***Submitting Your Phase I CBD SBIR Proposal***

**Your entire proposal (consisting of Proposal Cover Sheets, the full Technical Proposal, Cost Proposal, and Company Commercialization Report) must be submitted electronically through the DoD SBIR/STTR Proposal Submission system located at [www.dodsbir.net/submission](http://www.dodsbir.net/submission). A hardcopy is NOT required for CBD. Hand or electronic signature on the proposal is also NOT required.**

You must prepare a Company Commercialization Report through the Submission site and it will be included with your electronic submission; however, it does not count against the proposal page limit. Update your commercialization information if you have not done so in the past year. Please note that improper handling of the Commercialization Report may result in the proposal being substantially delayed and that information provided may have a direct impact on the review of the proposal. Refer to section 3.5d at the program solicitation for detailed instructions on the Company Commercialization Report.

Be reminded that section 3.5.a of this solicitation states: “If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released on the Internet; therefore, do not

include proprietary or classified information in these sections". Note also that the DoD web site contains timely information on firm, award, and abstract data for all DoD SBIR Phase I and II awards archived for several years. This information can be viewed on the DoD SBIR/STTR website at <http://www.acq.osd.mil/sadbu/sbir/>.

The CBD Program has enhanced its Phase I-Phase II transition process by implementing the use of a Phase I Option that may be exercised to fund interim Phase II activities while a Phase II contract is being negotiated. The maximum dollar amount for a Phase I feasibility study is \$70,000. The Phase I Option, which **must** be proposed as part of the Phase I proposal, covers activities over a period of up to three months and at a cost not to exceed \$30,000. All proposed Phase I Options must be fully costed and should describe appropriate initial Phase II activities, which would lead, in the event of a Phase II award, to the successful demonstration of a product or technology. **The CBD program will not accept Phase I proposals which exceed \$70,000 for the Phase I effort and \$30,000 for the Phase I Option effort.** Only those Phase I efforts selected for Phase II awards through the CBD SBIR Program's competitive process will be eligible to exercise the Phase I Option. To maintain the total cost for SBIR Phase I and Phase II activities at a limit of \$850,000, the total funding amount available for Phase II activities under a resulting Phase II contract will be \$750,000.

Companies submitting a Phase I proposal under this Solicitation must complete the Cost Proposal using the on-line form within a total cost of \$70,000 over a period of up to 6 months (plus up to \$30,000 for the Phase I Option over a period of up to three (3) months). Phase I and Phase I Option costs must be shown separately.

Selection of Phase I proposals will be based upon scientific and technical merit, according to the evaluation procedures and criteria discussed in section 4.2. The CBD SBIR Program reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality in the judgment of the evaluators will be funded.

Proposals not conforming to the terms of this solicitation, and unsolicited proposals, will not be considered. Awards are subject to the availability of funding and successful completion of contract negotiations.

### ***CBD Program Phase II Proposal Guidelines***

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the project technical monitor measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal. During or at the end of the Phase I effort, awardees will be invited to submit proposals for evaluation for a Phase II award. The invitation will be issued in writing by the organization responsible for the Phase I effort. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing the developed technology. Proposers are required to submit a budget for the entire 24 month Phase II period. During contract negotiation, the contracting officer may require a cost proposal for a base year and an option year, thus, proposers are advised to be mindful of this possibility. These costs must be submitted using the Cost Proposal format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Proposal Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. At the Contracting Officer's discretion, Phase II projects may be evaluated after the base year prior to extending funding for the option year.

The CBD Program is committed to minimizing the funding gap between Phase I and Phase II activities. All CBD Phase II proposals will receive expedited reviews and be eligible for interim funding (refer to top for information on the Phase I Option). Accordingly, all Phase II proposals will be evaluated within a single two-tiered evaluation process and schedule. Phase II proposals will thus typically be submitted within 5 months from the scheduled DoD Phase I award date (the scheduled DoD award date for Phase I, subject to the Congressional Budget process, is 4 months from close of the DoD Solicitation). The CBD Program typically funds a cost plus fixed fee Phase II award, but may award a firm fixed price contract at the discretion of the Contracting Officer.

**CONTRACTOR MANPOWER REPORTING (CMR) (Note: Applicable only to U.S. Army issued SBIR contracts)**

Accounting for Contract Services, otherwise known as Contractor Manpower Reporting (CMR), is a Department of Defense Business Initiative Council (BIC) sponsored program to obtain better visibility of the contractor service workforce. *This reporting requirement applies to all SBIR contracts issued by an Army Contracting Office.*

Beginning in the DoD 2006.2 SBIR solicitation, offerors are instructed to include an estimate for the cost of complying with CMR as part of the cost proposal for Phase I (\$70,000 max), Phase I Option (\$30,000 max), and Phase II (\$750,000 max), under “CMR Compliance” in Other Direct Costs. This is an estimated total cost (if any) that would be incurred to comply with the CMR requirement. Only proposals that receive an award will be required to deliver CMR reporting, i.e. if the proposal is selected and an award is made, the contract will include a deliverable for CMR.

To date, there has been a wide range of estimated costs for CMR. While most final negotiated costs have been minimal, there appears to be some higher cost estimates that can often be attributed to misunderstanding the requirement. The SBIR program desires for the Government to pay a fair and reasonable price. This technical analysis is intended to help determine this fair and reasonable price for CMR as it applies to SBIR contracts.

- The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains the secure CMR System. The CMR website is located here: <https://contractormanpower.army.pentagon.mil/>.
- The CMR requirement consists of the following 13 items, which are located within the contract document, the contractor's existing cost accounting system (i.e. estimated direct labor hours, estimated direct labor dollars), or obtained from the contracting officer representative:
  - (1) Contracting Office, Contracting Officer, Contracting Officer's Technical Representative;
  - (2) Contract number, including task and delivery order number;
  - (3) Beginning and ending dates covered by reporting period;
  - (4) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
  - (5) Estimated direct labor hours (including sub-contractors);
  - (6) Estimated direct labor dollars paid this reporting period (including sub-contractors);
  - (7) Total payments (including sub-contractors);
  - (8) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
  - (9) Estimated data collection cost;
  - (10) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (The Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
  - (11) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest city, country, when in an overseas location, using standardized nomenclature provided on website);
  - (12) Presence of deployment or contingency contract language; and
  - (13) Number of contractor and sub-contractor employees deployed in theater this reporting period (by country).
- The reporting period will be the period of performance not to exceed 12 months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.
- According to the required CMR contract language, the contractor may use a direct XML data transfer to the Contractor Manpower Reporting System database server or fill in the fields on the Government website. The CMR website also has a no-cost CMR XML Converter Tool.

- The CMR FAQ explains that a fair and reasonable price for CMR should not exceed 20 hours per contractor. Please note that this charge is PER CONTRACTOR not PER CONTRACT, for an optional one time set up of the XML schema to upload the data to the server from the contractor's payroll systems automatically. This is not a required technical approach for compliance with this requirement, nor is it likely the most economical for small businesses. If this is the chosen approach, the CMR FAQ goes on to explain that this is a ONE TIME CHARGE, and there should be no direct charge for recurring reporting. This would exclude charging for any future Government contract or to charge against the current SBIR contract if the one time set up of XML was previously funded in a prior Government contract.
- Given the small size of our SBIR contracts and companies, it is our opinion that the modification of contractor payroll systems for automatic XML data transfer is not in the best interest of the Government. CMR is an annual reporting requirement that can be achieved through multiple means to include manual entry, MS Excel spreadsheet development, or use of the free Government XML converter tool. The annual reporting should take less than a few hours annually by an administrative level employee. Depending on labor rates, we would expect the total annual cost for SBIR companies to not exceed \$500 annually, or to be included in overhead rates.

### *Key Dates*

07.1 Solicitation Open/Close	6 December 2006 – 10 January 2007
Phase I Evaluations	January - March 2007
Phase I Selections	March 2007
Phase I Awards	May 2007*
Phase II Invitations	September 2007
Phase II Proposals due	October 2007

\*Subject to the Congressional Budget process.

### **CBD SBIR PROPOSAL CHECKLIST**

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to ensure that your proposal meets the CBD SBIR requirements. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award.**

- \_\_\_\_\_ 1. The Proposal Cover Sheets along with the Technical Proposal, Cost Proposal and Company Commercialization Report were submitted via the Internet using the DoD's SBIR/STTR Proposal Submission website at <http://www.dodsbir.net/submission>.
- \_\_\_\_\_ 2. The proposal cost adheres to the CBD Program criteria specified.
- \_\_\_\_\_ 3. The proposal is limited to only **ONE** solicitation topic. All required documentation within the proposal references the same topic number.
- \_\_\_\_\_ 4. The Project Abstract and other content provided on the Proposal Cover Sheet contains no proprietary or classified information and is limited to the space provided.
- \_\_\_\_\_ 5. The Technical Content of the proposal, including the Option (if applicable), includes the items identified in Section 3.4 of the solicitation.

\_\_\_\_\_ 6. The technical proposal and Proposal Cover Sheets together is 25 pages or less in length. Pages in excess of this length will not be considered for review or award. (The Cost Proposal does not count towards the 25-page limit).

\_\_\_\_\_ 7. The Company Commercialization Report is submitted online in accordance with Section 3.5.d. This report is required even if the company has not received any SBIR funding. (This report does not count towards the 25-page limit).

\_\_\_\_\_ 8. The proposal contains no type smaller than 11-point font size (except as legend on reduced drawings, but not tables).

## **CBD SBIR 07.1 Topic Index**

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## CBD SBIR 07.1 Topic Descriptions

CBD07-101      TITLE: Sequencing of Multiple Chemical/Biological Aircraft Decontamination Agents

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Determine the most effective combination of current and emerging chemical and biological decontamination agents to decontaminate Large Frame Aircraft (LFA) exteriors.

DESCRIPTION: Current methods used to fully decontaminate a LFA result in excessive off-gassing, corrosive effects on aircraft components/electronic equipment, and limited success. These methods include the individual use of Cold Plasma, Vaporous Hydrogen Peroxide (VHP), modified VHP (mVHP), Hot Soapy Water (HSW), DF-200, Decon Green, Ultraviolet (UV) Light, Hot Air Decontamination (HAD), super tropical bleach (STB) etc. However, a combination of these partially effective chemical and/or biological decontamination agents (to include sequence, duration, and magnitude of each) may result in an increased decontamination capability without damage/corrosion to aircraft components. While each of the aforementioned decontamination agents may be individually effective, we seek novel approaches to a decontamination methodology using the most effective combination of known or emerging decontamination agents that can effectively decontaminate Large Frame Aircraft, contaminated with any agent, to levels where the aircraft can be safely used by the crew.

PHASE I: Develop a detailed analysis of predicted performance for a combination of decontamination agents that can effectively decontaminate LFA without producing corrosive effects or toxic by-products. This phase will demonstrate the feasibility of producing a combination decontamination methodology and will outline demonstration success criteria.

PHASE II: Conduct and demonstrate the implementation of the proposed methodology from Phase I, possibly by having selected the most promising of the decon agents and then experimenting with various combinations of sequence, duration, and magnitude to determine the most effective combination.

PHASE III DUAL USE APPLICATIONS: The military application of a successful combination of chemical/biological decontamination that exceeds any single decontamination agent is apparent. Success of such a combination will provide an effective methodology for decontaminating LFA within the military as well as provide a foundation for applying the developed methodology to Army assets (e.g., helicopters). This application could also be highly profitable by commercial airlines as well as commercial enterprises working in the building decontamination business. Improved manufacturing capabilities and processes may also be investigated.

REFERENCES: 1. Military Medical Technology, On Line Edition. Published Apr 15, 2003 in Volume: 7 Issue: 3. "ECBE: Experts in Equipment Decon Technology." <http://www.military-medical-technology.com/article.cfm?DocID=62>;

2. Air Force Manual 10-2602, Nuclear, Biological, Chemical, and Conventional (NBCC) Defense Operations and Standards, 29 May 2003, <http://www.e-publishing.af.mil/pubfiles/af/10/afman10-2602/afman10-2602.pdf>

3. Mundis, Chris et al., "Hot Air Decontamination of the C-141 Aircraft Technology Development Program." ECBC-TR-379, April 2004.

KEYWORDS: Laboratory test, Field test, WMDs, SARs, Avian influenza, simulants

CBD07-102      TITLE: Immediate Biodecontamination System

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The objective of this research is to develop a system for immediate decontamination of surfaces contaminated with biological warfare agents.

**DESCRIPTION:** An attack by hostile forces may lead to both exterior and interior surfaces of vehicles, buildings or equipment becoming contaminated with biological warfare (BW) agents. U.S. forces require the means to rapidly decontaminate these surfaces and allow continued and sustained operations. Systems to decontaminate enclosed spaces using a gas or vapor are well known and their efficacy has been demonstrated by numerous tests. Therefore, systems using a gas or vapor are not of interest in this solicitation. The specific focus of this topic is a system that will dispense a liquid to rapidly decontaminate exterior and interior surfaces of forward deployed vehicles and associated infrastructure. The goal of this project is a portable and rapidly deployed solution that will allow continued operations and restoration of operational tempo in the field. This unit may be part of the process of thorough decontamination and subsequent testing that would permit military actions and civilian workers to occupy the decontaminated space for an extended period without any precautions. It is assumed that the normal complement of BW agent or biohazard detection instruments is available, and indicators of the presence of contaminants or level of contaminants need not be part of the proposed system.

The system should satisfy the following requirements: (1) effective (8 log reduction of a 10X8 challenge) on the full range of biological threats, including bacterial and fungal spores, viruses and biological toxins (Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)); (2) safe for the user to dispense requiring minimal personal protective equipment and not requiring evacuation for decontamination of interior surfaces; (3) readily transported to the site of use, including transport on passenger aircraft, with no restrictions due to the presence of hazardous materials or compressed gases; (4) minimal weight and volume; (5) self-contained for maximum mobility, requiring no externally supplied power or materials; (6) readily operated/dispensed; (7) detoxifies rather than sequesters the BW agent, so that there is no biohazard remaining after treatment; (8) environmental friendly, producing no hazardous residues or waste disposal issues; (9) capable of use inside or outside (interior/exterior environments), daylight or dark (i.e., no solar photochemical processes), and in temperatures from -25°F to +120°F; (10) has an extended storage life, minimum two years without loss of decontamination capability; (11) compatible with all materials that may be encountered in military equipment, including personal protective equipment and monitors to detect BW or CW agents; and (12) low cost. The system must comply with the relevant regulatory requirements for manufacture, transport, use and disposal.

Effectiveness against chemical warfare (CW) agents and Toxic Industrial Chemical Materials (TICs and TIMs) is also desirable, provided it does not compromise any of the above properties (1-12 above). This includes complete neutralization of a 10g/m<sup>2</sup> load of chemical agent. Materials that have been shown to be effective for biodecontamination include solutions containing hydrogen peroxide and chlorine dioxide; however, any system that meets the stated requirements will be considered.

**PHASE I:** Initial research will focus on experiments to demonstrate the technology and formulation, and that the system proposed generates an effective level of decontaminant to potentially meet FIFRA requirements for decontamination. The proposer must demonstrate that the decontaminant is effective against biological agents using appropriate surrogates. Estimation of the system weight, volume, and cost should also be performed.

**PHASE II:** The technology developed in Phase I will be incorporated into full-scale, operational prototype units. The prototypes will be tested against suitable simulants for BW agents and, as appropriate and permissible, with live agents. The process to obtain Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) regulatory approval for use in the U.S. should be initiated.

**PHASE III DUAL USE APPLICATIONS:** Any additional required testing, including tests against live agents will be performed and effectiveness quantified. This technology will have dual use application both by military forces and first responders. Modified versions may have additional application in military or civilian medical facilities to decontaminate pathogens commonly found on surfaces (a significant source of infections) or remediation against mold in buildings.

**REFERENCES:** 1. SAIC (March 2005). "Compilation of Available Data On Building Decontamination Alternatives." Report prepared by Science Applications International Corporation (SAIC) for the U.S. EPA, National Homeland Security Research Center, under Contract No. 68-C-02-067

2. Tinlin, J., A. Willey, V. Gartstein, L. Procell, Z. Hess, D. Gehring and M.

Hall. "From The Kitchen To The Battle Field: Chlorine Dioxide As A Decontaminating Agent." Decon 2005, Tucson, AZ, December 13-15, 2005.

3. Wagner, G.W., L.R. Procell, V.D. Henderson, D.C. Sorrick, Z. A. Hess, D. G. Gehring and M.D. Brickhouse. "Update on Decon Green®: CBRN Efficacy, Environmental Decon, and Aircraft Decon." Decon 2005, Tucson, AZ, December 13-15, 2005.

KEYWORDS: Decontamination, biological warfare agent

CBD07-103      TITLE: Generic Adsorptive Carbon Residual Life Indicator

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The objective of this research is to develop, build and test a generic adsorptive carbon residual life indicator that can be used in a several formats that contain adsorptive carbon. The technology must provide a real-time assessment of the performance status of the carbon.

DESCRIPTION: Adsorptive carbon is widely used in chemical and biological protective gear for both individual protection (e.g. respirator cartridges, protective garments) and collective protection (e.g. air filters, protective enclosures). The effective life of adsorptive carbon is highly variable depending on many factors including type of carbon, environmental conditions, type of challenge agent(s), and concentration of challenge agent(s). In many applications for adsorptive carbon, there is no method currently implemented for determining the remaining life of the carbon. Where such methods exist, they are often limited in scope, cost-prohibitive, and/or operationally inefficient. For instance, some service life indicators are agent-specific (i.e. will only indicate the service life when exposed to a particular challenge agent), which severely limits their usefulness for military or first responder applications. Other approaches detect only the presence of toxic substances, but do not provide a real-time indication of the performance of the sorptive media.

This topic solicits proposals to develop a low-cost adsorptive carbon residual life indicator that overcomes the limitations indicated above and is easy to use in the field on a wide-array of gear containing adsorptive carbon. The system must be applicable to multiple different products containing adsorptive carbon, including but not limited to respirator canisters or cartridges. The system must show efficacy in determining the Residual Life when the carbon has been challenged against a wide array of chemical warfare agents (CWAs), biological warfare agents (BWA), toxic industrial chemicals (TICs), and toxic industrial materials (TIMs).

PHASE I: Phase I research should focus on the development of the technology and a laboratory prototype system to demonstrate the feasibility of the approach. The prototype must be in a form suitable for use with respirator canisters or cartridges. Testing with an array of TICs and/or CWA simulants in vapor form must be conducted. The system must show efficacy when the carbon has been challenged against at least 10 different TICs or CWA simulants. The proposer must demonstrate: (1) the current ability to generate precise concentrations (validated against analytical methods) of target vapors and liquids for testing purposes, (2) demonstrated experience with adsorptive media and flow dynamics within adsorptive media in respirator canisters or cartridges, (3) demonstrated experience in developing and deploying residual life indicators for respirator canisters or cartridges and (4) demonstrated experience in collaborating with manufacturers of respirator canisters or cartridges in order to allow for successful development, implementation and delivery of the resulting product.

PHASE II: Phase II should focus on development of field-ready prototypes in multiple (at least three) different types of adsorptive carbon based products. Testing against a wide array of TICs, live CWAs, and BWA simulants in vapor, liquid, and/or aerosol form, as required, will be performed. The system must show efficacy in determining the Residual Life of multiple products containing adsorptive carbon when challenged against a wide array of CWAs and TICs. The result of the phase II must be a device ready to be manufactured.

PHASE III DUAL USE APPLICATIONS: This system has potential for use in industrial and environmental fields (e.g. industrial respirators, industrial filters) and for first responders (e.g. garments, respirators).

KEYWORDS: adsorptive carbon, chemical agent, biological agent

CBD07-104 TITLE: Integrated Lab-on-a-Chip THz Sensors

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The Terahertz (THz) field has grown rapidly in recent years, especially in the area of imaging and telescoping for concealed object detection and identification. There is also a significant amount of experimental evidence that many biological macromolecules – DNA, proteins, and polysaccharides – display unique absorptive signatures in the THz region that should be useful in their identification and imaging [1]. Furthermore, these same studies [1] have shown a phenomenal capability for collecting reproducible signatures from nano-gram samples of biomolecules dissolved in liquids as long as highly controlled conditions are maintained. In addition, the detection of such biomaterials has recently been demonstrated in microfluidic cells [2], which opens up the possibility of a “lab-on-a-chip” capability for the THz region similar to what now exists for the infrared region [3]. These developments are extremely important because the primary obstacles to effective THz fingerprinting of materials and agents have long been associated with achieving controllable and reproducible spectral signatures [4]. Specifically, opportunities exist for achieving enhanced spectral sensing capability through the direct integration of a THz microscopy capability into a “lab-on-a-chip” platform. Therefore, the goal of this SBIR Topic is to develop and demonstrate integrated Lab-on-a-Chip THz sensors that can detect and image biomolecules at monolayer thicknesses in the aqueous state, and in near real-time.

DESCRIPTION: An attractive component for the desired THz microscope technology in any spectral region is a focal-plane array or artificial retina. The following requirements must be fulfilled to achieve a useful focal-plane for the biomolecular microscopy application: (1) room temperature operation, (2) noise-equivalent-power (NEP) no greater than 5 pW/Hz<sup>1/2</sup> at 600 GHz, (3) noise equivalent temperature difference (NETD) no greater than 1 K/Hz<sup>1/2</sup> averaged across the band 0.3 to 1.0 THz, (4) video bandwidth of at least 60 Hz, (5) coupling of each individual pixel to the free space through a beamwidth between  $f\# = 1.0$  and  $f\# = 2.0$ , and (6) center-to-center spacing of pixels in the array that satisfy the Whitaker-Shannon theorem of spatial sampling. When THz technology of this prescription is developed and successfully integrated into the “lab-on-a-chip” platform new capabilities for the detection and identification of bio-threat agents can be expected, and this work will have particular relevance to the important defense and security problem of monitoring the water supply.

PHASE I: Phase I of the program should focus on the specification and design of a suitable THz microscope technology for integrating into an existing fluidic chip platform. This initial phase should also include preliminary experimental investigations of fluidic-chip processing of biomaterials and/or bio-agents, along with the electrical characterization of the relevant Lab-on-a-Chip interfaces.

PHASE II: In Phase II of the program, an appropriate THz microscope design should be integrated into a pre-existing fluidic chip platform. The research and development work should include extensive testing of the integrated lab-on-a-chip sensor for appropriate biomaterial and/or bio-agent targets. The work conducted should lead to the realistic bench-marking of the effectiveness of the sensor for a relevant defense and security application – e.g., field monitoring of water supply contamination.

PHASE III DUAL USE APPLICATIONS: Once an effective prototype sensor is achieved, the unit will be amenable to numerous applications areas related to biological sensing and characterization. Specifically such a lab-on-a-chip sensor will have relevance to scientific studies on biological materials and structures, to the detection and identification of biological threats, to medical diagnostics of biological induced diseases, to the monitoring of commercial consumables for biological contamination, etc.

REFERENCES: 1. “Terahertz Sensing of Bio-Water Contaminants using Vibrational Spectroscopy,” T. Globus, T. Khromova, A. Bykhovski, B. Gelmont, and D. Woolard, Proc. 2006 Int. Symp. on Spectral Sensing Research, Bar Harbor, ME, p. 67 (2006).

2. “Terahertz Microfluidics for On-Chip Identification of Biomolecular Compositions and Conformations,” P.A. George, Proc. IEEE LEOS 2006, Paper MA3.4 (2006).

3. "Online Detection in Aqueous Micro-Volume Systems," M. Kolhed, B. Lendl, and B. Karlberg, The Royal Society of Chemistry, Analyst, vol. 128, p. 2-6 (2003).

4. "Terahertz Frequency Sensing and Imaging: A Time of Reckoning Future Applications?" Dwight Woolard, Elliott Brown, Michael Pepper and Michael Kemp, Proceedings of the IEEE, 93, pp. 1722-1743 (2005).

KEYWORDS: Terahertz, Spectroscopy, Fluidic Chip, Biological Detection, Water Monitoring

CBD07-105 TITLE: Enhanced Capability Point Combined Bio and Chem Sensor

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: Joint Biological Point Detection System (JBPDS) Increment 2

OBJECTIVE: We are seeking novel approaches to demonstrate feasibility of a compact, long-wave infrared (LWIR, 8-12 micron), point bio sensor with advanced algorithms, with extension to combined chemical detection, for manportable and small ground and airborne vehicle deployment.

DESCRIPTION: It was recently discovered in field testing with the FAL (Frequency Agile Laser) sensor that bio agent simulants and interferents could be detected and discriminated by their differential backscatter signatures in the 9-11  $\mu\text{m}$  band using a CO<sub>2</sub> TEA (transversely excited atmospheric) laser transmitter. The FAL had been used successfully for chemical vapor detection which suggests that a single transmitter/sensor could be used for both chem and bio detection. The FAL laser emits pulses composed of a 150 ns spike followed by a 1  $\mu\text{s}$  low intensity tail. The pulse rate is typically 200 Hz and pulse energy is on the order of 100 mJ which allows a standoff detection range on the order of 2.5 km. Importantly, laser wavelength can be rapidly shifted at a 200 Hz rate among about 60 lines within the 9-11  $\mu\text{m}$  band. This wavelength diversity is essential to biological and chemical agent detection/discrimination. For an LWIR point sensor, other transmitter types with wavelength diversity should be considered, including (but not limited to) the miniature CO<sub>2</sub> waveguide, the micro CO<sub>2</sub> TEA, the quantum cascade laser, and diode-pumped solid state crystal types with OPO (optic parametric oscillators). The concept of this topic is analogous to the previous extension of Laser Induced Fluorescence (LIF) from standoff to point configurations.

Point sensors for airborne bio agents have utilized various air flow mechanisms to capture samples and concentrate them for enhanced signal strength as in the case of vortex compactors. Point sensors based on LIF (laser induced fluorescence) use precision air metering systems to channel particles at the focus of a UV (ultraviolet) laser. Cavity ringdown spectroscopy (CRS) has been used for chemical detection based on the phenomenology of differential absorption. It may also be of interest to apply CRS to the case of differential scattering.

It would be of interest to extend the capability of the point sensor to include operation at very short standoff range for rapid scanning within and around relatively confined spaces such as rooms and between buildings and as a tool for developing a differential backscatter data base within the laboratory. It is also of interest to consider extension of the backscatter phenomenology to the 3-5  $\mu\text{m}$  band for detection of TICs (Toxic Industrial Chemicals).

Advanced algorithms have been applied to the case of bio detection by long wave IR (infrared) backscatter and to chemical detection by differential absorption. It is of interest to further integrate the algorithms with both detection phenomenologies and to develop a data base for algorithm quantification and validation.

PHASE I: Perform analysis and systems study to show feasibility of a 1-cubic-foot point sensor approach and develop a demonstration sensor conceptual design.

PHASE II: Develop a sensor detailed design. Fabricate and test the detection and discrimination capabilities of the point biological sensor, to include advanced algorithms. Investigate combined biological and chemical detection.

PHASE III DUAL-USE APPLICATIONS: In Phase III, a prototype point sensor system can be built for biological and chemical detection field trials. This would lead to a combined chemical and biological sensor suitable for deployment. Development of such a sensor would be of great benefit in homeland defense applications and for environmental pollution monitoring.

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KEYWORDS: chemical, biological, detection, sensors

CBD07-106      TITLE: Automated Objective Speech Intelligibility Assessment System

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: Program Manager for the Joint Service General Purpose Mask (JSGPM)

OBJECTIVE: To develop an automated speech recognition system to objectively assess speech intelligibility during respirator wear.

DESCRIPTION: Speech intelligibility is the main performance criterion used to assess the quality of speech sound transmission through a mask's speech transmission components. For decades, speech intelligibility during mask wear has been gauged by scores from the Modified Rhyme Test (MRT), which is a subjective test that evaluates a listener's ability to repeat single words spoken by a mask wearer. For example, the performance specification for the current Joint Service General Purpose Mask (JSGPM) sets an MRT score of greater than or equal to 85% accuracy as the acceptable performance for face-to-face communication. The drawbacks with relying solely on the MRT method for quantifying the worth of a mask's speech transmission components are many. First, administration of the MRT is logistically cumbersome, time consuming, and costly, mainly due to the extremely limited number of military and civilian personnel that have the time to volunteer for mask wear testing on a regular basis. Additionally, MRT test results can vary considerably based on both the language and hearing capabilities of the subject population. Again, limitations in test subject availability hinder the ability to adequately control for these factors or to permit a thorough evaluation of the effect of differing speech dialects and inflections, as well as hearing aptitude, on MRT results. In order to circumvent the inadequacies of the MRT and promote enhanced mask speech module design, an automated objective speech intelligibility assessment system needs to be developed. An objective measure would be able to identify both positive and negative design characteristics of individual mask components that impact transmission of speech sounds. The proposed system would greatly facilitate the development and rapid fielding of improved mask speech transmission and communication devices which would in turn lead to increased mission performance for military personnel operating in a chemical biological environment.

PHASE I: Create an automated speech recognition system that includes a pre-processor, recognition engine, and user interface including a "console" to permit detailed observation of the recognition process. The pre-processor should use standard voice representations plus additional signal derivatives such as sound quality metrics. The recognizer should be trained for perfect recognition of the words used in the MRT and the new military-specific Call Sign Acquisition Test (CAT). Recorded speech should be played from the mouth of a masked articulating speaker headform to ear microphones of a masked listener head and torso simulator. The recorded speech should be obtained from male and female native English speakers who do not have regional accents. The received sound signal should

be processed by the software and an intelligibility score provided. The console should identify phonemes unrecognized during respirator wear to aid in speech component modifications.

PHASE II: The results of the automated speech recognizer should be correlated with listening tests using human subjects and several mask/hood combinations. Refine and optimize the performance of the recognizer. Develop a beta prototype kit to include the talker/listener headform pair, trained recognizer libraries, software with an intuitive user interface, data acquisition front end, shipping case, first draft manual, and basic data analysis utilities. Provide one beta prototype kit for Government test and evaluation and a minimum of two kits to outside facilities for independent validation testing.

PHASE III DUAL-USE COMMERCIALIZATION: This phase includes further development of the objective speech intelligibility system for both military and commercial respirator communications testing. As core capabilities in mask communication component design, development, and testing will be enhanced, development of the proposed system will benefit all future respirator development programs by enabling pre-fabrication analysis of how the design of a mask interferes with face to face communications. The proposed system would also permit rapid evaluation of modified mask speech transmission components for fielded respirators. This automated system will have direct application to NIOSH communications certification testing for commercial CBRN air-purifying respirators.

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KEYWORDS: speech intelligibility, speech communications, speech recognition, mask communications

CBD07-107 TITLE: Enhanced Respirator Exhalation System

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: Program Manager for the Joint Service General Purpose Mask (JSGPM)

OBJECTIVE: To develop an enhanced exhalation system for military chemical, biological, radiological, nuclear (CBRN) respirators that is highly resistant to leakage.

DESCRIPTION: Military and commercial CBRN respirators (i.e., protective masks) use an outlet valve to remove humid, CO<sub>2</sub>-laden, exhaled air from the nosecup of the mask. The outlet valve also serves as a port to expel moisture and sweat that accumulates inside the mask. The outlet valve assembly consists of the following main components: a metal or plastic seat, a thin flexible synthetic rubber disc (outlet valve), and a protective cover. The outlet valve cover not only protects the valve from dust, dirt, wind, and physical damage but also prevents the backflow of outside contaminated air during inhalation by providing a "clean zone" (dead-space) for the filtered exhaled air. Outlet valves are also designed to provide low resistance to airflow (typically less than 20 mm H<sub>2</sub>O at 85 L/min) to reduce the physiological burden of breathing. An air-tight seal between the outlet valve and the seating surface is critical for the system to function properly. Even the best designs are susceptible to leakage from environmental and in-mask contaminants such as dirt, dust, and dried salts from sweat that can interfere with the seal. Novel technologies, materials, and designs are being sought that will minimize the likelihood of such failures. Concepts for improved respirator exhalation systems are envisioned that use self-cleaning technology, intelligent materials, or other means to clean, purge, and protect the valve from particulate and other foreign matter. The optimal system would have the following characteristics: light weight, low profile, increased durability, low breathing resistance, minimum maintenance, low manufacturing cost, and preferably non-powered. The system must be capable of meeting all interface, safety and support, durability, and operating environment requirements for military protective masks. This includes wear, carry, and long-term storage under adverse environmental conditions

associated with military operations. An enhanced exhalation system would decrease inward leakage and would thus provide the wearer with increased protection against CBRN agents and other hazardous contaminants.

PHASE I: Novel candidate technologies, materials, and designs to enhance the performance of the respirator exhalation system will be investigated. The research should focus on developing an advanced design concept(s) that will substantially reduce the risk of leakage from contaminated or “dirty” outlet valves and other exhalation system components. Concept models will be fabricated and evaluated for proof-of-principle.

PHASE II: Further develop, fabricate, and characterize the performance of prototype exhalation valve system(s). Appropriate parameters such as breathing resistance, leakage rate, effects of temperature and humidity extremes, self-cleaning capability (i.e., ability to prevent entrapment of dirt, dust and other physical contaminants), and other critical performance factors will be assessed. Based on the results of these evaluations, the optimum design will be determined. Fabricate a minimum of six (6) prototypes for follow-on demonstration testing to validate performance of the optimized exhalation valve prototypes. Two of the six prototypes shall be delivered to the Government for additional testing.

PHASE III DUAL-USE COMMERCIALIZATION: Phase III includes further development of the novel exhalation valve design for both military and commercial CBRN respirators. The improved exhalation system will directly benefit current and future developmental mask programs such as the Joint Service General Purpose Mask (XM50), the Joint Service Aircrew Mask, and Next Generation General Purpose Mask. The device demonstrated in Phase II will also have dual-use application for a variety of commercial respirators used in the workplace for protection against hazardous industrial airborne contaminants.

REFERENCES: 1. NIOSH APR CBRN Standard, “Statement of Standard for Chemical, Biological, Radiological, Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR).” Report prepared by National Institute for Occupational Safety and Health (NIOSH), Revision 2 (4 April 2003).

KEYWORDS: CBRN respirators, outlet valves, exhalation valves, protective masks

CBD07-108      TITLE: CB Sensor Array Algorithm to Improve Probability of Hazard Cloud Intercept

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop a software tool for soldiers in the field and sensor development researchers that is capable of optimizing the selection, placement, and analysis of data from a collection of point and standoff sensors when placed in a network for the defense of fixed facilities or mobile forces.. The system should utilize the known sensitivity, selectivity, vulnerability, and propensities for false alarm for each sensor available, as well as terrain, weather, and threat models, in order to configure the network for optimum performance. The tool should provide visualization capability to the end user of sensor placement as well as a confidence assessment of sensor network’s ability to respond accurately to threat events. The tool is meant to be 1) an end user application for force protection 2) a means to develop realistic requirements for sensors under development in the context of a networked system and 3) an approach to evaluate the utility of existing sensors in such networks.

DESCRIPTION: The DoD continues to make significant investments in the development and testing of point and standoff sensors for the detection of chemical, biological, nuclear, and radiological threats. Requirements for these sensors are often developed in the context of stand-alone use for specific deployments. Due to the many technical challenges in developing these sensors, many efforts to meet these requirements fall short in one or more areas, often under specific detection conditions or for given interferences. While use of small and low-cost sensors in networks has been explored extensively, much less attention has been devoted to the complementary deployment of existing point and standoff sensor systems in such a way that their vulnerabilities under certain environmental conditions are mitigated, sensitivity or selectivity is enhanced, and false alarm probabilities are reduced. Of particular interest are the use of complementary point sensors in large networks and the combined use of standoff sensors with sparse networks of rapidly deployed point sensors.

The US DoD would benefit from a systematic approach that would enable the capture of sensor technology advances that may not fully meet stand-alone detection requirements but might enable the achievement of force protection objectives when utilized with other sensors having orthogonal vulnerabilities with complementary cross sensitivities. It would also benefit from the ability to direct future sensor development activities towards gaps in the network capability without the need to impose the strict limits on false alarm rates commonly imposed on these sensors when used outside the network.

These sensors need to be positioned and allocated in the force protection areas of interest effectively. Innovative algorithms are required to ensure high probability of intercept and to reduce the probability of adversary evasion of the sensor array used for early warning.

PHASE I: This portion of the effort will consist of identifying the performance characteristics of several standoff and point sensor systems currently deployed or near deployment and developing a general methodology for their complementary use under a single threat environment. The system must identify improvements in force protection achieved by this configuration as well as sensor characteristics that would further improve the marginal performance of the network.

Formulate advanced probability methods to model distribution and allocation of chemical and biological sensors, the hazard cloud intercept, and reduce array of evasion. Formulate software architecture for intercept probability and sensor allocation.

PHASE II: Using the results from Phase I, the effort will be to build a robust system capable of analyzing a range of deployment environments and threat scenarios.

Refine the intercept and allocation algorithms. Using the advanced algorithms, develop the software application for representative detector arrays in representative force protection areas of interest. Upon completion of a two year development effort, demonstrate the application for a distinct chemical tract and a distinct biological tract.

PHASE III Dual Use Commercialization: The resultant technology is applicable to Homeland Defense, Environmental Protection, Forest Fire Fighting, and hazardous material applications. This technology will be extremely useful throughout the chemical and biological production industry and technology industries to provide alert, warning, and characterization of hazard clouds. The sensor array application will serve to protect national and private woodlands, safeguarding forestry resources by rapid detection of the smoke plume associated with forest fires. The resultant technologies will be useful across a broad spectrum of local, state, and federal agencies to numerous industries.

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**KEYWORDS:** Sensor, standoff, point, network, complementary, mitigation, protection, Chemical Detection, Standoff Detection, Passive Detection, Long-wave infrared, infrared signatures, CB Sensor positioning, Chemical Sensor positioning, Biological sensor positioning, chemical sensor allocation, biological sensor allocation, CB Detector Array, CB Sensor Array, Sensor Network, Sensor Data Fusion, Cloud Characterization

CBD07-109      **TITLE:** Source Term Model for Fine Particles off Indoor Surfaces

**TECHNOLOGY AREAS:** Chemical/Bio Defense

**OBJECTIVE:** This topic will develop mathematical modeling of release mechanisms of fine particles from indoor surfaces under typical building heating, ventilating and air conditioning (HVAC) operation. The project will investigate resuspension mechanisms of fine particles from indoor surface, identify physical and transport properties governing the rate of resuspension, and formulate the resuspension flux as a functional of the identified parameters and a system of transport equations. The results will be used as source boundary condition for computational fluid dynamics (CFD) simulation of particle transport and dispersion (T&D) inside a building as a part of CB defense. The results will also be useful for study of indoor air quality to improve building HVAC performance.

**DESCRIPTION:** This project will provide critical boundary conditions for accurate simulation of particle transport and dispersion inside a building. The release rate, i.e. source term model, is identified to be one of the two key technical elements for current and future interior and exterior CFD codes [1]. The resuspension rate of pollutants in the outdoor environment has been extensively studied and experimentally validated for simulation of outdoor transport and dispersion [2]. Need and interest in the resuspension model for indoor environment, however, has arisen since 2001. Current model assumes qualitative approximation (e.g., steady flux of predetermined concentration) for the source term boundary condition in the CFD simulation of internal dispersion. Impact of source model on the simulation accuracy of internal dispersion has been well demonstrated in the previous study [3]. This project is to develop a realistic model for source flux under typical building HVAC environment.

**PHASE I:** Investigate the responsible mechanism for fine particles from indoor surfaces. Development of theoretical model for the indoor resuspension of fine particles is the goal of Phase I research. Innovative and creative approach to the model development is encouraged. Demonstration of the theoretical model against experimental data in the published domain will conclude the Phase 1.

**PHASE II:** Innovative and creative experiments are expected to verify the theoretical model. The experiments are expected on a number of different types of surfaces and different sizes of particles. Validation of the model will be accomplished by integration of the source term model into an internal T&D CFD code. Demonstration of the improvement in accuracy of internal T&D simulation concludes the Phase 2.

**PHASE III:** Integration of the source term model to general T&D CFD codes will be the focus of Phase III activity. Examples for commercial applications include incorporation of the resuspension model to indoor air quality simulation (e.g., CONTAM and/or COMIS) and building energy simulation tools (e.g., Airpak, EnegyPlus). Military application includes incorporation of the model into Joint Effects Module (JEM) codes and Hazard Prediction and Assessment Capability (HPAC). Due to the sensitivity of information, the source term integration into military CFD codes will be strictly coordinated with the appropriate authorities.

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KEYWORDS: Indoor source term, internal transmission and dispersion, CB modeling

CBD07-110 TITLE: Self Sanitizing Thin Films Using Discrete Toxicant/Germinant Surface Features

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: There is a need to investigate reactive self-decontaminating surfaces and surface treatments with the maximum potential to kill biological organisms in order to minimize hazard to human health. Self sanitizing surfaces have relevant applications to both porous and non-porous surfaces including bandages, clothing, CB-Agent resistant coatings for vehicles, equipment, and structures. The biological effects of combining a discrete germinant / toxicant array on a thin film surface have only been initially investigated.

DESCRIPTION: One approach to creating such a property is to modify the chemistry of the free surface to include small length scale germinant and toxicant features which come into contact with a target organism at the same time. The goal is to force the organism into a more vulnerable mode (i.e., change of metabolic state from endospore to vegetative). This change in metabolism changes the behavior of the cell wall, making it more susceptible to uptake of toxicant agents, thus increasing the chances of killing the agent.

It is very important for a successful proposal to demonstrate PI qualifications in both surface physics and microbiology. This is a highly interdisciplinary topic area and diverse teams are encouraged to apply.

PHASE I: There are a great many potential materials and feature length scales and geometries that could be used for such an approach. In Phase I the contractor should test a number of surfaces looking at the effects of geometry, spacing, and different concentrations and types of toxicants and germinants in order to gain a better understanding of the underlying mechanisms. The surfaces should be tested against live agent simulants.

PHASE II: The best performing sample surfaces should be selected for a larger scale performance trial. The physical and chemical interaction between biological agents and the surface should be observed and characterized in order to tailor the surface to optimize the effective log kill while maintaining mechanical durability. The surfaces have the potential to be used in combat, and therefore must be sufficiently robust to maintain effectiveness under harsh conditions (abrasion, etc.). Civilian commercial sector applications may not require this additional hardening constraint, but it is a genuine requirement for a truly successful Phase II project.

PHASE III DUAL USE COMMERCIALIZATION: Self sanitizing surfaces have potential industrial and architectural applications including heating and ventilation duct linings, furniture, kitchen surfaces, medical equipment, operating room floors and walls, and many others. Military applications include forward facilities, CONUS facilities, vehicles, equipment which may be exposed to biological agents or simply need to be kept free of biological agents.

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KEYWORDS: self-sanitizing, thin film, discrete component, surface physics, bio agent

CBD07-111 TITLE: Nanotechnology Supported Aerosolized Collection Methods for Chem-Bio Threats

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The objective is to design and build a portable aerosol sampler that can collect and archive encounters with chemical and biological threat agents. Remote and distributed placement of these samplers of contaminants is ultimately desired.

DESCRIPTION: There is a need for the development of short response time ( $\sim <5$  seconds) for innovative nano-fiber collection technologies that serve to maintain biological sample integrity/ viability and be flexible for bacteria, viruses and toxins. The development and application of such a new type technology is encouraged to include the use of novel nanotechnology based aerosol collection and have the potential for dual use applications. Aerosol particles should be captured on an electrospun nanofilter strip or material that could be either stored on the filter or released into a small volume of water for further biochemical or microbiological analysis. Potential components of the technology involve use of a nano-filter, created from the soft ionization spinning techniques of nanofibers. The potential aerosol collector will consume less energy, concentrate samples, and provide higher viability and structural integrity of collected bacteria, viruses, and toxins. Finally, the sample collector should be field portable and adhere to the performance specifications needed to meet soldier deployable collection systems. Any system developed must address the flow rate thru the system, concentration and capacity of the filter. In addition, the system should be durable to environmental elements, such as extreme temperatures, salinity fluctuations, and pH variations, and as light weight as possible for soldier's to carry, use, and place throughout the battlefield environment.

PHASE I: Complete a conceptual design and demonstrate feasibility of a nanotechnology-based aerosol sampler and has a collection and an archiving capability. The concept design should include: the ability to maintain biological sample integrity/ viability for bacteria, viruses and toxins. As part of the feasibility demonstration, it would be desirable to include tests of the aerosol sampler and its archiving capability.

PHASE II: Develop and demonstrate a prototype system. Test under a range of controlled material/threat agent concentrations released in the air under various environmental conditions. Apply different analytical procedures for "harvesting" the target stimulant to threat agent. Time, date, and potentially global position (GPS) stamping should provide the needed information for monitoring the archiving capability and dispersal rates.

PHASE III DUAL USE COMMERCIALIZATION: Such a device has broad use applications from monitoring environmental air quality for soldier health that would expand to industrial hygiene applications. Additionally, drones may be adapted to distribute and remotely monitor the samplers.

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KEYWORDS: Aerosol, nano-filter strips, threat agents

CBD07-112      TITLE: Real-Time Respiratory Measurement for High Containment Aerosol Exposures

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop a technology and method for real-time measurement of nonhuman primate respiratory tidal volume that is suitable for use in a Class 3 biological safety cabinet. The end product must withstand decontamination with formaldehyde and hydrogen peroxide gases, be operable within a sealed safety cabinet, and provide real-time, streaming tidal volume measurements accessible by a computer located outside of the sealed safety cabinet.

DESCRIPTION: Aerosol exposures of nonhuman primates are routinely conducted in biodefense research studies to evaluate the efficacy of medical countermeasures developed to protect against the threat of biowarfare agents. Because these studies are conducted with high consequence pathogens, all aerosol exposures are conducted in Class 3 biological safety cabinets. Continuous measurement of the respiratory tidal volume of the animal is needed in order to accurately control and measure the desired challenge dose. A real-time tidal volume measure will allow challenges for individual animals to be shortened or extended based on individual respiratory performance and the required challenge dose. While technologies currently exist for measuring respiratory parameters of nonhuman primates, none is suitable for use in the closed environment of a biological safety cabinet, rugged enough to withstand repeated decontamination procedures, and dynamic enough to allow for real-time incorporation of respiratory measurements into the aerosol control process. A respiratory measurement technology and method meeting these requirements will enable more accurate aerosol challenge studies to be conducted, speed development of medical countermeasures, and reduce the costs of countermeasure development.

PHASE I: Develop system design and concept for real-time tidal volume output, suitability for formaldehyde gas and hydrogen peroxide decontamination, and feasibility in Class-3 biological safety cabinet.

PHASE II: Develop and assemble prototype. Demonstrate prototype functionality in a closed chamber or biological safety cabinet. Displaying real-time tidal volume values on a standard computer station while measurements are being taken. Repeat demonstration and measurement after decontamination with formaldehyde and hydrogen peroxide gases.

PHASE III: A system meeting these requirements could be used in a range of applications in both biodefense research and commercial preclinical research and development. Inhalation exposure systems are commonly used in pharmaceutical and toxicological research applications. A robust real-time respiratory measurement system suitable for use in the environment described would have translational applications in each of these fields.

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KEYWORDS: respiratory dosimetry, aerosol challenge, nonhuman primate

CBD07-113      TITLE: Development of novel therapeutic approaches for exposure to chemical agents

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop novel approaches to counteract the effects of exposure to chemical warfare agents taking full advantage of advancements medical technology. The primary purpose of the work will be to apply innovative techniques in the development of medical countermeasures against chemical warfare agents.

DESCRIPTION: Recent advancements in medical technology including, but not limited to, molecular modeling, drug design technology, molecular and recombinant technology suggest that novel approaches and opportunities exist in developing medical countermeasures to combat the effects of chemical warfare agents. Our warfighters are routinely called upon to conduct operations on a world-wide front with little prior warning or preparation. In these cases prophylaxis may not be possible or desirable. Also, development of multiple prophylactic materials may in itself result in problems in half-life, efficacy or toxicity when administered in combination within a short time frame. What is needed is fast acting, self or automated administration of therapeutic agents that prevent the soldier from becoming a casualty but only dose when there has been an exposure limiting the pharmaceutical burden on the unexposed soldier.

PHASE I: Develop a concept or approach to one or more chemical agents and defend the hypothesis that this approach will work in vivo with no untoward events. Contractors will use their innovation and creativity to develop a detailed plan which articulates an effective strategy to formulate a therapeutic against one or more conventional chemical warfare agents (acetylcholinesterase inhibitor, vesicant, cyanide, pulmonary edemigenic) The plan must clearly describe why this approach is considered novel and yet has a potential for success. Feasibility, applicability, logical approach and cost are some of the key parameters that must be addressed in the detailed plan. Use of human cells and tissues and/or animals requires approval by the appropriate US Army Medical Research and Materiel Command regulatory office. Phase I should include approval of appropriate regulatory documents (human or animal use) necessary to execute Phase II.

PHASE II: An approach will be developed that can demonstrate safety and efficacy of a medical countermeasure to one or more chemical warfare agent. Demonstrate efficacy in vitro and ex-vivo, if feasible. Computer modeling or other simulation approaches should be utilized as much as possible to minimize use of animals, time, cost and effort and expedite the program. Preliminary studies in animals is desirable. Evaluation of the approach for efficacy will be performed by USAMRICD.

PHASE III: Dual use demonstrated in first responders, emergency room personnel, as well as the military. This technology has dual use applications and thus could be used in a broad range of military and civilian settings. For example, this approach could be adopted by civilian medical treatment systems as a means of responding to a terrorist use of a chemical warfare agent.

REFERENCES: 1. Textbook of Military Medicine, Part I Warfare, Weaponry and the Casualty, Medical Aspects of Chemical and Biological Warfare, Office of the Surgeon General, Borden Institute, Walter Reed Army Medical Center, 1989

2. Briefing by the Deputy Assistant to the Secretary of Defense for Chemical and Biological Defense at the National Defense University, Ft. McNair, VA, 2004.

KEYWORDS: chemical warfare, medical countermeasures, molecular modeling, drug design, WMD, therapeutics

CBD07-114      TITLE: Development of an Integrated Database Management System for Biodefense Research

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To develop data management and bioinformatics computational analysis tools that support the design of assays for detection and identification of human exposure to biological threats. More specifically, we are interested in the development of integrated database management systems (DBMS) to warehouse, manage, query, visualize, and analyze data from DNA microarrays, protein arrays, real-time Polymerase Chain Reaction (PCR), and immunoassay results from both host expression response and agent detection studies. The DBMS should also possess mechanisms to track the sequential steps and associated data generated in support of the design of multiple diagnostic assay platforms. The final product is anticipated to have a database management software architecture that is versatile and flexible, and can be easily modified to accommodate new project demands including organization, querability, and presentation of new data types. Solutions that are compatible with ORACLE collaborative suite are preferred.

**DESCRIPTION:** The U.S. Army Medical Research and Materiel Command is employing different genomics- and proteomics-based technologies to design assays for the detection and diagnosis of human exposure to biological threats. To support the development of these assays, we are looking for bioinformatics DBMS that will:

(1) Manage a variety of diverse data types derived from assay results, including results from DNA arrays, protein arrays, real-time PCR, immunological assays (including electro chemo luminescence (ECL) and traditional assays, such as ELISA and Western Blot), and future technologies.

(2) Manage a variety of data types used to guide the development of assays. For example, data pertinent to the identification of useful pan-specific and agent-specific DNA sequences, and reagent data, such as probe sequences for DNA arrays and real-time PCR, monoclonal antibodies, and all the reagents used in a given assay to include lot numbers and other important information.

The DBMS should allow us to filter the data in a multitude of ways for a number of parameters, such as sequence data, probe data, antibody identifier, ligand identifier, sample identifier, and identity and lot number of all reagents used for a particular assay. In addition, the system should allow for queries of a given pathogen within an assay platform as well as across different studies and assay platforms. Furthermore, the system should be integrated with statistical/mining tools for analysis of intra- and inter-assay data, with the results outputted in a format that can be easily imported into reports and publications.

**PHASE I:** Conceptualize and develop a preliminary integrated DBMS prototype to warehouse, manage, query, visualize, and analyze data from DNA microarrays, protein arrays, real-time PCR, and immunoassay results from both host expression response and agent detection studies. The prototype should also illustrate mechanisms to track the sequence of steps taken and associated generated data to support the design of multiple diagnostic assay platforms.

**PHASE II:** Develop a functional prototype software system fully demonstrating the concepts developed during the Phase I effort.

**PHASE III DUAL USE APPLICATIONS:** This set of computational tools will have both military and civilian applications, as the general public defense against chemical and biological warfare agents is now an integral component of homeland defense. There is now significant overlap between the Department of Defense and the National Institutes of Health, National Institute of Allergies and Infections Diseases research and development programs in the detection, characterization, and diagnosis of biological threats.

**REFERENCES:** 1. DaSilva L, Cote D, Roy C, Martinez M, Duniho S, Pitt MLM, Downey T, Dertzbaugh M. Pulmonary Gene Expression Profiling of Inhaled Ricin. *Toxicol* 2003; 41(7):813-822.

2. Hammamieh R, Mani S, Das R, Neil R, and Jett M: Establishment of bioinformatic analysis and data mining tools for correlating gene discovery and proteomics applications. Proc. 23rd Army Science Conference, Orlando, FL, 2-5 Dec 2002.

3. Draghici S, Chen D, and Reifman J: Review and challenges of DNA microarray technology in military medical research. *Military Medicine* (in press, June 2004).

4. Pleifòner KP et al.: Web-accessible proteome databases for microbial research. *Proteomics* 2004; 4:1305-1313.

**KEYWORDS:** pathogen database, genomics, proteomics, biological threats, warfare agents, bioinformatics, systems biology

CBD07-115      **TITLE:** Personal Air Ventilation System (PAVS)

**TECHNOLOGY AREAS:** Chemical/Bio Defense

**OBJECTIVE:** Design a Personal Air Ventilation System (PAVS) that can be integrated with Chemical/Biological (CB) protective clothing, providing a ventilation/cooling capability.

**DESCRIPTION:** Individuals operating in hot environments can be exposed to high heat stress conditions. As a result, their health may be compromised and operational performance can become severely impaired, even at low activity levels. In 2005, the Department of the Army, Office of the Surgeon General, reported that over 1700 heat injuries occurred in the Army, including 258 cases of heat stroke and 1467 cases of heat exhaustion. The use of Chemical/Biological (CB) protective clothing can further exacerbate a Soldier's heat stress, significantly diminishing the ability of the body to reject metabolic heat to the ambient environment. As a result, body heat is stored, core temperature rises and operational performance can become severely impaired.

The use of auxiliary Microclimate Cooling Systems (MCS) has been shown to mitigate these affects. For Soldiers wearing CB protective clothing, physiological studies have documented mission duration enhancements of greater than 300% for Soldiers using MCS. In recent years, MCS have been successfully developed and fielded for use on military platforms, including Army rotary wing aircraft and armored tactical vehicles. However, there is also a need to mitigate Soldier heat stress while dismounted. While significant progress has been made in the development of personal cooling systems over the past several years, the current state-of-the-art systems are too large, too heavy and consume a significant amount of electrical power, precluding their use for many users during dismounted operations.

Active ventilation systems have been shown to mitigate Soldier heat stress at potentially acceptable size, weight and power consumption levels. A ventilation system primarily uses ambient air to enhance sweat evaporation; thus, its heat removal capability is directly dependent on the temperature and moisture content of the air. While these systems tend to provide less cooling than conditioned air or chilled liquid based systems, the benefit is their reduced size, weight and power consumption. Therefore, the intent of a Personal Air Ventilation System (PAVS) is to be used in moderate environments where an actual cooling system may not be warranted, and/or in more extreme environments where Soldiers do not want to be burdened by the size, weight, and power penalties of an active cooling system.

The primary focus of the research should be on the design and development of the motor/blower to meet the flow characteristics, power constraints, and size/weight requirements as specified below. Research should concentrate on novel approaches to achieve the design flow rate while overcoming the pressure drop of the uniform and the back pressure of the filtration device. However, the topic may support some efforts to develop an innovative power source (e.g. custom battery) and/or filtration module.

Following are the minimum performance criteria for the development of a PAVS:

- Provide a minimum flow rate of 10 cubic feet per minute (cfm) of air through two (2) C2A1 filters (NSN 4240-01-119-2315), or a filtration module (providing equivalent CB percutaneous protection), and the uniform. Assume that the uniform layers provide 2 inches of water backpressure at 10 cfm.
- Interface with two (2) C2A1 filters or a filtration module
- Power consumption not to exceed 15 watts at the design flow rate of 10 cfm.
- Maximum of 2 pounds, excluding C2A1 filters or filtration module. Weight includes the motor/blower, power source, and requisite packaging. Weight of a filtration module, if applicable, should not exceed 1.2 pounds.
- Maximum size (i.e. volume) should not exceed 60 in<sup>3</sup>, excluding C2A1 filters, or filtration module. Volume includes blower/motor and integral power source housing. The depth dimension of the PAVS should not exceed two inches. Volume of the filtration module, if applicable, should not exceed 58 in<sup>3</sup>.
- Minimum of 4 hours run time before the power source needs to be recharged/replaced; eight hours desired.

**PHASE I:** Research, develop and propose a system design with the potential of realizing the goals in the description above. Identify components (e.g. market survey) and/or develop technical specifications for components that, when integrated, will meet the performance goals. Conduct necessary investigation on the design and performance of the components to demonstrate the feasibility and practicality of the proposed system design for maximum efficiency, including mitigation of risks associated with factors limiting system performance. Deliver monthly progress reports as well as a final report documenting the research and development efforts, identifying any technical challenges that may cause a performance parameter(s) not to be met. Also include a detailed description of the proposed system to include specifications and drawings of the components and integrated system.

PHASE II: Develop the system designed in Phase I. Fabricate and demonstrate three prototype systems. The delivered prototypes must be a Technology Readiness Level (TRL) of 5, and be capable of being used and operated in a relevant environment. The system performance goals stated in the description above must be verified. Deliver monthly progress reports and a final report documenting the design specifications, performance characterization and any recommendations for system performance.

PHASE III DUAL-USE APPLICATIONS: A PAVS meeting the performance requirements outlined in this effort would be applicable to military, industrial, and recreational user groups. DoD personnel who train and/or operate in environments requiring the use of chemical/biological protective clothing and/or body armor would realize heat relief benefits. First Responders, would also be able to extend their mission durations in heat stress environments if a ventilation system was provided with their protective ensembles. Factory workers or laborers in facilities where environmental air conditioning is not provided would derive some thermal comfort from an autonomous ambient air ventilation system.

REFERENCES: 1. Microclimate Cooling Options for the Individual Soldier, Technical Report, June 1983

2.

<http://www.dtic.mil/dodsrch/docView?c=5523EBCD2CDE5FFD&dk=http%3A%2F%2Fstinet.dtic.mil%2Fstinet%2FXSLTServlet%3Fad%3DADA259410&t=y>

KEYWORDS: Body Ventilation, Personal Cooling, Ventilation, Blowers, Soldier Cooling

CBD07-116      TITLE: High Efficiency CBR Sensor Inlet

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop an omnidirectional (i.e., 360o in the plane of flow field lines) chemical, biological, and radiological (CBR) sampling inlet that requires low power and samples effectively and efficiently in medium to high wind conditions by reducing unwanted particle impaction both on the exterior and interior walls and achieves (or closely approximates) isokinetic sampling.

DESCRIPTION: Novel inlet designs are required for improved CBR sampling of the ambient atmosphere; particularly in moderate to high wind conditions. Present inlet designs for the Naval dry filter unit (DFU) have been found to exhibit excessive power requirements, system failure, and serious degradation in sampling efficiency with increasing wind speeds. Requirements exist to reduce power expenditure associated with internal fans and to reduce sampling bias in particulate sizes due to particulate impaction on the outer and inner surfaces of the inlet. Consequently, an inlet is needed that is capable of sampling the air in moderate to high wind speeds in such a way that high powered fans are not required. It is also highly desired that the inlet interfere as little as possible with the surrounding flow field in order to sample at the same velocity as the environment; i.e., isokinetic sampling.

PHASE I: Design concept(s) for novel inlet design(s) for CBR sampling in all wind conditions that reduces energy requirements by diminishing the need for high powered fans and reduces or eliminates particulate impaction and deposition on the inlet surfaces. Phase I deliverables must include computer simulations of inlet performance under varying wind states and multi-species particulate dynamics at the proof-of-concept level.

PHASE II: Perform optimization studies and/or alternative designs based upon the proof-of-concept inlet(s) proposed in the Phase I effort. Establish superiority of new design over present inlets in terms of reduced power requirements, reduced particulate impaction upon surfaces and enhanced control over particulate size selectivity; isokinetic sampling should also be approximated if not achieved.

PHASE III: The final inlet design is expected to transition to full scale engineering development as a subsystem of the DFU and air intake ports on naval vessels. Other DoD applications yet to be specifically identified, may include Air Force, Army and Marine CBR sensors.

PRIVATE SECTOR COMMERCIAL POTENTIAL/DUAL-USE APPLICATIONS: This inlet design will be applicable to sensor inlets wherever environmental sampling in mid to high flow speeds is required. Examples include, but are not limited to, the following: off-shore oil platforms, commercial sea, air and ground vehicles, interior pipe and duct flow, industrial hygiene monitoring, etc.

REFERENCES: 1. Benjamin Y. H. Liu, David Y. H. Pui, Aerosol Sampling and Inhalable Particles, Atmospheric Environment, Vol. 15, 589-600

KEYWORDS: sensors, inlets, sampling, monitoring, environment