Chemical and Biological Division

Angela M. Ervin, Ph.D.
Program Manager
Chem Bio R&D Branch
Science and Technology Directorate
Department of Homeland Security

“Putting First Responders First”
Outline

• DHS S&T CBD Mission and Requirements
• Chemical Thrust Programs
• Current Projects
• Past Successes
• Future Project
• SBIR Projects
• Summary
Chemical and Biological Division Overview

**Mission:** To increase the Nation’s preparedness against chemical and biological threats through improved threat awareness, advanced surveillance and detection, and protective countermeasures.

**Key 5 year deliverables:**
- Integrated CBRN risk assessments
- Anticipation of future & unconventional threats
- Chemical infrastructure risk assessment
- Fully automated Gen 3 BioWatch
- Integrated CBRN facility protection
- National lead for operational biological and chemical forensics
- Decision tools and veterinary countermeasures for Foreign Animal Diseases (FADs)

**IPT Co-Chairs:** OHA, IP
**DHS Drivers:** OHA, IP, I&A, CBP, NPPD, PLCY, DNDO, Interagency Gaps
**End-Users:** HSC, HHS, FBI, USDA, IC, EPA, local public health, critical facilities

Current BioWatch collects air samples & analyzes them in LRN lab
Where do our requirements come from?

Directly from a Capstone Integrated Product Team (IPT)
- Co-chaired by DHS Office of Health Affairs (OHA) and DHS Infrastructure Protection (IP)
- Membership from other DHS operational arms
- Identified 50+ Capability Gaps for 2007

And they in-turn, base their requirements on
- Homeland Security Presidential Directives – 10, 7, 9, 18
- Congressional legislation & guidance
- National planning & implementation guidance – NIPP, NRP, NIMS, and the National Planning Scenarios
- Risk, vulnerability and mitigation studies
- Private, local, state inputs
# CB Division Chemical Thrust

<table>
<thead>
<tr>
<th>THRUST</th>
<th>PROGRAM</th>
<th>PROJECT</th>
<th>Program Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>Analysis</td>
<td>Chemical Threat Analysis and Assessment</td>
<td>Famini</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemical Infrastructure Risk Assessment</td>
<td>Famini</td>
</tr>
<tr>
<td>Detection</td>
<td></td>
<td>Autonomous Rapid Facility Chemical Agent Monitor (ARFCAM)</td>
<td>Ervin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lightweight Autonomous Chemical Identification System (LACIS)</td>
<td>Ervin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surface Detector for Analytes with Low Volatility (LVPCDS)</td>
<td>Bansleben</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Chemical, Biological, Nuclear, Radiological, Explosive System Demo</td>
<td>Lustig</td>
</tr>
</tbody>
</table>

E-mail: First Name.Last Name@dhs.gov
## CB Division Chem Thrust (cont)

<table>
<thead>
<tr>
<th>THRUST</th>
<th>PROGRAM</th>
<th>PROJECT</th>
<th>Program Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>Response and Recovery</td>
<td>Decontamination R&amp;D</td>
<td>Bansleben</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facility Restoration Demonstration</td>
<td>Bansleben</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fixed Laboratory Response Capability</td>
<td>Bansleben</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Portable High Throughput Integrated Laboratory Identification System (PHILIS)</td>
<td>Bansleben</td>
</tr>
</tbody>
</table>

E-mail: First Name.Last Name@dhs.gov
Mission: To provide analysis and scientific assessment of the chemical threat against the American homeland and American public.

Objectives:
- Chemical threat awareness, assessment and analysis
- Integration and analysis of chemical threat information and data
- Reachback capability to provide expert analysis support
- Science-based risk assessment

Payoffs:
- Centralized repository of chemical threat data
- Comprehensive S&T based assessments of chemical threat materials
- Centralized reachback capability for chemical threat information
- A prioritized assessment of chemical threats to provide guidance to Interagency activities

Program Manager: George Famini
Autonomous Rapid Facility Chemical Agent Monitor (ARFCAM)

**Objective:** Develop, demonstrate, and commercialize a networked capability to continuously (24/7/365) and autonomously detect and identify, presence of a broad range of toxic chemical hazards for facility protection.

**Challenges:**
- *Selectivity for* target agents and against common backgrounds
- *Wide dynamic range:* IDLH to PEL
- *Speed:* target <1 min (IDLH)/15 min (PEL)
- *System cost:* $1,000/10k units

**Schedule:**
- FY04: Initiated program
- FY05: Down-select for lab prototype
- FY07: Down-select for “field” prototype
- FY08: Complete “field” prototypes
- FY09: Complete field testing, IT&E
- FY10: Down-select for “operational” prototype
- FY11: Complete OT&E, transition

Program Manager: Angela Ervin
Lightweight Autonomous Chemical Identification System (LACIS)

**Objective:** Develop, demonstrate, and commercialize a networked responder capability to detect and identify a broad range of toxic chemical hazards to assess a scene for contamination and provide guidance on PPE use.

**Challenges:**
- Selectivity for target agents and against common backgrounds
- Wide dynamic range: IDLH to LOD
- Speed: ≤ 10 min warm-up
  ≤ 2 min response (IDLH & LOD)
- System cost: $2,000/10k units

**Schedule:**
- FY04: Initiated program
- FY05: Down-select for lab prototype
- FY07: Down-select for “field” prototype
- FY08: Complete “field” prototypes
- FY09: Complete field testing, IT&E
- FY10: Down-select for “operational” prototype
- FY11: Complete OT&E, transition

Program Manager: Angela Ervin
# TIC List for Prototype Testing

<table>
<thead>
<tr>
<th>TIC</th>
<th>CAS No.</th>
<th>IDLH (mg/m³)*</th>
<th>PEL (mg/m³)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen cyanide (AC)</td>
<td>74-90-8</td>
<td>55.27</td>
<td>11.05</td>
</tr>
<tr>
<td>Cyanogen chloride (CK)***</td>
<td>506-77-4</td>
<td>50</td>
<td>0.6</td>
</tr>
<tr>
<td>Chlorine (gas)</td>
<td>7782-50-5</td>
<td>29</td>
<td>2.9</td>
</tr>
<tr>
<td>Ammonia</td>
<td>7664-41-7</td>
<td>208.96</td>
<td>34.83</td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>75-21-8</td>
<td>1441.41</td>
<td>1.8</td>
</tr>
<tr>
<td>Arsine</td>
<td>7784-42-1</td>
<td>9.56</td>
<td>0.2</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>50-00-0</td>
<td>24.56</td>
<td>0.92</td>
</tr>
<tr>
<td>Acrolein</td>
<td>107-02-8</td>
<td>4.59</td>
<td>0.23</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>107-13-1</td>
<td>184.47</td>
<td>4.34</td>
</tr>
<tr>
<td>Phosgene</td>
<td>75-44-5</td>
<td>8.09</td>
<td>0.4</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>7446-09-5</td>
<td>262</td>
<td>13</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>7664-93-9</td>
<td>74.5</td>
<td>7</td>
</tr>
</tbody>
</table>

Documentation for Concentrations:
* NIOSH Chemical Listing and Documentation of Revised IDLH Values
** NIOSH Pocket Guide to Chemical Hazards
*** Extrapolated and estimated from AC data

Program Manager: Angela Ervin
CWAs and Interferents for Prototype Testing

<table>
<thead>
<tr>
<th>CWA</th>
<th>CAS No.</th>
<th>IDLH (mg/m²)</th>
<th>PEL (mg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarin (GB)</td>
<td>107-44-8</td>
<td>0.1</td>
<td>3x10⁻⁵</td>
</tr>
<tr>
<td>Tabun (GA)</td>
<td>77-81-6</td>
<td>0.1</td>
<td>3x10⁻⁵</td>
</tr>
<tr>
<td>Nerve Agent (VX)</td>
<td>50782-69-9</td>
<td>0.003</td>
<td>1x10⁻⁶</td>
</tr>
<tr>
<td>Sulfur Mustard (HD)</td>
<td>505-60-2</td>
<td>0.7</td>
<td>0.0004</td>
</tr>
<tr>
<td>Lewisite (L)</td>
<td>541-25-3</td>
<td>0.23*</td>
<td>0.003</td>
</tr>
</tbody>
</table>

* AEGL 2 value at 30 min., [www.epa.gov/oppt/aegl/chemlist.htm](http://www.epa.gov/oppt/aegl/chemlist.htm)

ARFCAM Phase II Interferents

<table>
<thead>
<tr>
<th>Interferent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zep Perimeter Floor Stripper</td>
</tr>
<tr>
<td>Windex</td>
</tr>
<tr>
<td>Clorox Bleach</td>
</tr>
<tr>
<td>Diesel Exhaust</td>
</tr>
<tr>
<td>Paint Fumes (Glidden America's Finest Interior Latex Flat Wall Paint - HM1224 White)</td>
</tr>
</tbody>
</table>

LACIS Phase II Interferents

<table>
<thead>
<tr>
<th>Interferent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Exhaust</td>
</tr>
<tr>
<td>Second Hand Smoke</td>
</tr>
<tr>
<td>Aqueous Film-Forming Foam (AFFF)</td>
</tr>
<tr>
<td>Gasoline (87 octane) exhaust</td>
</tr>
</tbody>
</table>

Program Manager: Angela Ervin
# Current ARFCAM and LACIS Technologies

## ARFCAM

<table>
<thead>
<tr>
<th>ARFCAM</th>
<th>IMS</th>
<th>DMS</th>
<th>GC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruker Daltonics</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smiths – Watford</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hamilton Sundstrand</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

## LACIS

<table>
<thead>
<tr>
<th>LACIS</th>
<th>IMS</th>
<th>Chemi-resistors</th>
<th>Metal Oxides</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRD Corp</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Smiths – Edgewood</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purdue University</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

IMS = Ion Mobility Spectrometry  
DMS = Differential Mobility Spectrometry  
GC = Gas Chromatography  
MS = Mass Spectrometry
Low Vapor Pressure Chemical Detection Systems (LVPCDS) Project

LISA Manportable – ITT Industries (Laser Interrogation of Surface Agents)

Program goal: Develop, field-test, and transition to commercialization existing state-of-the-art and next-generation systems that can detect toxic, low vapor pressure chemicals without contacting the contaminated surface.

Begin Phase II, development of a Fieldable Prototype - January 2008
LVPCDS Objectives and Payoffs

Capabilities
• Rapidly detect and identify persistent chemical compounds (vapor pressures $\leq 10^{-4}$ Torr) on a variety of surfaces
  • Include WMD and CBRNE threats
• Nominal stand-off working distance 3 meters from source without contacting the contaminated surface
  • Uses UV-Raman backscatter
• Manportable (<20 kg) detection system
• Few to no consumables – Battery operation for 1 hr (rechargable)

Payoffs
• Fill an existing gap in chemical countermeasures detection capabilities for emerging threat agents

Program Manager: Don Bansleben
Integrated CBRN(E) Detection System

Background

- Seven US Senators letter to the Department of Homeland Security (DHS) “encouraging DHS to quickly move forward in developing and deploying a city-wide Weapons of Mass Destruction detection, alert, and emergency communications system,” and stating that there is a “critical need to deploy tested and reliable integrated sensor networks linked to high-volume alert systems.”

- House and Senate legislation has tasked DHS’ Science and Technology (S&T) Directorate to investigate the feasibility of integrating CBRNE countermeasure detection devices and systems to counteract all CBRNE threats within focused regional areas.

- Appropriations language required DHS D&T to integrate its maturing systems with other tools and to work with other departments that may have existing systems or relatively mature prototype systems.
CBRN(E) Data/Information Flow

Detectors

Data Sharing Agency(s)

Responding Agencies

Program Manager: Teresa Lustig
Phase I: Architecture Study

• Identify and investigate existing fielded CBRN(E) systems whose interface should be addressed
  – Seattle, Los Angeles, Chicago, New York & Boston
  – Accommodate detection systems outside of BioWatch, BWIC and PROTECT
• Review Concepts of Operations

Phase II: Phased City Pilots

• Develop prototype executable operating systems
  – command control software
  – communications
  – support for video
  – data transfer to respond through OPEN/IPAWS/NIEM/HAN
  – *interoperability to other communication systems*
• Perform initial prototype execution testing of the reference implementation open architecture system software
  – focus on information brokering and alerting/situational awareness interfaces
  – provide methods to incorporate new families of detectors and information systems.

Program Manager: Teresa Lustig
Benefits to Pilot Cities

1. **Provide a process for electronic sharing of actionable CBRN(E) information** through open architecture options and existing communication systems *using information exchange standards*.

2. **Integrate and leverage existing stand-alone CBRN(E) systems**.

3. **Bundle CBRN(E) sensor/collector information** onto an already supported infrastructure *with cost savings and increased effectiveness*.

4. **Enable city agencies to rapidly share decisions made in detection, crisis management, and response**, as well as utilize impact assessment tools and impact area videos.

5. **Enable city agencies to easily share critical information** using advanced communication standards-compliant software applications and standards-based messaging and protocols.

Program Manager: Teresa Lustig
Facility Restoration Operational Technology Demonstration (OTD): Restoration of Major Transportation Facilities Following a Chemical Agent release

- Develop a systems approach to restoration of critical transportation facilities following a chemical agent release
  - Develop efficient planning tools
  - Identify decontamination methods
  - Identify sampling methods
  - Develop analysis tools

- Pre-plan the restoration process at a representative critical transportation facility – LAX (Partner Airport)

- Avoid delays inherent in Hart Building anthrax clean-up
OTD will develop a template Restoration Guidance Document

Development of a site-specific remediation plan for LAX that forms basis of a generic remediation plan ‘template’ for use by other facilities

A Remediation Plan must to able to handle multiple contamination scenarios

- The OTD ‘pre-plans’ the recovery process by developing a comprehensive remediation plan
  - All phases of the operation are examined
  - Reduce the time before restoration can begin
- Key issues can be addressed before an incident occurs
  - Capability gaps are identified/resolved
- Planning templates can speed the process and help all stakeholders better understand the issues
  - Identify necessary resources (personnel, equipment, and consumables)
  - Make key decisions (e.g., decon versus replacement, waste management)
  - Determine sampling protocols and methods
  - Obtain “buy-in” from stakeholders

Draft guidance is currently under review by 13 Federal, State and local agencies

Program Manager: Don Bansleben
PROTECT: Chemical Early Warning System for Transit Systems

- Demonstration completed 2003
- This program has transitioned and is an allowable expenditure under the Transit Security Grants Program
- Operations Control Center (OCC)
- Closed Circuit Television Camera (CCTV)
- Concourse Level
- Pedway (Underground)
- Fiber Optic Link
- External Fireman Jacks

Monitor screen view

Homeland Security
Portable High-throughput Integrated Laboratory Identification System (PHILIS)

- Mobile lab system that can be rapidly deployed to the site of significant chemical event
- State-of-the-art analytical instrumentation to rapidly determine identity of chemical contaminants such as Toxic Industrial Chemicals (TICs) and Chemical Warfare Agents (CWAs)
- High-throughput capacity enables mapping of area to establish extent of contamination
- Capable of supporting site recovery and restoration following an event
- *Transitioned to EPA in 2007*
Non-Intrusive Container Monitor

Provide rapid and efficient determination of the contents of suspicious containers in cargo or passing through security portals of various types.

Performance objectives

• Enhance security at portals within and at the perimeter of key infrastructure elements
• Promote the interception and confiscation of illicit materials by a variety of customs, law enforcement, and responder personnel

FY09 Start Date
The Small Business Innovation Research Program (SBIR) Program was established by Congress in 1982. It funds early-stage R&D at small technology companies and is designed to:

- Stimulate technological innovation
- Increase private sector commercialization of federal R&D
- Increase small business participation in federally funded R&D
- Foster participation by minority and disadvantaged firms in technological innovation

### Three Phased Program

<table>
<thead>
<tr>
<th>Phase I: Project feasibility</th>
<th>6 months up to $100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase II: Project development to prototype</td>
<td>2 years up to $750,000</td>
</tr>
<tr>
<td>Phase III: Commercialization</td>
<td>Commercialize, with non-SBIR funds, the technology in military and/or private sector markets</td>
</tr>
</tbody>
</table>
### Related Chem SBIR Projects

- **SBIR 6.1 – 005: Human Detection for Cargo Shipping Containers**
  - Phase I – Demonstrated the feasibility of the proposed concept to accurately and reliably detect humans within shipping containers.
  - Phase II – Design, develop, fabricate and test a prototype device.

  **Offerors**
  - Applied Nano Tech
  - Giner Inc.

  **Proposed Concepts**
  - Gated-metal oxide for CO₂ and O₂
  - Electrochemical for CO₂ and O₂

- **SBIR 7.1 – 007: Improved Chemiresistor Sensing Arrays for Detection of Small Molecule Gases**
  - Phase I – Provide a feasibility report describing the proposed analytical approach, based on a microarray sensor platform, that will compensate for current limitations, stabilize drift, and increase lifetime.

  **Offerors**
  - Carbon Solutions Inc
  - Next Dimension Tech Inc
  - NSC Technology
  - Seacoast Science, Inc

  **Proposed Analytical Approach**
  - Functionalized SWNTs
  - Phthalocyanine-based polymers
  - Nanostructured thin-film assemblies
  - QSPR-guided polymer development

- **SBIR 7.2 – 006: Robust Algorithm Development for Multidimensional Chemical Analysis**
  - Phase I awards under negotiation.
In Summary

S&T Chem-Bio efforts are part of a national strategy as reflected through the requirements of the DHS operational offices

We have already made a difference with first generation systems, e.g.,

• Chem risk assessments to help prioritize national investments
• Developed and transitioned to operation bio and chem detection systems (BioWatch, PROTECT, RDCDS, PHILIS)
• Operational forensic capabilities
• Improved protocols and tools for protecting transportation facilities

We are currently developing the next generation tools & systems to meet DHS and National requirements

http://www.hsarpabaa.com
Annual DHS Chem/Bio Conference

• 28 Jan – 01 Feb 08
• The St. Anthony – Wyndham Hotel, San Antonio, TX

http://www.wyndham.com/hotels/SATST/main.wnt
Emails: Carl.Newman@associates.dhs.gov and Robert.Plemons@associates.dhs.gov