



I  
N  
T  
E  
R  
P  
O  
L



2009

# AGENT DETECTION



# Tests

- Qualitative
  - Primary result is an attribute (the agent is present)
- Quantitative
  - Primary result is a value, (0.1g of agent is present)
- Presumptive Test
  - Initial test suggests the presence of the agent
- Confirmatory Test
  - Indicates the presence of the agent
  - Recognised as valid in a court of law



I  
N  
T  
E  
R  
P  
O  
L



2009

## Why is field detection important ?

- Provides rapid on-site assessment
- Presumptive identification of substance can be made
- Timely and appropriate response
  - Appropriate mitigation strategies can be identified
  - Appropriate treatment for exposed individuals can be initiated if available
- Additional appropriate resources can be identified and mobilized
  - Specific equipment
  - Trained specialists



# Detection of CBR Agents

## ■ Chemicals



- signs and symptoms may be present within minutes of exposure
- may produce gases and vapors
- Hand held detectors available
- Field detection of chemical liquids and vapors

## ■ Radiation



- Field detection of alpha, beta, and gamma particles
- Scintillation counters for detection of alpha particles and lower energy beta particles

## ■ Biologicals



- do not emit vapors or gases
- Must rely on organism specific detection
- Detectors can be inhibited by environmental substances
- Specificity and limit of detection may result in false positives and false negatives
- No hand held detectors for use by first responders
- ***Suspect biological samples must be sent to a reputable laboratory for confirmatory testing***



I  
N  
T  
E  
R  
P  
O  
L



2009

# Detectors: Radiological Agents



Field detectors available for beta and gamma particles



SAM 935 Portable Gamma Spectroscopy System:  
Identifies the source



Detect radiation but  
don't identify source





I  
N  
T  
E  
R  
P  
O  
L



2009

# Detectors: Chemical Agents



Field detectors available for chemical vapors and liquids:



SABRE 4000: Particle and vapour analyser



Detects oxygen concentration and some toxic gases



M8 paper: liquid detection of nerve and blister agents

Draeger AccuroPump for vapors





I  
N  
T  
E  
R  
P  
O  
L



2009

# Commercial Chemical and Radiological Detection Instruments: Examples



## Radiological / Nuclear

- Dosimeter
- RAM
- GR-135



## Toxic Gases (*Vapour*)

- Photo ionising device (PID)
- Flame ionising device (FID)
- Multi-RAE

## Powders / liquids (*infrared*)

- Travel FTIR
- HAZMAT ID

## Chemical Warfare Agents

- Bruker RAID (*vapour*)
- ECAM (*vapour*)
- M8 and M9 paper (*liquid*)
- SABRE (*particle / vapour*)



I  
N  
T  
E  
R  
P  
O  
L



2009

# Detection: Biological Agents



- *Bacillus anthracis* (anthrax)
- *Yersinia pestis* (plague)
- *Francisella tularensis* (tularemia)
- Botulinum toxin
- Ricin
- Variola Major virus (smallpox)
- Viral Hemorrhagic Fever viruses
  - Ebola virus
  - Rift Valley Fever virus



Smallpox



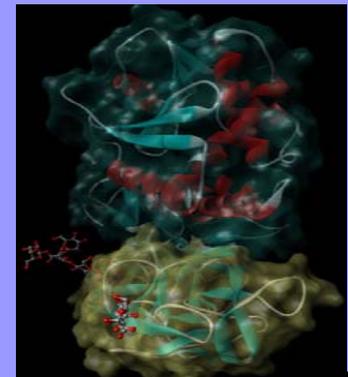
*Bacillus anthracis*



Ebola virus



Cutaneous anthrax



Ricin toxin  
(computer generated)



# Comparison of Biological Agents to Nuclear and Radiological Materials

## Biological Materials



- Found in nature
- Living; able to replicate
- Relatively inexpensive to produce
- Highly diverse
- Present at numerous types of facilities and in many locations throughout the facilities
- Legitimate applications in biomedical research and pharmaceutical industry
- *Cannot be detected from a distance with available technologies*
- *Cannot be identified in the field by first responders*

## Fissile Materials



- Are not found in nature
- Non-living; synthetic
- Very expensive to produce
- Not diverse
  - Plutonium
  - Highly enriched uranium
- Stored at a limited number of sites
- Few non-military applications
  - Research reactors
  - Thermo-electric generators
- *Can be detected from a distance*
- *Can be detected in the field with hand held technologies*



# Comparison of Biological Agents to Chemicals

## Biological Materials



- Majority cannot penetrate intact skin
- Exist in nature
- Signs and symptoms require hours to weeks
- Require external energy to aerosolize
- *Cannot be detected from a distance with available technologies*
- *Cannot be detected or identified in the field by first responders*

## Chemical Materials



- Many can penetrate intact skin
- Do not exist in nature
- Onset of signs and symptoms occur within seconds or minutes of exposure
- Many can volatilize without external energy
- *Many can be detected from a distance*
- *Many can be detected and identified with available hand held technologies*



I  
N  
T  
E  
R  
P  
O  
L



2009



# Field Detection of Biological Agents

- Biological materials are different from chemical and radiological materials in a variety of ways
  - *There are no biological agent detectors validated for use by first responders to detect or identify biological agents definitively in the field.*
  - *All samples suspected of containing biological material collected in the field must be definitively identified in a reputable laboratory.*



I  
N  
T  
E  
R  
P  
O  
L



2009

# Detectors: Biological Agents



Traditional biochemical analysis



PCR



Microscopy



MSA BioSensor 2200R



# Biological Agent Detection Example : PCR Technology

## ■ Advantages

- Specific to target
- Fewer false positives
- Sensitive
- Portable devices exist
- Detection in as few as 40minutes for some detectors



## ■ Disadvantages

- Expensive
- Requires technical expertise/knowledge
- Requires specific reagents that must be refrigerated and have expiration dates
- Reaction can be inhibited
  - Environmental contaminants
- May lead to false negatives
  - Requires advanced knowledge for interpretation



# Biological Agent Detection Example : Laboratory Confirmatory Testing



- Identification must be confirmed by appropriate laboratory
- Need to identify the appropriate microbiology laboratory
- Screen samples for other hazards prior to transport to the laboratory
  - Explosives
  - Chemicals
  - Radiologicals
- Bacterial and viral culture remains the 'gold standard'
- Traditional biochemical analysis also performed
- Molecular diagnostics becoming more available
  - PCR
  - Immunoassay



Bacterial growth on agar plates  
can require 12 or more hours  
depending on the agent



# Biological Detection

- Must be confirmed by laboratory
  - Clear samples of more immediate hazards prior to collection and submission to the laboratory
    - Explosives
    - Chemicals
    - Radiologicals
- Must be used by trained operators
- Individuals must understand the limitations of instruments
  - What can and cannot be detected
  - Limits of detection
  - Specificity
  - Result interpretation
    - Potential false positives
    - Potential false negatives
    - Positive and negative controls