Detection of Chemical, Biological, and Radiological Agents

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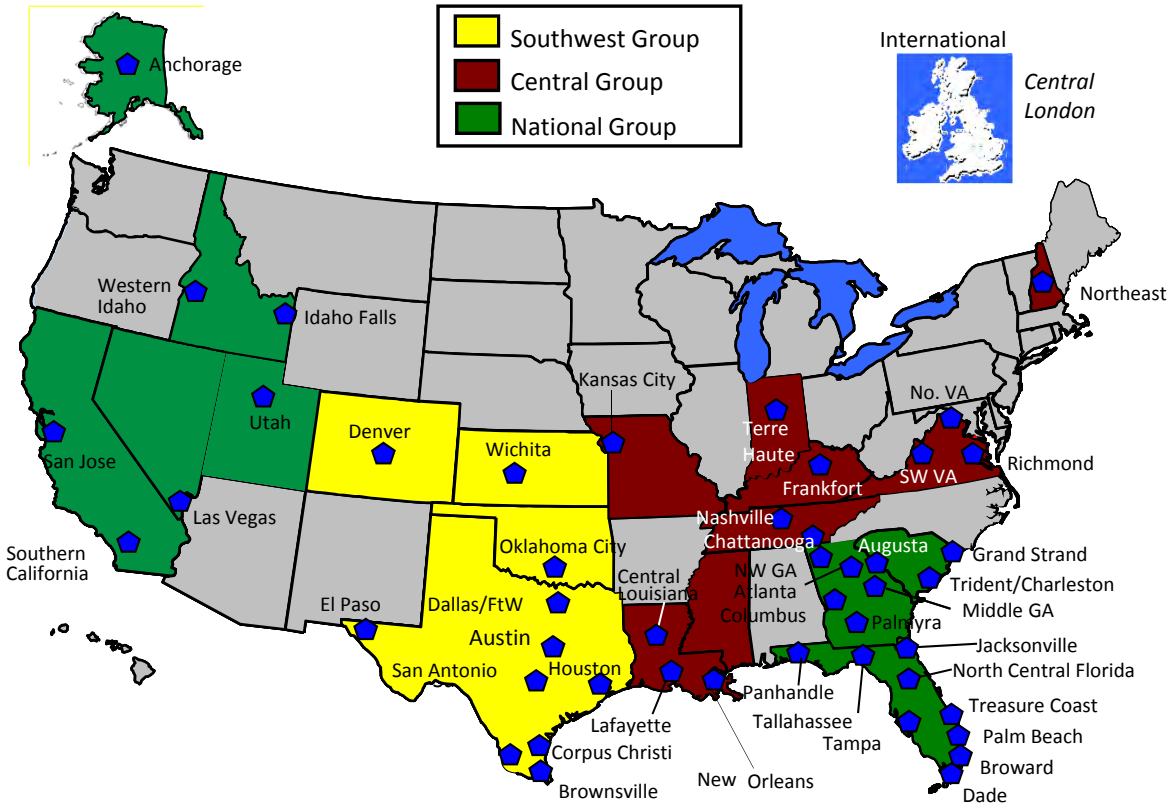
HCA Overview



Accounted for approximately 5% of major hospital service in U.S.:

- Admissions > 1.5 million
- Patient Days > 7.6 million
- Deliveries > 0.23 million
- Total Surgeries > 1.3 million
- ED Visits ~ 6 million

- 164 hospitals , 106 freestanding surgery centers, and 400 physician practices in 20 states and England
- Hospitals range from complex tertiary referral & academic medical centers to urban and suburban community medical centers
- ~ 194,000 employees
- 35,000 affiliated physicians
- More than 38,000 licensed beds
- ~ 150,000 Health Care Workers

Disaster Response

- 2001- Amerithrax
- 2005-Hurricane Katrina
- 2008- Hurricanes Gustav and Ike
- 2009- H1N1 Pandemic
- 2010- Haiti Earthquake, Nashville, TN Floods
- 2011- Hurricane Irene
- 2012-Virginia Storms, Hurricanes Isaac and Sandy, Fungal Meningitis Outbreak

Enabling Learning Objectives

Recognize effective methods of detection and monitoring at a CBRNE event involving a potentially hazardous environment and/or hazardous substances.

Recognize chemical and physical properties of materials and how they relate to effective detection and monitoring.

(a) Refer to Site Characterization section on WMD Response Algorithm
(b) If explosive risk, contact EOD
(c) If radiation risk, contact DOE
(d) Use sketch, video, digital to map site

Mission Objectives
Site Survey
- Recon (a)
- Monitoring
- Field Screening (b)(c)
- Site Mapping (d)

Threat Assessment Flowchart

Corrosive atmosphere → pH paper, Corrosive gas detectors

Flammability/ Explosivity → Multi-meter, Explosimeter

Oxygen Level → O_2 sensor, multi-meters (CO, H_2S, LEL,O_2)

Radiation → Radiation detector

Toxic Atmosphere → Colormetric tubes, PID/FID, AP2C, M256 Kit, CAM, HazMatCAD, APD 2000

Toxic/Corrosive Liquid/Solid → pH paper, M-8/C-8 paper, M-9 tape, Chemical classifier tickets

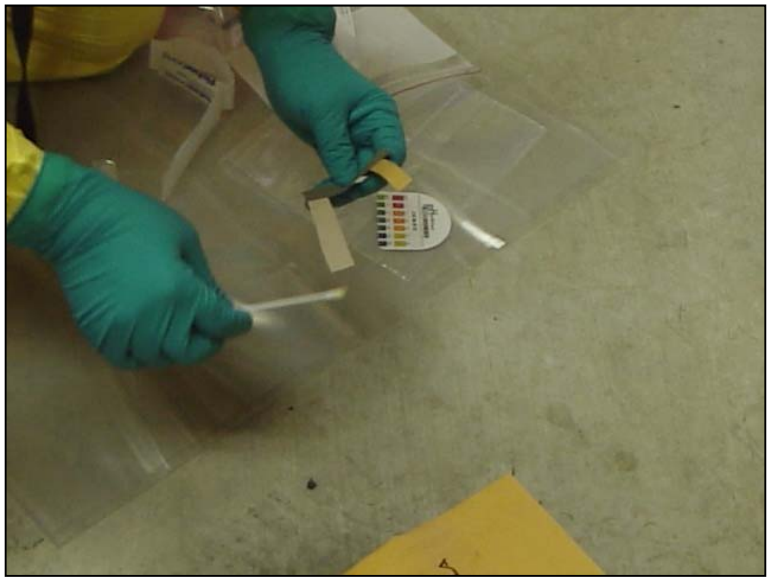
pH/protein content → 20/20 BioCheck Kit

If positive results, mitigate according to local protocol & site-specific Incident Action Plan

Survey Operation Flowchart

Field Screening

- General hazard classification of sample for lab
- Specific to each sample
- Characteristics of:
  - Radioactivity
  - Corrosivity (pH)
  - Flammability
  - Toxicity/volatility



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Physical Properties

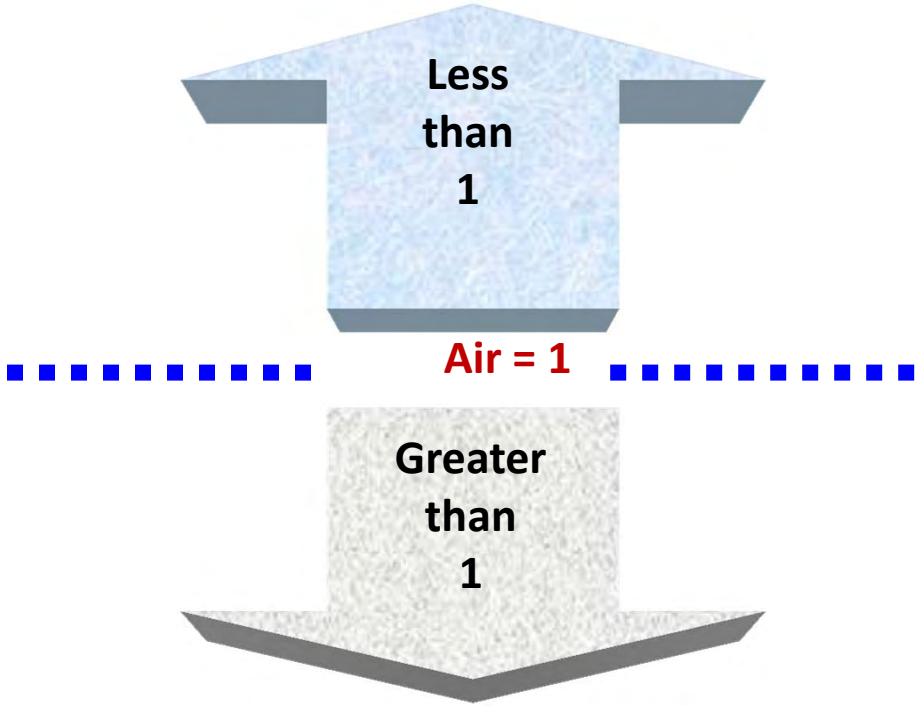
- Public safety responders need to understand physical properties of substances:
  - To properly use and interpret the various detection and monitoring equipment assigned to them
  - To identify potential hazardous evidence collection locations and identify the proper collection techniques

Vapors

- A substance in the gaseous state as distinguished from the liquid or solid state

Vapor Density

- The weight of a vapor or gas compared to the weight of an equal volume of air.

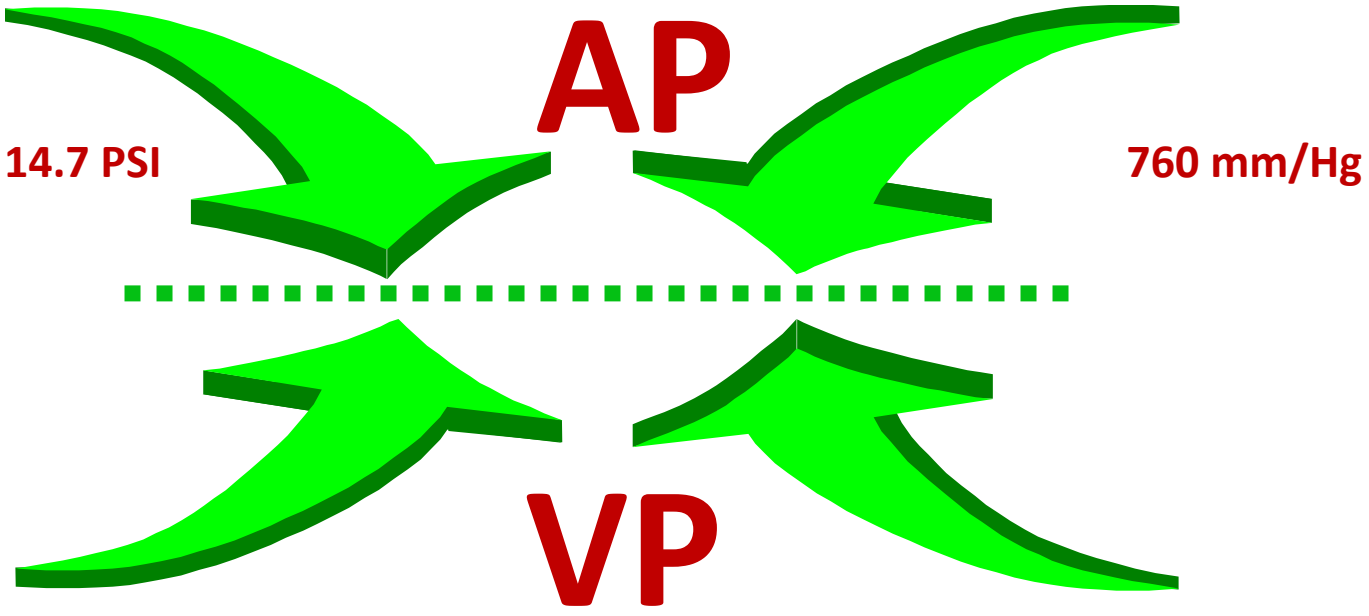


Vapor Pressure

- The pressure exerted by a vapor (on its container, if enclosed) in equilibrium with a liquid or solid at a given temperature
- Substances with high vapor pressures evaporate quickly

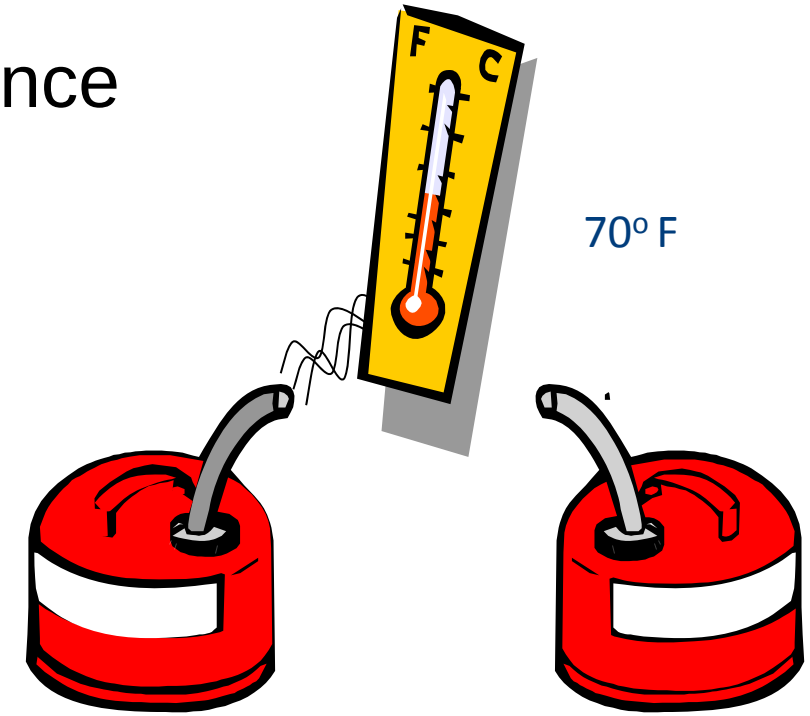
Boiling Point

- The temperature at which the vapor pressure of a liquid equals atmospheric pressure



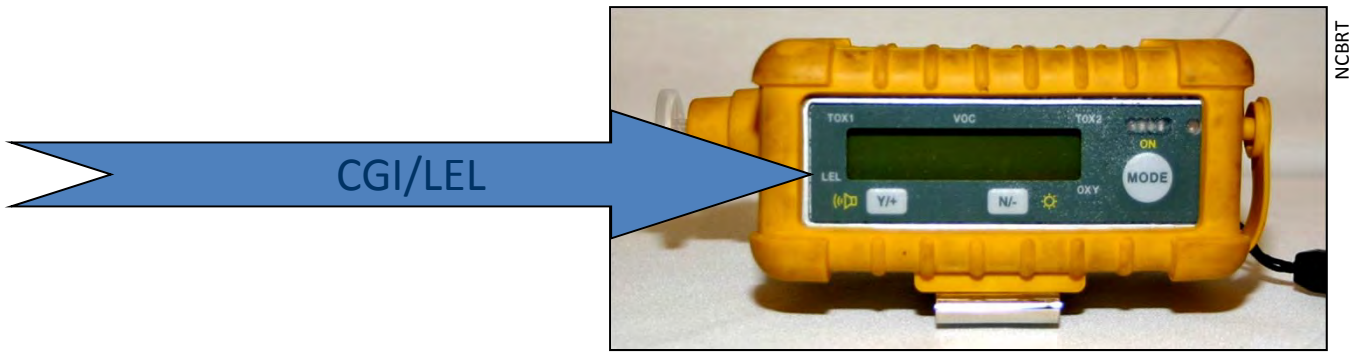
Flash Point

- The minimum temperature to which a material must be raised to allow for combustion in the presence of an ignition source



Flammable Range

- The range of concentration of a flammable gas or vapor (% by volume in air) in which explosion can occur upon ignition in a confined area.



Combustible Gas Monitoring

- Hazards monitored:
  - Flammable/explosive atmospheres

CGI/LEL

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Combustible Gas Indicator (CGI)

Combustible Gas Monitoring

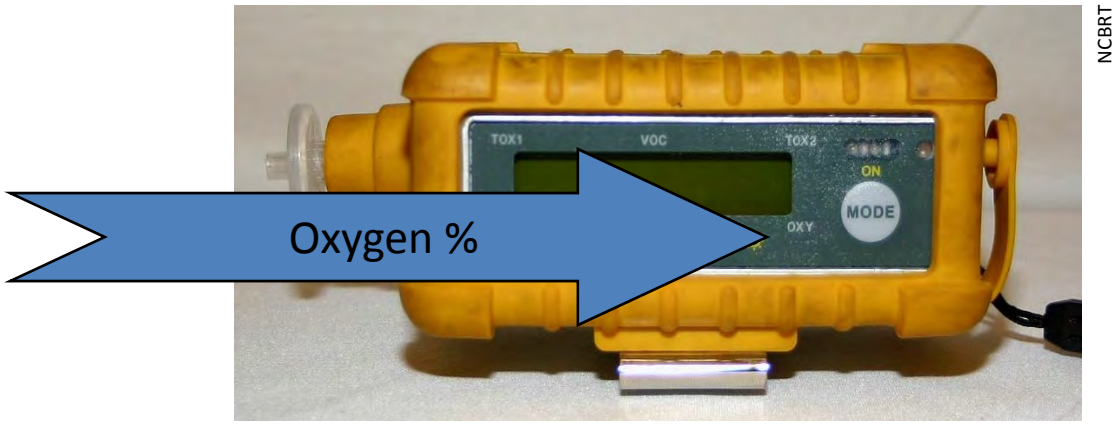
- Application:
  - Detects potentially flammable/explosive atmospheres
  - Reads in % of LEL
- Limitations:
  - Adverse O_2 levels
  - Environmental factors

Oxygen Monitoring

- Hazards monitored:
  - Observe for enrichment / deficiency 19.5%-23.5%
- Application:
  - Usually limited to interior/confined area
  - Displays oxygen content (%)

Oxygen Monitoring

- Limitations:
  - Interferents
  - Humidity



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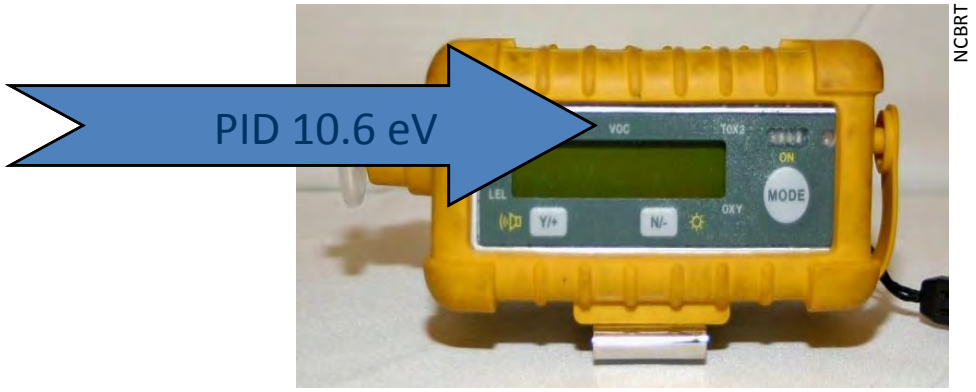
Photoionization Detection

- Hazards monitored:
  - Detects volatile organic compounds (VOCs)
  - 0-2000ppm detection range



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Photoionization Detection

- Application:
  - Initial reconnaissance
  - Relative measurement of total VOC
  - Screening for material volatility/toxicity
  - Reads in PPM or PPB
- Limitations:
  - eV potential of PID lamp
  - High humidity/dust conditions

Toxic Atmosphere Detection

- Chemical reaction monitoring
- M256A1 Chemical Agent Detector Kit
- Colorimetric tubes

Toxic Atmosphere Detection

- Electronic monitoring:
  - SAW Technology
  - Photoionization Detection (PID)
  - Flame Ionization Detection (FID)
  - Ion Mobility Spectroscopy (IMS)
  - Raman Spectroscopy
  - Infrared (IR) Spectroscopy
  - Gas Chromatograph/Mass Spectrometer (GC/MS)

M256A1 Chemical Agent Detector Kit

- Hazards monitored:
  - Nerve, blister, blood agents
  - IDLH for most agents

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M256A1 Chemical Agent Detector Kit

- Application:
  - Initial reconnaissance
  - Verify chemical detection
  - Enzymatic color change

M256A1 Chemical Agent Detector Kit

- Limitations:
  - 15-plus minutes to use
  - Hand manipulation
  - Does not detect choking agents

Colorimetric Detection Tubes

- Hazards monitored:
  - Nerve, blister, blood agents
  - Many toxic industrial chemicals (TIC)

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Colorimetric Detection Tubes

- Application:
  - Initial reconnaissance
  - Verify chemical detection
  - Qualification, not quantification

Colorimetric Detection Tubes

- Limitations:
  - Number and type of detection tubes
  - Hand manipulation
  - Cross sensitivity and interferents
  - +/- effect

Surface Acoustical Wave (SAW) MiniCAD

- Hazards monitored:
  - Detects G and H agents


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Surface Acoustical Wave (SAW) MiniCAD

- Application:
  - Initial reconnaissance
  - Sample screening
  - Decontamination efficacy
  - Reads RELATIVE intensity of signal

Surface Acoustical Wave (SAW) MiniCAD

- Limitations:
  - Not intrinsically safe
  - Operator training needs
  - Cycle time

Flame Ionization Detection

- Hazards monitored:
  - Measures atmospheric VOC
- Application:
  - Initial reconnaissance
  - Sample screening
  - Decontamination efficacy
  - Reads in PPM

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Flame Ionization Detection

- Limitations:
  - Not intrinsically safe
  - Operator training needs
  - Cost and consumables (i.e., hydrogen)
  - Cold weather

Flame Spectrophotometer

- Hazards monitored:
  - Detects nerve and blister agents = IDLH
  - Solids, liquids and vapors

AP2C

Flame Spectrophotometer

- Application:
  - Initial reconnaissance
  - Sample screening
  - Decontamination efficacy

Flame Spectrophotometer

- Limitations:
  - Not intrinsically safe
  - Operator training needs
  - Cost and consumables (i.e., hydrogen)
  - Cold weather

pH Monitoring

- Hazards monitored:
  - pH of water-based materials
- Application:
  - Determines relative pH of liquid materials
  - Apply product to paper

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Radiation Monitoring

- Hazards monitored:
  - Alpha, Beta, and Gamma radiation

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Radiation Monitor

Radiation Monitoring

- Application:
  - Screen site
  - Radiological Dispersal Device (RDD)
  - Reads in CPM uR/hr, mR/hr, R/hr
- Limitations:
  - Not intrinsically safe
  - User knowledge

Ludlum Model 44-9 Pancake G-M Detector Tube

- Detects alpha, beta and gamma radiation
- Used for survey and personnel monitoring

Ludlum Model 44-2 Gamma Scintillator

- Detects low intensity gamma radiation
- Used for background radiation monitoring, low level radiation detection, and spectrum analysis
- gamma radiation in the range of 60 keV to 1.25 MeV

Ludlum Model 133-2 G-M Detector

- Detects high range gamma radiation
- Used for area monitoring

Ion Mobility Spectroscopy

- Hazards monitored
  - Detection of nerve, blister agents and TICs

Lightweight Chemical Detector

APD 2000

Sabre 4000

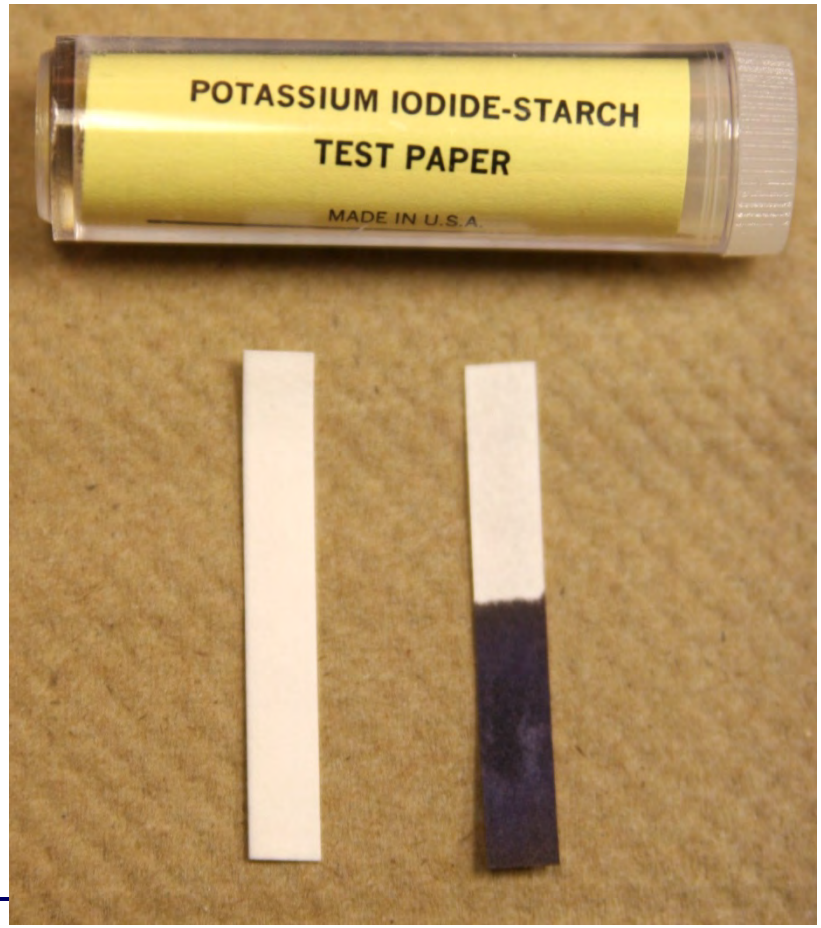
CAM

Ion Mobility Spectroscopy

- Application:
  - Initial reconnaissance
  - Sample screening
  - Decontamination efficacy
  - Reads RELATIVE intensity of signal
- Limitations:
  - Not intrinsically safe
  - Operator training needs

Oxidizer Test Paper

- Tests for the presence of some oxidizers
  - Turns gray to blue / gray to black in the presence of some oxidizers



Water Test Paper

- Tests for the presence of water in a solution
  - The presence of water in a sample does not preclude the presence of an agent
  - Turns lavender in the presence of water

Toxic Liquid Detection: M-8 Paper

- Hazards monitored
  - Detects G and VX nerve and blister agents

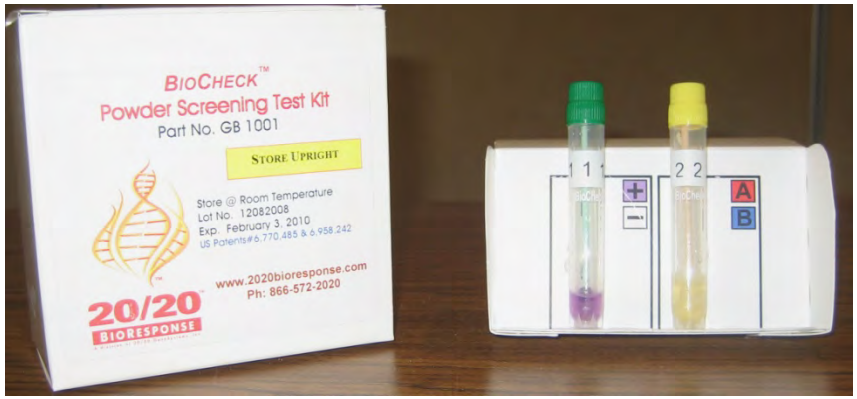
Toxic Liquid Detection:
M-8 Paper

- Application:
  - Detects and classifies
  - Initial recon
  - Reads in color change

Toxic Liquid Detection: M-8 Paper

- Limitations:
  - Liquid contact only
  - Environmental factors may affect indicator time
  - Color change indicates possible type of chemical agent

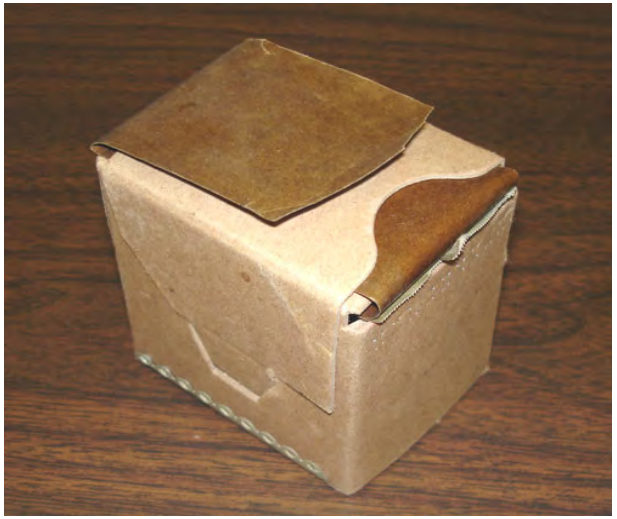
BioCheck Powder Screening Test



- Tests for protein in the sample
  - Turns purple in the presence of protein
- Also includes pH test
- Need to have visible powder
  - 12µg or more

Toxic Liquid Detection: M-9 Tape

- Hazards monitored
  - Detects liquid chemical agents (nerve or blister)



Toxic Liquid Detection:
M-9 Tape

- Application:
  - Screening site
  - Turns dark pink to red upon contact with chemical agent

Toxic Liquid Detection: M-9 Tape

- Limitations:
  - Does not classify agent
  - Known carcinogen; treat as such
  - Will not absorb water-based products

RAMAN Spectroscopy

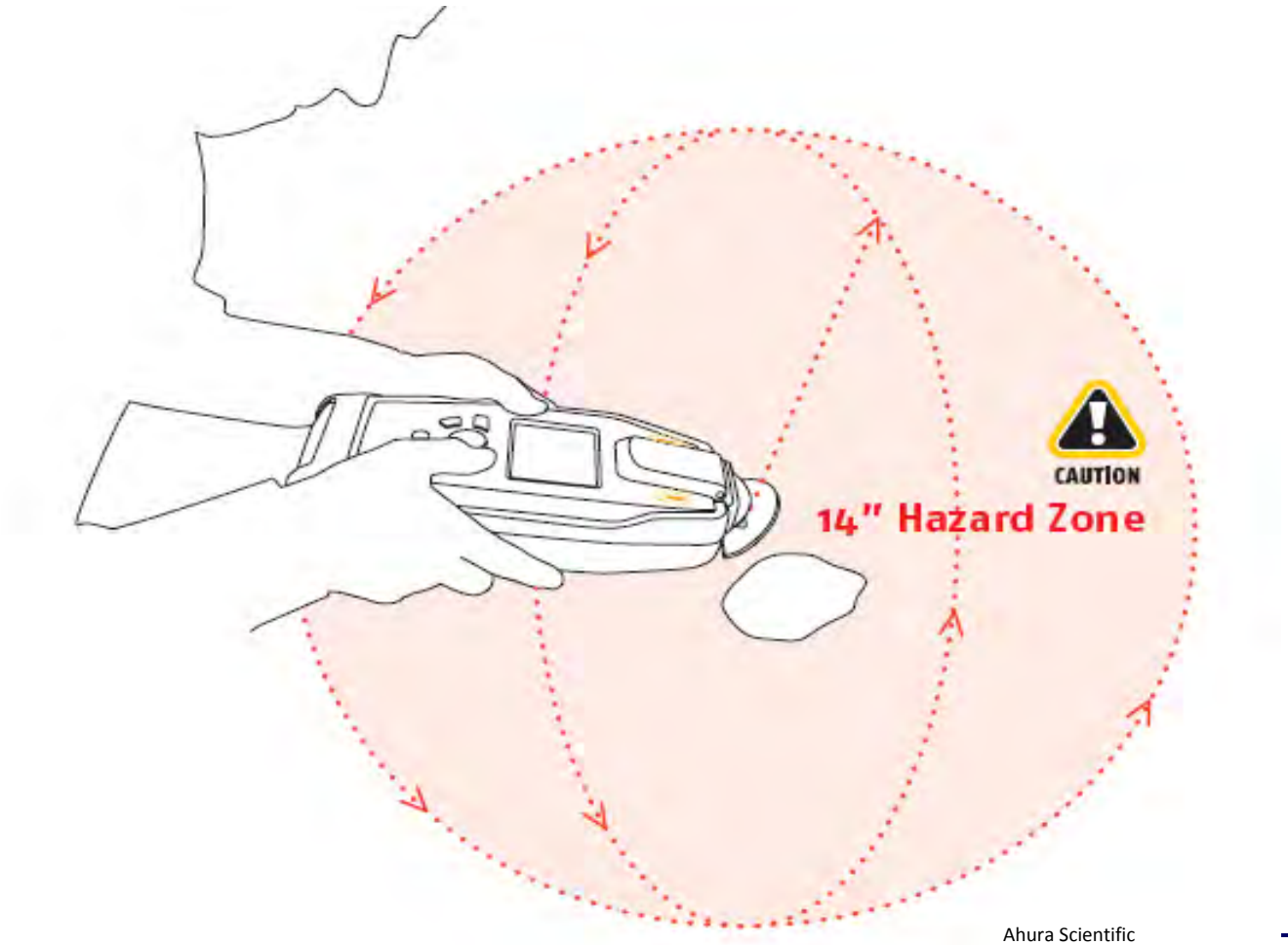
- Hazards monitored:
  - Solids and liquids
  - Chemical warfare agents, TICs, and “white powders”

FirstDefender

RAMAN Spectroscopy

- Advantages:
  - Point-and-shoot
  - Sample vial compartment
  - Organic and inorganic, water-based solutions
- Limitations:
  - Dark-colored samples
  - Fluorescence

Precautions For Safe Use



Infrared Spectroscopy

- Hazards monitored:
  - Solids and liquids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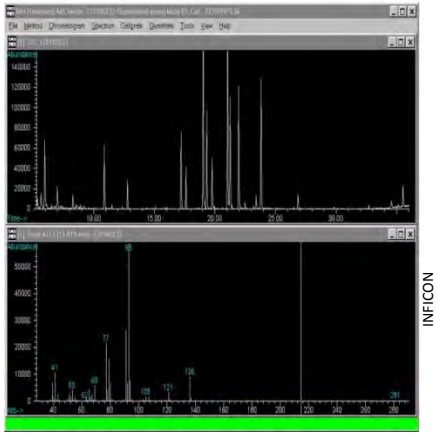
Infrared Spectroscopy

- Applications:
  - Identify organic compounds
  - Identify unknown powders and liquids
- Limitations:
  - Mixtures

Gas Chromatograph / Mass Spectrometer

- Hazards monitored:
  - Liquids and vapors
  - Volatile organics



HAPSITE Smart Chemical Identification System

Gas Chromatograph / Mass Spectrometer

- Applications:
  - Identify unknown liquids and gases
- Limitations:
  - Time required to make a run
  - Consumables

Conclusion

- Site survey equipment: techniques, capabilities, and limitations of its use