Environics

Application Note: 102

Decision-Making in Chemical Warfare Agent (CWA) Response

In response to releases of Chemical Warfare Agent (CWA), there may not be one technology or one "answer" that is correct. The responder must take into account all of the clues present to conclude the presence or absence of CWAs and take appropriate action. Understanding what the clues are and how to layer them to make a decision is critical to successful CWA response.

Why Is Gas Detection Important?

Responders cannot rely on their senses for decision-making. Without effectively knowing how to use detection techniques, responders are unable to properly identify threats and make decisions that are appropriate to the actual hazard. Detection technologies supplement responders senses when making decisions in potentially hazardous environments. Relying on the senses alone can be dangerous in chemical response; detectors become the eyes and ears when those senses fail. Proper use of detection technologies coupled with the clues present at the scene allow for better decision making.

Over-Responding Can Be Dangerous to the Community

Over-responding can be dangerous to the community because panic is as effective a killer as bullets, bombs, or chemical attacks. The community will echo how the first responders act. If the first responders are calm, civilians will act accordingly. If the first responders over-react and immediately jump into full encapsulation protection, it could panic the public and cause unnecessary worry and even injury.

Overprotection Can Be Dangerous to the Responder

Heat stress is the number one injury in HazMat response and immediately jumping into full Level A encapsulation is a good way of overheating oneself. Level A encapsulation also makes one much more susceptible to slip, trip, and fall injuries. Finally, overprotection makes it harder to get things done. When properly used, detection allows responders to respond at lower levels of personal protective equipment (PPE) to provide the highest levels of safety to themselves and to the community that they protect.

CWA Response Is a 3-Step Process

1. **Location:** One needs to quickly figure out where the problem is coming from using clues, common sense, and survey tools. Victims running from a central location, clouds of chemical, and pools of liquid all provide location clues. Survey technologies like Photoionization and Flame Ionization Detectors (PIDs and FIDs) also can help in location.
2. **Classification:** One needs to quickly get a general idea of the kind of threat by using clues, common sense, or classification technologies like colorimetric techniques, Ion Mobility Spectroscopy (IMS), Surface Acoustical Wave (SAW), or Flame Spectrophotometry. In the case of CWAs, at this stage, it is not necessary to differentiate between Soman (GA) or Sarin (GB) because the initial response protocol is the same.
3. **Identification:** Using clues, common sense, or an instrument, the specific identity of a chemical or a mixture of chemicals can be determined. This can back up the initial classification and will be helpful in further prosecution of the perpetrators. Common technologies include Fourier Transform InfraRed (FTIR) and Gas Chromatography/Mass Spectroscopy (GC/MS).

Why Worry About CWAs?

CWAs are chemicals designed to either kill or debilitate an opposing military. They are often derived from civilian Toxic Industrial Chemicals (TICs) such as insecticides, chlorine, and hydrogen cyanide. In 1994, the Japanese Cult Aum Shinrikyo released a Sarin spray from a refrigerated box truck in a quiet neighborhood of Matsumoto Japan with the intent to kill three judges who were due to rule against the cult. Seven people were

Environics USA, Inc.
1308 Continental Drive, Suite J, Abingdon, MD 21009
Tel: (410) 612-1250, Fax: (410) 612-1251
sales@environicsusa.com, www.environicsusa.com

killed and 200 hospitalized. In 1995, the Aum cult again used Sarin to terrorize the Tokyo subways by simultaneously spilling Sarin liquid in a number of subway cars. Twelve people were killed, about 1000 were hospitalized, and thousands became ill. In Iraq, insurgents have used chemical munitions to make roadside IEDs (Improvised Explosive Devices). With terrorist groups having demonstrated their ability to make and use CWAs, responders must look at ways to effectively detect and respond to these compounds.

CWAs Are Accessible

Abandoned munitions and lab materials at military or research facilities can provide easy access to CWAs. The best way to dispose of chemical munitions up until the last few years was to bury and forget them but, because of this, facilities have lost track of some. CWAs can be stolen from poorly maintained regulated stockpiles. CWAs can be obtained from former war zones. Terrorists in Iraq and Afghanistan have used CWAs as IEDs either intentionally or inadvertently. Finally, it can be expected that others can and will follow Aum's example.

A Brief History of CWAs

Chemical warfare is not a 20th century development. The Chinese used arsenical smokes in 1000 BC. The Spartans used noxious smoke and flame against the Athenian allied cities in the Peloponnesian War in 429 and 424 BC. Leonardo DaVinci proposed a powder of sulfur and verdigris (oxidized copper) as a weapon in the 17th century. John Doughty, a New York City school teacher, proposed chlorine filled 10-in. shells during the U.S. Civil War but was turned down because the weapon was too inhumane. In 1915, the Germans used chlorine against the English trenches in Ypres, Belgium. One of the lessons from using chlorine is that it is not persistent. Wind easily carried the chlorine gas over to the English trenches. However, the weather is fickle and, when the wind changed, it carried the chlorine gas back over to the Germans. What was needed was a stable and persistent chemical that would stay where it was needed. Mustard "gas" is a liquid at normal temperatures and it is very persistent. That is, it is not a gas and it stays where it is put.

The Invention of Modern "Nerve Agents"

On December 23, 1936, Dr. Gerhard Schrader of I.G. Farben invented Tabun (GA) as an insecticide. Because of a 1935 Nazi decree, it was reported to the Ministry of War as an invention of possible military significance. In 1938, Sarin was invented and was named for its discoverers ***S***chrader, ***A***mbros, ***R***igriger, and Vad Der L***in***de.

CWA Classes and Characteristics

Nerve: Agents are liquids at normal temperatures that are stable and persistent. Nerve agents are organophosphates that are similar to insecticides but 100-500 times more powerful. They quickly shut down the nervous system by blocking acetylcholinesterase transmission at the nerve synapses (acetylcholinesterase inhibitors). At high dose levels, they produce muscle twitches, foaming at the mouth, tremors, and lung constriction plus lungs filling with fluids. At lower dosage levels, they can produce pinpoint pupils, watery eyes, and stomach cramps, or it can feel like a bad hangover. One thing to remember is that victims are always the ultimate and best nerve agent detector.

Blister: Agents are liquids at normal temperatures that are stable and persistent. Blister agents can take minutes to hours to develop blisters. They often do not immediately kill their victims like nerve agents. But blister agents certainly make it difficult for soldiers to perform their tasks. When inhaled, blister agents can fill the victims' lungs with fluid and can cause pneumonia. Because Blister Agent symptoms take time to develop and it does not immediately cause death, many people do not consider blister agents an effective WMD agent.

There Is No Such Thing as "Nerve Gas"

Owing to their low vapor pressure and high boiling points, CWAs do not represent much of a vapor threat unless they have been aerosolized in some way (see the following chart). They are heavier than air and tend to stay low to the ground.

Environics USA, Inc.
1308 Continental Drive, Suite J, Abingdon, MD 21009
Tel: (410) 612-1250, Fax: (410) 612-1251
sales@environicsusa.com, www.environicsusa.com

A Summary of CWA Chemical Properties

Name	Abbreviation	Melting Point (°C)/(°F)	Vapor Pressure mm/Hg (@20°C)	Boiling Point °C/°F
Tabun	GA	-50/-58	0.07	246/475
Sarin	GB	-57/-70	1.48	147/297
Soman	GD	-80/0112	0.92	190/374
Mustard	H	14/57	0.11	217/422
Lewisite	L	-18/-0.4	0.35	190/374
VX	VX	-51/-59	0.0007	298/568
Water	H_2O	0	17.54	100/212
Diesel	Diesel		0.40	160-371/ 320-700
Heavy Fuel Oil	#6 Fuel Oil		<5.2	176-648/ 350-1200

All of the CWAs have vapor pressures less than 40 mm/Hg (the arbitrary "vapor threat" pressure), less than 20mm/Hg for water (which is not that volatile), less than diesel, and even less than #6 fuel oil (essentially crank case oil).

CWAs are stable and persistent liquids, as opposed to gases, because the army that deploys them wants them to stay on their enemy and not float back. Compared to gases like chlorine, hydrogen fluoride, and ammonia, which all can move readily in air, CWAs are very toxic but they are not that tough to contain. Finally, unlike most other atmospheric threats (like lack of oxygen) there are antidotes for CWA exposure. Without some means of dissemination via aerosolization, CWAs will take some time to produce vapors that would affect people at room temperature of ~20°C/65°F.

Dissemination Is the Key

If one were to solely look at CWAs chemical characteristics they do not appear that threatening. While they are very toxic, they do not want to move and "chase" as gases like chlorine and ammonia can and will do. The key to successful deployment of CWAs is dissemination. There are four dissemination techniques, which can provide a clue as to the nature of the attack/event:

1. **Explosive Dissemination**
   - The military has honed their skills on using low level explosive (dispersant) charges to disseminate chemicals. A CWA shell is lofted into the air by its propellant charge. Then, when it reaches the proper altitude, a secondary "dispersant" charge is detonated to turn the heavy liquid into a mist or a spray that spreads out over the opposing military.
   - Big explosions burn up chemicals like a fuel-air bomb, but small ones spread it effectively. So if witnesses/victims talk of hearing a "pop" without a fireball, that is a good sign of a dispersant charge. If they speak of a big boom or whoomp followed by a fireball, it is highly probable that the explosion consumed the CWA.
2. **Pneumatic Dissemination**
   - Aum's first strike was against judges in Masumoto, Japan, using a sprayer that killed 7.
3. **Mechanical Action Dissemination**
   - Plastic bags inside paper bags or boxes that were poked with sharpened umbrella tips in Tokyo proved to be a poor dissemination method. This seems to indicate that their intent may have been to create more of a distraction than to kill large numbers of people.
   - Glass bottles dropped from above and splashed down the station steps may have been more effective.
4. **Chemical Reaction Dissemination**
   - Cyanide tablets plus acid = gas

Dissemination is the key to killing a lot of people. With proper dissemination, Tokyo could have been the first 9/11 type of event with thousands of fatalities.

Multiple Detection Techniques Are Required

There are a wide variety of techniques to determine the presence of CWAs. With the exception of human victims displaying the characteristic symptoms of CWA exposure, all of the other detection techniques should be supplemented with additional detection technologies before drawing a final

Environics USA, Inc.
1308 Continental Drive, Suite J, Abingdon, MD 21009
Tel: (410) 612-1250, Fax: (410) 612-1251
sales@environicsusa.com, www.environicsusa.com

conclusion. That is, one should never draw a conclusion about the presence of CWAs using just one technology. Like all of gas detection, additional clues should be considered.

Biological Detection

Nerve agent will kill other species. Smaller animals with fast metabolisms will be affected faster than large animals with slower metabolisms. Insects, amphibians, reptiles, birds, and small mammals will all be affected by nerve agents before humans. Because of its low vapor pressure and high vapor density, nerve agents will not stay aerosolized, meaning that they will quickly fall to the ground, affecting ground dwelling and grazing species first. The characteristic symptoms of CWA exposure, both in humans and in animals, are one of the best and most unequivocal means of establishing the presence of CWAs.

Sensitive>insects>amphibians>birds>mammals>**Less sensitive**

Nerve Agent Symptoms

There are two major mnemonics used to remember human (and animal) nerve agent symptoms: DUMBBELLS and SLUDGEM. Each captures many of the same symptoms somewhat differently.

DUMBBELLS

D - Diarrhea (Diaphoresis-excessive sweating)
U - Urination (peeing)
M - Miosis (constriction of the pupil of the eye)
B - Bronchospasm (difficulty breathing)
B - Bradycardia (slow heart beat)
E - Excite skeletal muscle and CNS emesis (vomiting)
L - Lacrimation (tearing)
L - Lethargy (fatigue)
S - Salivation (excessive drooling)

SLUDGEM

S - salivation (excessive drooling)
L - lacrimation (tearing)
U – urination
D - defecation / diarrhea
G - GI upset (cramps)
E - emesis (vomiting)
M - muscle (twitching, spasm, "bag of worms")

Why Are Survey Sensors Important?

Survey sensors or "sniffers" are one of the best tools to quickly identify if something is out there and where it is located. On their own, survey sensors will not tell what that "something" is, but they can often quickly (<3-10 seconds) tell where it is coming from and how much is there. "Classification" and "Identification" devices may be too slow to "sniff."

PIDs and FIDs

A PID or FID will provide faster "sniffing" for the location of CWA than most CWA classifiers because they not only respond faster but can display below the alarm threshold so that concentration gradients can be "seen." CWA classifiers often require more time to detect, therefore, when sampling, the user often must check for potential contamination slowly and methodically, much like when checking for alpha radiation contamination. Coupled with clues (e.g., chemical pools, clouds, dead animals, victims, placards, and waybills) that provide identification of a chemical, some survey sensors like PIDs and FIDs can quickly tell how much is there when the proper scaling factors (Correction Factors) are used.

- Advantages
    - Relatively inexpensive to purchase
    - Can detect CWAs in air
    - Fast response time
    - Store well
    - Inexpensive to use <$0.25/hr for PID <$1.00hr for FID
- Disadvantages
    - Non-specific
    - The 10.6eV lamp used by most PIDs has difficulty detecting GB

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M9 tape

M9 is a “dumb” survey technique. M9 tape is a simple colorimetric technology. It is designed to be taped to personnel (on boots and the bottom of pant legs) and to vehicle bumpers. It only indicates red as a positive response and is best used with a classification technology.

- Advantages
  - Simple
  - Stores well (keep cool)
  - Inexpensive (<$7 for 10 m roll)
- Disadvantages
  - A liquid sample is required
  - Many organics will provide positive response including cleaning solvents, ammonia, some petroleum products, and even high temperatures.

CWA Classification Techniques

Classification may take more time than location. Classifiers will typically come up with an answer quicker on real agent than on cross-sensitive chemicals. There are two fundamental types of CWA classification techniques, chemical color change technologies (colorimetrics) and direct reading devices. Properly used in conjunction with each other and the other clues at a scene, these technologies can provide a very high degree of confidence.

M8 Paper

M8 Paper is one of the simplest means of classifying CWAs. Some have called it “pH paper” for CWA. Detection is based upon solubility of dyes in CWA. Nerve indicates yellow, Blister indicates red and VX indicates green.

- Advantages
  - Simple
  - Stores well (when kept cool)
  - Inexpensive (<$5 per book)
- Disadvantages
  - A liquid sample is required
  - Many organics will also dissolve the dyes including cleaning solvents, ammonia, some petroleum products, and even high temperatures.

M256A1 Kit

The M256A1 kit is an organic chemistry set on a paper card to provide classification of nerve, blister, and blood agent gas, vapors, and liquids (an undocumented feature of the M256A1 kit is that drops of chemical samples can be put on the sample pads for faster response than waiting for an airborne sample). The test process takes 12-25 minutes and the instructions are complicated and hard to read off of the dark green packaging material. It is counter-intuitive that the G series indication is a lack of color change where the other pads do change colors. Most colorimetric techniques make a positive color change, from white to a new color, in the presence of the target chemical.

- Advantages
  - Cheapest way into vapor detection of CWAs ($140 per kit)
  - Can do liquids too
  - Stores well (keep cool)
- Disadvantages
  - 15-25 minute test time
  - Complicated instructions
  - “Trainer” kits are only differentiated from the real thing by a hard to see blue band around the dark olive green package.
  - Interferents: some smokes, high temperatures, and petroleum products
  - Per use cost of $140 is high if multiple samples are required

Colorimetric Tubes

Often referred to as “Draeger” tubes after the German manufacturer, a colorimetric tube is a glass tube filled with a silica substrate coated with reagent that will produce a color change when exposed to the chemical of interest. The user draws a predetermined sample through the tube and reads the scale like reading an old glass thermometer. The

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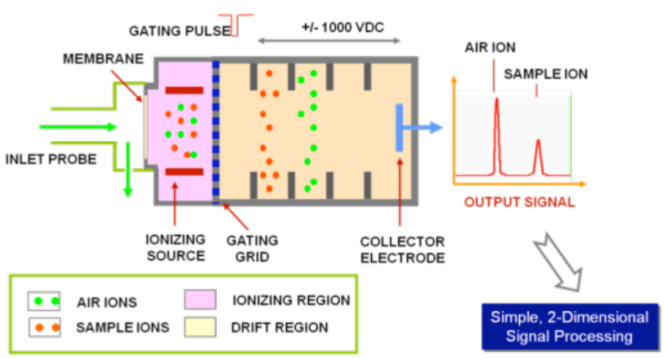
tube is calibrated at the factory and this calibration is printed on the side of the tube as a scale. Calibration is typically valid for operation life of tube (2 years).

- Advantages
    - Proven technology
    - Factory calibrated (no expensive calibration gas required)
    - Relatively inexpensive vapor detection technique ($2-10 per sample)
- Disadvantages
    - "Snap Shots," non-continuous, no alarms can result in sampling error
    - Respond in minutes rather than seconds
    - 15-25% accuracy Piston/Bellows style
    - Readings subject to interpretation
    - Does not store well, tubes expire, and large stock is expensive to keep up to date (keep cool)

Traditional "Closed Loop" IMS

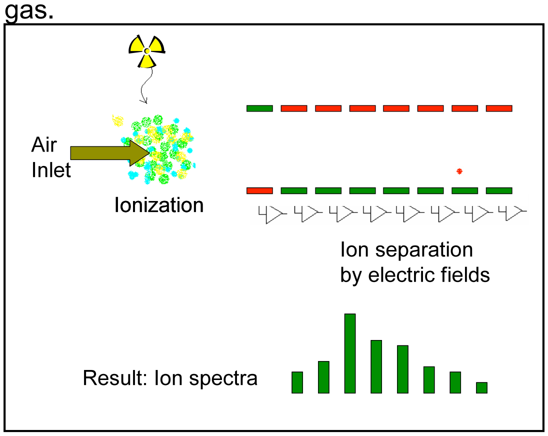


Ion Mobility Spectroscopy (IMS) uses a radiation source (ionizing and non-ionizing) to break down a sample into ions that then travel down a magnetic drift tube to generate a characteristic spectra or "picture." This picture is matched up against pictures in the detector's library to provide a positive identification. One simplistic way to look at IMS is "ion distillation." In traditional closed loop IMS, the ion cell is separated from ambient air by a membrane to keep contaminants from affecting the signal. Clean air, provided by a sieve pack, keeps the inside of the ion cell perfectly clean. Sometimes chemical dopants are also used to keep contaminant under control. For example, acetone is used by one manufacturer to help absorb moisture. Membranes, sieve packs, and dopants are expensive consumables that have to be periodically replaced (typically annually depending on use). Sometimes change out is predictable but they can fail unpredictably when presented with gross contaminants. The membrane slows response time, especially on VX, and also slows recovery when the detector is exposed to high chemical concentrations. Some closed loop IMS CWA detectors need to be "exercised" or run once per day/week/month or else they will not work when an emergency comes. To "exercise" a detector, turn it on, wait for it to stabilize, challenge it with simulant, and then wait for it to clear. This process may take over an hour.

- Advantages
    - Sensitive instrument good for vapor detection
    - Military proven technology
    - Quick response time
    - Good detection of class (i.e., G vs. H)
- Disadvantages
    - False positives to many common urban chemicals
    - Small to no TIC capability until $20-30K detectors
    - Some use radioactive sources that require NRC license and periodic wipe testing
    - Unpredictable maintenance intervals, if the sieve gets chemically contaminated it will not work
    - Membranes slow response time
    - Stores poorly, must be exercised
    - Can be expensive to maintain, lifetime costs of +$2/hr of use

Open Loop or "Aspirated" IMS

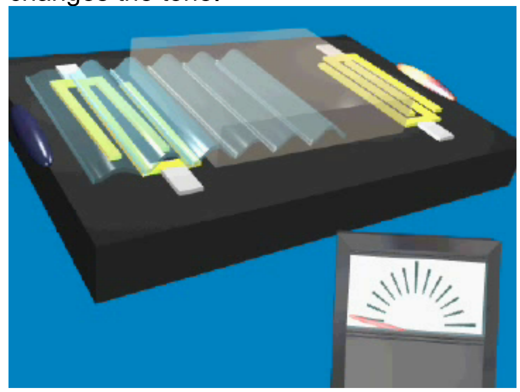
The open-loop IMS sensor uses a Nuclear Regulatory Commission (NRC) exempt Am^{241} (Americium) ionization source. As safe as a smoke detector, it does not require periodic nuclear wipe tests like Ni^{63} in some other IMS products. The IMS sensor is open to the environment, no membrane or sieve pack is used to maintain cleanliness in the sensor. Because of this, the open loop IMS can provide much faster response and clearing times than closed loop IMS, allowing for open-loop IMS to also be used for location or "sniffing." The high ionization potential of its Am^{241} source allows it to be used to sniff for GB, chlorine, and other high ionization potential chemicals largely unseen by PIDs with a 10.6eV lamp. Life-cycle costs and logistical footprint are much less than those of traditional IMS and flame-spectrophotometer based devices because it does not require costly membranes and sieves to keep the sensor clean and it does not use expensive hydrogen gas.



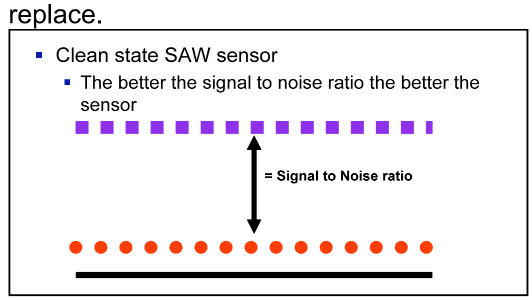
- Advantages
    - Fast enough to both locate and classify
    - Military proven technology
    - Good detection of class (i.e., G vs. H)
    - Good TIC capability (~40)
    - As safe as a smoke detector
    - Predictable service intervals
    - Stores well, no need to exercised
    - Inexpensive to maintain, lifetime costs ~$0.33/hr of use
- Disadvantages
    - False positives to many common urban chemicals (typically shown as a "Chemical Threat" alarm)

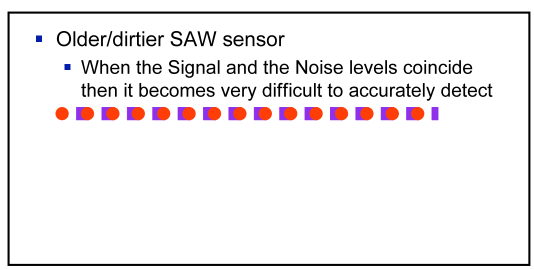
Surface Acoustical Wave (SAW)

A waveform (sound) is generated on a quartz substrate. The substrate is coated with a polymer that has an affinity with the chemical to be detected. When the target chemical bonds with the polymer coating, the wave form frequency changes (tone changes), indicating that the target chemical is present. Selectivity comes from the choice of the polymer coating. Simplified, a SAW is essentially a polymer ("paint") on a quartz substrate; the chemical of interest is absorbed into the paint and changes the tone.



While an elegant solution, the problem with SAWs is chemical contamination of their polymer coatings. Consider a handprint by a light switch on the wall. After cleaning the handprint (especially with small children), it comes back. Eventually cleaning the handprint is not enough and the wall must be repainted. As the paint (polymer) in a SAW absorbs chemical, some of that chemical (either target or interferent) is left behind. As chemical is left behind, the baseline signal rises. Eventually the baseline signal rises to the point that it equals the signal level. When detection is no longer possible, a new sensor is needed and SAW sensors are expensive to replace.



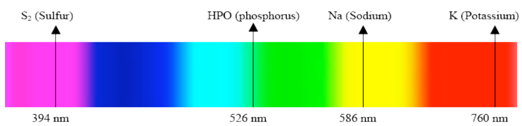


- Advantages
    - Very specific vapor detector
    - Proven technology

- Stores well (assuming no contaminants in the air)
- Disadvantages
    - Some common vapors (like alcohols) may ruin the polymer coating
    - While specific, they are less sensitive and often do not alarm until IDLH levels
    - Unpredictable end of life
    - Lifetime costs can be significantly higher than IMS based products ($2.40 per hour of use)

Flame Spectrophotometry

Chemicals produce characteristic electromagnetic spectra (colors) when they burn in a colorless hydrogen flame. The detector looks for the spectra that are specific to sulfur and phosphorous compounds that are a defining characteristic of blister and nerve agents. It quantifies by the intensity of the color.



The brighter the color, the more chemical is present. It is very sensitive and quick to respond to chemicals that contain sulfur (blister) and phosphorous (nerve). However, this technology is perhaps the least specific to CWAs of any of the competing technologies because any chemical containing phosphorous or sulfur will give false positive alarms. Product manuals warn against locating near exhausts, which can produce blister alarms because sulfur dioxide is a byproduct of the combustion process. Phosphorous is not just in organophosphates, its largest use is as a fabric safe whitener in detergents. So if one does not rinse clothing thoroughly, a Flame Spectrophotometry detector could improperly identify detergent residue as nerve agent contamination. These devices only classify to the main chemical species and are not as specific as IMS and SAW detectors, which are much more specific to organophosphates and blister agents.

- Advantages
    - Military proven technology
    - Quick response time
    - Stores well, no memory affect
- Disadvantages
    - EXPENSIVE to purchase
    - False positives to exhausts, fuel spills, and detergent
    - Does not measure TICs (unless they have sulfur or phosphorous in them)
    - Run time constrained by hydrogen size to 12 hours per cylinder (@$100 per cylinder)
    - Long-term operations can be hindered by the requirement for hydrogen gas
    - Hydrogen gas is difficult to ship by air, which hinders air deployment of this technology (hydrogen fill station costs $75K)
    - $9+/hour to run

Orthogonal Detectors

"Orthogonal" means to look at something from many different angles and orthogonal detectors do this by using a variety of sensors rather than just one type to come to a conclusion. Each sensor has its strengths and weaknesses. "Sensor fusion" takes advantage of this by utilizing the strengths of a number of sensors to come to a final conclusion. Advanced signal processing is used to match the pattern from the sensor array to a library of compounds. By using multiple sensors, the goal is to increase sensitivity while reducing false alarms. Another way of looking at this is that redundancy is built into the detector.

- Advantages
    - Less false alarms
    - More chemicals detected than just a short CWA list
    - Great when they cost less or the same as the sum of the various detectors that they replace
- Disadvantages
    - Can be very expensive
    - Can be larger and heavier
    - Their value is questionable when they cost much more than the sum of the detection technologies they include

CWA Classifiers Can Be Fooled

CWA classification techniques were designed for the battlefield environment and do not always take into account cross-sensitivities from common chemicals found in the urban environment. Low vapor pressure for most CWAs complicates classification because other low vapor pressure chemicals can fool the algorithms. This is not a condemnation of CWA classifiers, just a realization that multiple confirmational techniques may be required in CWA response. CWA classifiers tend to take longer to come up with a solution when presented with simulants than if presented with the real thing.

CWA Simulants/Cross-Sensitivities for Classifiers

- Brake fluid (nerve on some IMS)
- Anti-freeze (blister on some IMS)
- Anything with methyl salicylate (oil of wintergreen) including: Skoal, Wintergreen Altoids, Peppermint Oil, Mennen "Speed Stick," "Deep Heat," Ben Gay, (blister on some IMS)
- Detergent residue on clothing due to the phosphorous in "whiteners" (nerve-Flame Spectrophotometry)
- Sulfur compounds in fuel products or exhaust (blister-Flame Spectrophotometry)
- Fingernail polish remover (nerve-M8)
- Cleaners that containing esters including: "Super Gleam" glass cleaner, ACE Brand window cleaner, "Spray-9" industrial cleaner (nerve on some IMS)
- Real toxic materials (chemically similar to nerve)
    - Parathion (nerve)
    - DMMP: Dimethyl Methyl Phosphonate (nerve)
    - TEP: Triethyl Phosphate (nerve)
    - Sevin (nerve)

CWA Identification

After a chemical has been located and classified in some special situations, it is necessary to identify it. Speciation (typically spectroscopy) technologies are used to identify chemicals so that additional actions can be taken. "Spectroscopy" is the study of how electromagnetic radiation interacts with the atoms and molecules:

- "Infrared" or FTIR spectroscopy is the study of how infrared light is absorbed by the bonds between atoms that form molecules
- Mass Spectroscopy ionizes pure chemical peaks, produced by a gas chromatograph, which breaks down into characteristic and identifiable pieces; this spectral "fingerprint" is unique to a particular chemical and can be matched to a library.

Essentially spectroscopy is the science of taking a "picture" and matching that picture to another known "picture" in a library. Once a spectrum is acquired, the system software can perform a search analysis for the "unknown" in question.

Integrating Gas Detection Technologies

Every technology has its strengths and weakness. In the following chart, there are three continuums. The top line moves from broadband detection to very specific gaseous detection. The second line is a metaphoric line and the lowest line represents speed of detection. A PID can locate contamination in seconds. Metaphorically speaking, the PID can get to the right state in seconds. An IMS product can classify in 10s of seconds. Metaphorically speaking, it can get to the right town in 20-30 seconds. A GC/MS can identify a gas/vapor in 15-25 minutes. Metaphorically speaking, it can identify the correct "address" in 15-25 minutes. So a PID can be used to find contamination while an IMS can classify it. While classification is adequate for making antidote decisions in the field it is not good enough for evidence and a GC/MS or FTIR analysis of the sample provides more solid identification.

Environics USA, Inc.
1308 Continental Drive, Suite J, Abingdon, MD 21009
Tel: (410) 612-1250, Fax: (410) 612-1251
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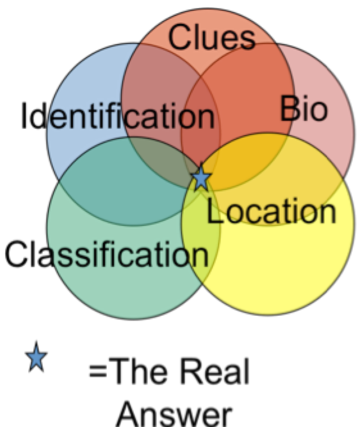
Putting It All Together

In the following diagram, each circle represents whether or not a particular technique/clue is providing a positive response. By overlaying multiple techniques, a solution can be zoomed in on just like a detective uses multiple clues to solve a crime. Multiple techniques should be used until the user feels comfortable with the solution.



Physical clues

- Any signs of dissemination techniques?
- What is going on with the weather or indoor environment?
- Are there any physical clues?

Biological clues

- Are there any dead animals or ones that display SLUDGEM /DUMBBELLS type symptoms?
- Are there any human victims displaying SLUDGEM /DUMBBELLS symptoms?

Location devices

- Using PID, FID, M9, are there any areas of higher concentrations?

Classification devices

- What are the color change technologies saying?
- What is the CWA detection technology(s) saying?

Identification devices

- Verify the above clues with an identification technology

In the future represented by the old TV show "Star Trek," one of the characters "Mr. Spock" used a "Tricorder" to analyze unknown environments. But even in this future, the Tricorder was given to the smartest guy on the spaceship. In present-day CWA response, smart decisions must be made using not only the high-tech detection technologies provided, but also the clues that users can see with their own eyes.

About the Author

Christopher Wrenn is the Sr. Director of Sales and Marketing for Environics USA, a provider of sophisticated gas and vapor detection solutions for the military, first responder, safety, and homeland security markets. Previously Mr. Wrenn was a key member of the RAE Systems team. Chris has been a featured speaker at more than 20 international conferences and has written numerous articles, papers, and book chapters on gas detection in HazMat and industrial safety applications.