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ABSTRACT

First responders need appropriate measurement technologies for evaluating incident scenes. This report provides information about photoionization detectors (PIDs), obtained from manufacturers and independent laboratory tests, and the use of PIDs by first responders, obtained from incident commanders in the United States and Canada. PIDs are valued for their relatively low cost, light weight, rapid detection response, and ease of use. However, it is clear that further efforts are needed to provide suitable instruments and decision tools to incident commanders and first responders for assessing potential hazardous chemical releases. Information provided in this report indicates that PIDs should always be part of a decision-making context in which other qualitative and more definitive tests and instruments are used to confirm a finding. Possible amelioratory actions ranging from quick and relatively easy fixes to those requiring significant additional effort are outlined in the report.

SUMMARY

In support of the Department of Homeland Security (DHS) Standards Portfolio, a team of the Idaho National Laboratory (INL), Neptune and Company, and SAIC were asked to provide "Support in developing an easy to use, consumer report style performance assessment of existing measurement technologies, to include identifying critical data gaps that hinder our ability to report on a specific performance characteristic for a potentially promising technology." As a result of discussions with the client and first-hand information from users, it was decided to focus on photoionization detectors (PIDs), which are commonly used by first responders to detect chemical vapors.

Incident commanders (ICs) from the United States and one from Canada were interviewed to learn how well PIDs meet their first response needs. In brief, we learned that

- False negative findings are a critical metric for ICs. (False positives will sort themselves out in follow-up analyses.)
- Instrument manufacturers have sometimes oversold the capabilities of their instruments, resulting in the purchase of ineffective or inadequate instrumentation.
- Additional, independent, third-party evaluation of instrument capabilities is needed to establish how well PIDs work in first-response scenarios.
- ICs would like instruments specifically designed to meet first responder needs and specifications. (Current instruments were originally designed for other purposes.)
- Fertilizer/fuel bombs and large volume transporters of chlorine gas, gasoline, and other fuels are of more concern to ICs than exotic chemicals such as chemical warfare agents (CWAs).

PIDs are valued for their relatively low cost, light weight, rapid detection response, and ease of use. We contacted PID manufacturers for information about their instruments and reviewed the findings from an independent performance evaluation of selected PIDs. The independent laboratory evaluation generally matches the experience of users in the field but is not always consistent with the manufacturer's stated capabilities of their equipment.

Information provided in this report indicates that PIDs should always be part of a decision-making context in which other qualitative and more definitive tests and instruments are used to confirm a finding. The performance of PIDs, as observed by users and quantified by independent testing, may affect the ability to make correct field decisions. Many variables influence PID performance and thus decisions based on instrument findings. Therefore, it is strongly encouraged that a decision flow process approach, such as outlined in this report, be used by first responders.

Additional actions DHS may wish to pursue include

- Refined listing of chemical constituents that DHS wants to prepare for emergency response
- Develop a user decision context for PID use in the field
- Expand the decision context for PIDs to other instruments and decision scenarios
- Train DHS decision makers, incident commanders and first responders in the use of these decision tools with specific field instruments
- Plan independent instrument performance validation tests with interpretation and reporting of the results
- Provide independent validation testing of instruments for known chemical constituents of concern
- Develop chemical standards at varying concentrations and with appropriate matrix to demonstrate, in real time, the instrument performance in the field
- Develop and implement components of a decision-based and value-added quality assurance system to support field decision makers.

ACKNOWLEDGMENTS

Our thanks to the incident commanders who allowed us to interview them. They are Chief Luther Fincher of the Charlotte, North Carolina, Fire Department; Chiefs Steve Abraira and Eddie Burns, Jr. of the Dallas, Texas, Fire Department; Chief Bill MacKay, Incident Commander of the Fairfax County Battalion; Captain John Lund of the Idaho Falls, Idaho, Fire Department and Regional HAZMAT Response Team; Deputy Chief Michael Bryant of the Los Angeles County, California, Fire Department; Chief Dave A. Pasquale of the Raton, New Mexico, Fire and Emergency Services; Chief Jeff Bowman of the San Diego, California, Fire Department; Chief John Donnelly of the Washington, D.C. Fire Department; and Chief W. H. (Wes) Shoemaker and Deputy Chief Ken Sim of the Winnipeg, Canada, Fire Paramedic Service.

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ACRONYMS

AEL	Allowable Exposure Limit
ALERT	Advanced Local Emergency Response Team
CATS	Consequence Assessment Tool Set
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosives
CCR	California Code of Regulations
CDC	Center for Disease Control
COG	Council of Governments
CSTI	California Specialized Training Institute
CWA	chemical warfare agent
DECON	Decontamination
DHS	Department of Homeland Security
EMS	Emergency Management System
EPA	Environmental Protection Agency
FBI	Federal Bureau of Investigation
FID	flame ionization detector
FRO	First Responder Operational
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GIS	Global Information System
Haz Cat	hazard categorization
HAZMAT	hazardous materials
HPAC	Hazard Prediction and Assessment Capability
IC	incident commander
ICS	Incident Command System
IDL	instrument detection limit

IDLH	Immediately Dangerous to Life or Health
IMS	Ion Mobility Spectrometry
INL	Idaho National Laboratory
IP	ionization potential
JTTF	Joint Terrorism Task Force
LEL	Lower Explosive Limit
LEPC	Local Emergency Planning Committee
LRN	Laboratory Response Network
MDL	method detection limit
MIPT	Memorial Institute for the Prevention of Terrorism
MSDS	material safety data sheets
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NMCST	New Mexico Center for Specialized Training
OSHA	Occupational Safety and Health Administration
PHRST	Public Health Regional Surveillance Team
PID	photoionization detector
PPE	personal protective equipment
PQL	practical quantitation limit
RSD	relative standard deviation
SOG	standard operating guidelines
SOP	standard operating procedures
STEL	short-term exposure limit
TIC	toxic industrial chemicals
TOV	total organic vapor
TWA	time-weighted average

UL	Underwriters Laboratories, Inc.
UV	ultraviolet
VOC	volatile organic compound
WMD	weapons of mass destruction

Data for First Responder Use of Photoionization Detectors for Vapor Chemical Constituents

1. INTRODUCTION

The Department of Homeland Security (DHS) is interested in assuring that first responders have appropriate measurement technologies for evaluating incident scenes. To that end, a team from Idaho National Laboratory (INL), Neptune and Company, and SAIC was asked to provide “Support in developing an easy to use, consumer report style performance assessment of existing measurement technologies, to include identifying critical data gaps that hinder our ability to report on a specific performance characteristic for a potentially promising technology.” After discussions with DHS, the focus turned to chemical vapor detectors, first-hand information from their users, and independent test results. Incident commanders (ICs) representing cities of various sizes or regional areas from across the United States and one from Canada were contacted. The ICs provided their professional, but subjective, perspectives on instruments used and how well these instruments met their first response needs. Based on their input, a decision was made to investigate only photoionization detectors (PIDs). These field safety tools, valued for their relatively low cost, light weight, rapid detection response, and ease of use, are commonly used by first responders.

This report briefly describes what PIDs are and how they can be used at an incident scene, gives manufacturer’s data about PIDs, presents data from independent tests, and summarizes the interviews with the incident commanders.

2. BACKGROUND

PIDs are typically used in first responder scenarios to give preliminary information about a variety of chemicals. Table 1 lists some chemical warfare agents (CWAs) and toxic industrial chemicals (TICs) that are important to first responders. Many of the time-weighted averages (TWAs) and lethal concentrations (LC-50) for these gases are at the ppm and sub-ppm level, driving the need for sensitivity in a first responder instrument. As noted in the table, some important chemicals are not detected by PIDs, including hydrogen cyanide and chlorine gas.

PIDs generally function in a broad concentration range, with some being linear from less than 1 to 300 ppmv. Higher concentrations can be reached under ideal conditions. Only a small fraction of the analyte molecules are actually ionized in the PID chamber. Consequently, analyte gas can be taken from the exhaust port of the PID and connected to another detector for confirmatory or subsequent analysis.

2.1 Description of PIDs

A photoionization detector is a field instrument that is relatively simple and easy to use. It provides rapid information about volatile organic compounds (VOCs) in air samples. Stand-alone PIDs are usually classified as a total organic vapor (TOV) analytical method. That is, they provide information about the relative magnitude of contamination, but are unable to directly distinguish specific compounds. Another common type of TOV instrument is the flame ionization detector (FID). Although both PID and FID technologies can be used for gas chromatography, PIDs were only investigated as stand-alone detectors. The critical component of a PID is a lamp, which produces photons in the ultraviolet (UV) energy range. The sample is collected by a small air pump and introduced into the PID where it passes in front of the lamp and is exposed to the UV radiation. Atoms and molecules in the sample that have an ionization potential (IP) lower than the energy of the UV lamp are ionized with some efficiency. An electric field then pulls ions to the appropriate electrode where a current can be measured. See Figure 1 for a diagram of a PID instrument.

The instrument response in PIDs is related to an electric current generated by a photoionized molecular ion from the compound. Compounds with higher IPs, such as aliphatics, require more energy for ionization. Other compounds, such as aromatics, have lower IPs and require less energy for ionization. The specific wavelength (energy) of the UV lamp determines which compounds can be ionized. To bracket typical compounds, UV lamps in a PID range in energy from 8.4 to 11.7 eV.

The critical part of a PID is the lamp. These lamps come in different sizes, but most have the shape of an ampoule. The lamp is filled with a low-pressure inert gas that specifies the energy of ultraviolet radiation produced. For example, krypton gas emits 123.9 nm and 116.9 nm radiation, which matches IPs of 10 eV and 10.6 eV, respectively. The 10.6 eV lamp is a common choice in PIDs. Other gases, such as argon and xenon, produce other wavelengths that correspond to other IPs. Basic lamp requirements include a relatively high voltage, a stable source over time, and low power consumption. Older lamp designs had internal electrodes, but more recent lamps do not have internal electrodes. In these lamps, the low-pressure inert gas enclosed in the lamp must be excited by an outside energy source through the lamp wall. This is often accomplished via electrodes placed on the exterior wall of the lamp. These electrodes have a high-voltage, low-current charge with sufficient energy to excite the gas inside the lamp.

Windows must transmit light; however, many materials absorb in the UV energy range interfering with or preventing light transmission and cannot be used as windows for PID detectors. Crystals, such as sapphire, have good transmission in the UV region and can be used as window material. Magnesium fluoride glass windows work well with the krypton gas 10.6 eV lamps, while lithium fluoride windows work well with argon gas 11.7 eV lamps. Both magnesium fluoride and lithium fluoride make a soft glass

Table 1. Chemical warfare agents and toxic industrial chemicals of importance to first responders.[a]

Compound	Structure or Empirical Formula	CAS Number	Lamp Energy (eV)	Correction Factor (sensitivity[b])	8-h TWA (mg/m^3)	8-h TWA (ppbv)	LC-50 (ppmv-min)
Chemical Warfare Agents (CWA)							
Phosgene	O=CCl_2	75-44-5	11.7	2	0.4	100	2
Hydrogen Cyanide	HCN	74-90-8	ND[c]	ND	11	10,000	270
Mustard (HD)	$S(EtCl)_2$	505-60-2	10.6	0.6	0.003	0.46	>230
Lewisite (L)	ClCH=$CHAsCl_2$	541-25-3	10.6	1	0.003	0.35	140
Tabun (GA)	O=PF(Me)(OEt)(NMe_2)	77-81-6	10.6	0.8	0.0001	0.015	20
Sarin (GB)	O=PF(Me)(OiPr)	107-44-8	10.6	3	0.0001	0.017	12
Soman (GD)	O=PF(Me)(OCH(Me)(tBu))	96-64-0	10.6	3	0.00003	0.004	9
Arsine	AsH_3	7784-42-1	10.6	1.9	0.16	0.05	
Cyanogen Chloride	ClCN	506-77-4	ND	ND	0.6 max	300 max	
DMMP	O=P(Me)$(OMe)_2$	756-79-6	10.6	4.3			
GF	O=PF(Me)(O-Cyclohex)$Me)_2$		10.6	3			
Methyl salicylate	2-(HO)$C_6H_4CO_2$Me	119-36-8	10.6	0.9			
Triethylphosphate	O=P$(OEt)_3$	78-40-0	10.6	3.1			
VX	O=P(Me)(OEt)(SetN$(iPr)_2$)	50782-69-9	10.6	0.5	0.00001	0.00091	2
Toxic Industrial Chemicals (TIC)							
Chlorine gas	Cl_2	7782-50-5	ND	ND		0.5	
Benzene	C_6H_6 (also component of gasoline)	71-43-2	9.8	0.55		0.5	
Toluene	C_7H_8 (also component of gasoline)	108-88-3	10.6	0.5		50	
Ethylbenzene	C_8H_{10} (also component of gasoline)	100-41-4	10.6	0.52		100	
Xylene, o, m, p	C_8H_{10} (also component of gasoline)	95-47-6 108-38-3 106-42-3	10.6	0.50 0.43 0.45		100 100 100	
n-Butane	C_4H_{10}	106-97-8	11.7	1.2		800	
n-Octane	C_8H_{18}	111-65-9	10.6	1.8		300	
Acetone	Dimethylketone C_3H_6O	67-64-1	10.6	1.1		500	
MEK	Methylethylketone C_4H_8O	78-93-3	10.6	0.9		200	

Table 1. (continued).

Compound	Structure or Empirical Formula	CAS Number	Lamp Energy (eV)	Correction Factor (sensitivity[b])	8-h TWA		LC-50 (ppmv-min)
					(mg/m^3)	(ppbv)	
Acetaldehyde	C_2H_4O	75-07-0	11.7	3.3		25 max	
Diethylamine	C_2H_7N	124-40-3	10.6	1.5		5	
1,3-butadiene	C_4H_6	106-99-0	10.6	0.85		2	
Isobutylene	C_4H_8	115-11-7	10.6	1			
Diesel Fuel #2 auto	Na[d]	68334-30-5	10.6	0.7		11	
Jet Fuel JP-4	na	64741-42-0	10.6	1			
Jet Fuel JP-5	na	64747-77-1	10.6	0.6		15	
Jet Fuel JP-8	na	64741-77-1	10.6	0.6		15	
Gasoline	na	8006-61-9	10.6	1		300	
Methyl isocyanate	CH_3NCO	624-83-9	11.7	1.5		0.02	

a. Data provided by instrument manufacturers.

b. Consider PIDs for exposure limit decisions when CF<10 and for leak detection decisions when CF>10.

c. ND = Not Detected by PID.

d. Not applicable.

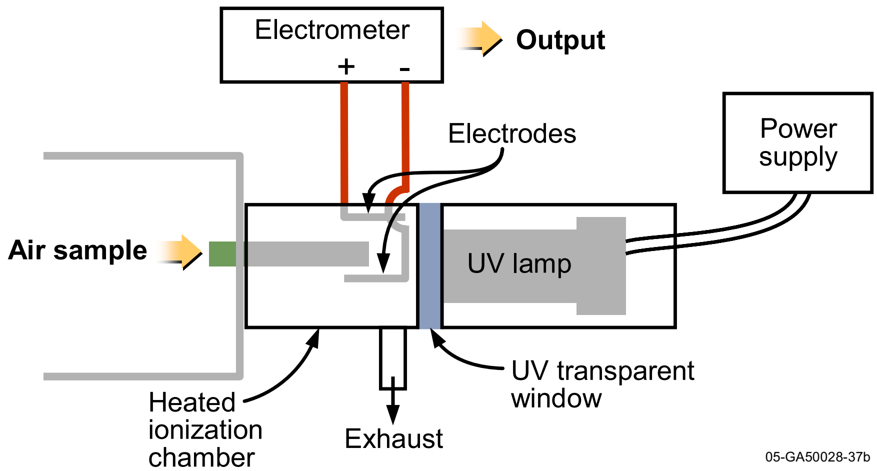

Figure 1. Schematic of a PID.

that is fragile and expensive. These materials are also hygroscopic, making the window susceptible to degradation. Other window materials are also sometimes used. A PID lamp requires frequent cleaning because it is directly exposed to the sample stream and is easily fouled by gases and particles in the air. The periodic cleaning limits the life of the lamp.

Typical lamp energies include 11.7 eV, 10.6 eV, 9.5 eV, and 8.4 eV, with lamps being interchangeable within an instrument. The lamp energies match with the energy needed to ionize typical analytes. The 9.5 eV lamp detects benzene, aromatic compounds, and amines. Switching to the 10.6 eV lamp adds detection of ammonia, ethanol, and acetone. Installing the 11.7 eV lamp adds acetylene, formaldehyde, and methanol. Each lamp only ionizes the chemicals that have IPs lower than its rated energy. Changing lamps for analysis of an unknown air sample can bracket the IP of the unknown. The common components of air, such as nitrogen, oxygen, helium, carbon dioxide, and water vapor, all have IPs higher than 11.7 eV and are not ionized and are not detected.

2.2 Information from PIDs

The response of a PID depends upon the absorption cross section of the molecule, ionization efficiency, and molar concentration of the compound in question. Within a homologous series where IP is related to carbon number, there is also a relationship between PID response and carbon number. The PID response for different compounds with the same carbon number can vary considerably depending upon the IP. Because the instrument response in PIDs is related to a generated electric current, PID response can be affected by high electrical fields (e.g., power lines). PIDs can operate in conditions of high relative humidity and low O_2, but they require a calibration gas that approximates the analysis conditions.

When a chemical constituent is ionized by a PID, it yields a current or response. This response is a characteristic property of a specific chemical constituent that is influenced by its molecular structure. The slope of the response curve is different for different chemicals. To properly report the concentration for a given chemical constituent, the detector uses individual response factors. PIDs are typically calibrated with isobutylene—it is stable, relatively easy to handle, easily available, and can be stored at high pressure. Instrument responses for other gases are obtained by multiplying the reading by a correction factor that takes into account response relative to isobutylene. Instrument manufacturers typically supply a list of correction factors with their product. However, the correction factors are not an absolute scale, and they vary between manufacturers, between lamps, and with the quality of the lamp for the same instrument. Therefore, for accurate readings on specific gases, it is necessary to calibrate each gas individually.

If the sample gas contains other compounds that can form ions, and if the IPs of these compounds are higher than the output of the lamp, then the UV radiation can be scattered and absorbed. This is typically referred to as quenching because it reduces the signal. In air sampling, quench gases include water vapor, carbon dioxide, methane, and carbon monoxide.

PIDs can be extremely sensitive to the composition of the sampled gas, which adversely affects their sensitivity. Common problems include vapors from fuels and partial combustion products from burning materials. These conditions can produce unwanted vapor phase chemicals, aerosols, and small particles in the sampled air. Lamp effectiveness can be limited and the analyte signal can be altered by charge competition. These are not trivial issues for first responders.

2.3 Role of PIDs in Field Decisions

PIDs offer a rapid and convenient indication of whether volatile chemical constituents are present in the air. Consequently, PIDs are among the instruments and tests typically used by first responders in the early phase of a field investigation when harmful volatile compounds may be present. PID information begins the evaluation of the potential threat and helps guide measures for protection of field personnel. The PID provides suggestive, not definitive, information about whether a site has been compromised. This information supports decisions about the potential presence or absence of compounds of concern, but cannot be relied upon to identify or quantify a particular compound. As discussed above, PIDs are subject to false positive and false negative errors, in part because of potential interferences from naturally occurring conditions such as smoke and dust. The site-specific effectiveness of a PID depends in large part on whether it has been calibrated appropriately for site conditions and potential chemical threats.

Figure 2 depicts the typical decision logic for preliminary evaluation of a suspected threat or incident with a potential to release volatile chemical constituents into the air. The diagram addresses two key early decisions: is the threat possible, and is the threat credible? A *possible threat* is one in which the circumstances of a threat warning appear to have provided an opportunity for contamination. This is the lowest threshold in the threat evaluation process and the point at which a decision is made whether to proceed with the investigation. A threat warning is an unusual event, observation, or discovery that indicates the potential for contamination. It may involve a detected security breach, a witness account, direct notification by an alleged perpetrator, an observed catastrophic event, or other means of discovery. A decision about a possible threat is typically made speedily on the basis of already available information. However, a PID may be employed at this early point for the safety of first responders. Thus, the Incident Commander may have access to initial PID results while making the initial determination of whether the threat is possible.

If the threat is determined to be possible, the typical course of action is to screen for chemical constituents at the scene, while at the same time considering an interim operational response (such as evacuating those living or working in the vicinity). Based on interviews with a number of incident commanders (see Section 4 below), a PID is widely considered to be a key element of this characterization effort, perhaps in conjunction with other field instruments. Its purpose is to determine very rapidly whether volatile compounds of interest can be detected in the vicinity. A positive PID response would typically be immediately followed by use of a more specific screening instrument or test (e.g., Draeger tubes or color spot test), and possibly by collection and analysis of vapor samples by gas chromatography or other more definitive techniques to identify what volatile gases are present and estimate their concentration.

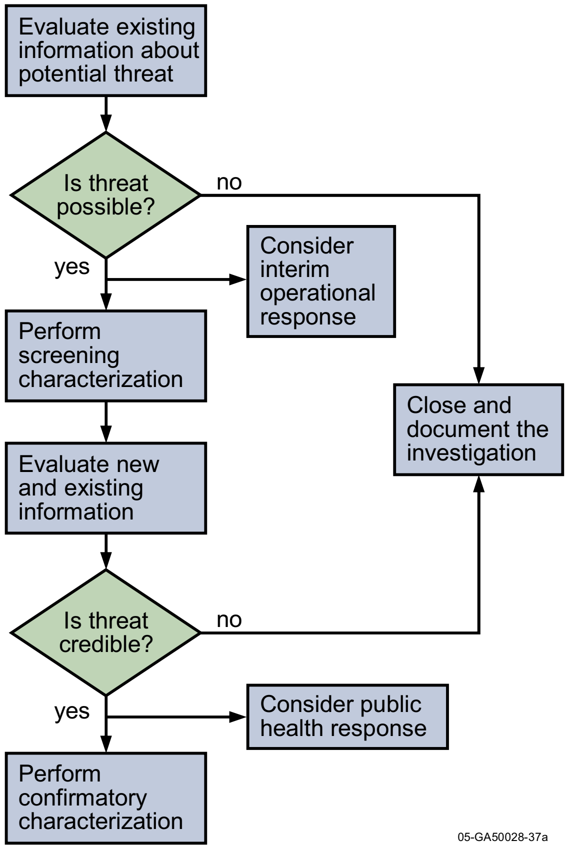

Figure 2. Decision flow diagram for generic preliminary threat evaluation.

The information collected during screening is combined with previously available information to support decision-making about the credibility of the threat. At this point the incident commander may also have access to relevant information from external sources (such as law enforcement authorities), or perspective based on evaluation of previous similar security incidents. A *credible threat* is one in which information collected during preliminary threat evaluation corroborates information from the initial threat warning. If the threat is determined to be credible, then the typical path forward is to conduct confirmatory chemical constituent characterization of the site, possibly combined with a public health response. The goal of confirmatory characterization is to determine exactly which compounds are present and at what concentration. At this stage, continued use of a PID would likely be limited to site worker health and safety support, while other more definitive measurement methods would be used to guide subsequent decisions related to the threat and the extent of the threat.

3. COMMERCIAL PIDS

3.1 Performance Data from Manufacturers

Given the widespread use of PIDs by first responders faced with possible vapor threats, an effort was made to obtain a variety of data from PID manufacturers that could be used to compare and contrast available instruments. PID manufacturers were initially identified in the Responder Knowledge Base (http://www2.rkb.mipt.org/) of the National Memorial Institute for the Prevention of Terrorism (MIPT). This Web site listed 14 PID instruments under their authorized equipment list (dated 2004). The Web site provides summary information about these instruments and links to the manufacturers' Web sites. Some agencies allow only authorized instruments to be purchased using grant monies. A few additional instruments were subsequently identified through Internet searches. The instrument manufacturers were then contacted to obtain information beyond that readily available online. No claim is made that all PID instruments were identified, or that identified instruments represent the best available. Appendix A contains the questions posed to each of the manufacturers contacted for this study and a comprehensive summary of the information obtained from them and reviewing from online brochures and manuals; a brief summary of the key features of the PIDs is presented in Table 2.

To assist in qualitatively comparing instruments, a subset of physical and performance data is presented in a "Consumer Report" style table (Table 3). Four categories were developed for most indicators, with a solid circle being the highest rating and an open circle the lowest; criteria used for scoring are presented below the table. No attempt has been made to re-contact manufacturers to verify that the information provided was correctly interpreted and all categories were based strictly on judgment, with the intent of displaying differences observed, without claiming these differences are critical from the standpoint of use by first responders. In other words, while there was a view of quality of performance in context of a specific use, such analyses are beyond the scope of this effort. Instead, the potential value of condensing information in this manner to assist ICs in selecting appropriate devises for their specific uses was demonstrated.

Table 2. Key features of PIDs as reported by their manufacturers.

Manufacturer and Model	Key features
Aerion Technologies, AIM 450 PID	None reported
GrayWolf Sensing Solutions, Direct Sense TVOC-ppm Multi-Gas PID Monitor	Low price Extended battery life for field applications is available Dynamic range from ppb to 5,000 ppm Multigas and PID detector
GrayWolf Sensing Solutions, Direct Sense TVOC-ppb Multi-Gas PID Monitor	Similar features with a dynamic range from 20 ppb to 20 ppm
Industrial Scientific, VX500 Photo Ionization Detector	Low price Tested durability Minimal response time Dynamic range from ppb to 5,000 ppm
Ion Science, First Check 6000 PID plus	Multigas and PID detector, capable of analysis of VOCs and O_2, CO, H_2S, and LEL Dynamic range from ppb to 10,000 ppm Minimal response time Tested durability

Table 2. (continued).

Manufacturer and Model	Key features
Ion Science, First Check 5000 PID	Similar features, but is used only for VOCs
Mine Safety Applications, Sirius Multigas Detector	Dynamic range of ppb to 2,000 ppm Tested durability Multigas and PID detector, capable of analysis of VOCs and O_2, CO, H_2S and LEL
Photovac, 2020PRO Photoionization Monitor	Dynamic range of 0.1–2000 ppm
PID Analyzers, Model 102 PID analyzer	Dynamic range of 0.1–3000 ppm
RAE Systems, Area RAE	Dynamic range of 0.1–2000 ppm Tested durability PID detector, tested and capable of analysis of 17 of 18 TICs as tested by Longworth et al. (1999, 2001) Field battery life longer than most field instruments, reported by manufacturer as 18 hours Multigas and PID detector, capable of analysis of VOCs and O_2, CO, H_2S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, PH_3, and LEL
RAE Systems, MiniRAE 2000	Dynamic range of 0.1–10000 ppm. This instrument is capable of detecting higher concentrations than most instruments without detector saturation Tested durability Low price
RAE Systems, ToxiRAE Plus PID	Dynamic range of 0.1–2000 ppm Tested durability Very low price
RAE Systems, ppb RAE	Dynamic range of 0.001–2000 ppm. This dynamic range is lower and provides a greater span than most other field PIDs Tested durability Average battery life
RAE Systems, MultiRAE plus	Dynamic range of 0.1–2000 ppm Low price Tested durability Multigas and PID detector, capable of analysis of VOCs and O_2, CO, H_2S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, PH_3, and LEL
Thermo Electron, Photovac 2020 PID Monitor	Dynamic range of 0.5–2000 ppm
Thermo Electron, TVA-1000B Toxic Vapor Analyzer	Dynamic range of 0.1–2000 ppm High precision instrument as reported by manufacturer

Table 3. Comparison of manufacturer's data for PID instruments.

Manufacturer	Instrument Model	Precision	Dynamic Range	Response time (s)	Weight (lbs)	Battery life	Cost	Cost
Aerion Technologies	AIM 450 PID	◕	ND	ND	◕	◐	ND	ND
GrayWolf Sensing Solutions	Direct Sense TVOC-ppm Multi-Gas PID Monitor	ND	◕	○	ND	●	◕	$3,995
GrayWolf Sensing Solutions	Direct Sense TVOC-ppb Multi-Gas PID Monitor	ND	◐	○	ND	●	◕	$3,995
Industrial Scientific	VX500 Photo Ionization Detector	ND	◕	●	●	◕	◕	$2,995
Ion Science	FirstCheck 6000	●	●	●	●	◕	○	$6,995
Ion Science	FirstCheck 5000	●	●	●	●	◕	◐	$5,995
Mine Safety Appliances	Sirius Multigas Detector	◕	◕	◕	●	ND	ND	ND
Photovac	2020PRO Photoionization Monitor	◕	◕	●	●	◐	ND	ND
PID Analyzers	Model 102 PID analyzer	●	◕	●	●	ND	ND	ND
RAE Systems	Area RAE	●	◕	◕	○	◕	◐	$6,000
RAE Systems	MiniRAE 2000	◕	●	●	●	◐	◕	$3,245
RAE Systems	ToxiRAE Plus PID	◕	◕	◕	●	◐	●	$1,450
RAE Systems	ppbRAE	●	●	●	●	◐	◐	$6,000
RAE Systems	MultiRAE Plus	◕	◕	◕	●	◐	◕	$3,000
Thermo Electron	Photovac 2020 PID Monitor	◕	◕	●	●	◕	ND	ND
Thermo Electron	TVA-1000B Toxic Vapor Analyzer	◕	◕	ND	○	◐	ND	ND

Key:	○	◐	◕	●
Precision			+/- 0.5 ppm or 2 ppm or 10%	+/-40 ppb or 10% and 5%
Dynamic Range		0.02–20 ppm	0.1–5000, 0.02–20 ppm, 0.5–2,000, 0.1–3,000 ppm	0.001–2,000 0.1 to 100,000 ppm
Response Time	$\geq$1 min	21–30 sec	6–20 sec	1–5 sec
Weight	>8 lbs.	4–8 lbs.	2–<4 lbs.	0.5–<2 lbs.
Battery Life	<8 hrs	8 hrs	10–18 hrs	180 hrs
Cost	>$6000	$4000–6000	$1500–3999	<$1500
ND: No data available in manufacturer's response				

A quick review of Table 3 shows that all instruments, as reported by their manufacturers, look quite good. Dynamic range is a discriminator, with two instruments capable of measuring constituents in the lower ppb ranges while most cover high ppb to ppm ranges. Cost ranged from $1.5K to $7K. Battery life for most instruments was roughly 1–2 days, while one instrument claimed 180 hours. Most instruments were very light and portable, with two exceptions that weighed more than 8 pounds. It is not clear if all specifications include battery weight, are calling this comparison into question.

3.2 Independent Evaluation of PIDs

Two independent scientific studies authorized by the Expert Assistance (Equipment Test) Program for the U.S. Army Soldier and Biological Chemical Command Program for Domestic Preparedness were conducted to evaluate the use of PIDs and other instruments for the detection of CWAs (Longworth et al. 1999 and 2001). These studies involved rigorous laboratory experimental evaluation of the detectors' performance testing a range of commercially available instruments, many of which were manufactured by the same manufacturers as those reported in this document. The results of these studies tell a very different story than that told by performance data provided by manufacturers. Since those studies, manufacturers have updated PID designs, changed model numbers, and produced new PIDs. None of the models identified in this report match with those tested. However, the results of those studies are still useful in a general sense for evaluation of PIDs.

Longworth et al. evaluated the performance of the detection devices for three warfare agents (Tabun, Sarin, and Mustard) at different concentrations in a range of temperatures and humidities. Four PIDs were tested in 1999; in 2001, multiple units of a single instrument designed to detect constituents at ppb levels were evaluated. This work evaluated the performance of instruments before and after exposure to warfare agents and looked at the effect of various commonly occurring volatiles to evaluate the potential for interference in detecting the agents of concern.

General conclusions of these studies are summarized below.

- UV lamps became easily contaminated by dust, dirt, moisture. and residue during use
- To maintain performance, extensive and frequent cleaning was required, which was considered impractical in the face of a terrorist threat
- PIDs were not considered reliable detectors for detecting CWAs due to the significantly degraded performance once exposed to vapors of CWAs or other substances
- None of the instruments tested, including the instrument designed to detect VOCs at ppb levels, were capable of reliably detecting all three agents at levels of concern
- There was significant variability within units of the same model.

Longworth et al. concluded that due to the poor performance of the selected instruments, further testing would be of little or no value. It is important to note that these studies focused on CWAs, for which instrument sensitivity and consistent performance in the presence of potential interferences, and across a wide range of temperatures and humidities is critical. These tests did not evaluate the performance for the wide range of industrial chemicals that are also considered potential agents for terrorist activities and many of which do not require detection at very low concentrations to protect public health. Nevertheless, the Longworth et al. studies emphasize the need for Homeland Security to develop and implement a comprehensive and rigorous testing program to provide objective information to support ICs in selecting and maintaining appropriate instrumentation for detection of vapor chemical threats.

4. SUMMARY OF INTERVIEW RESPONSES FROM INCIDENT COMMANDERS

To better understand the incident commanders' perspectives on instrumentation available for measurement of vapor threats, ICs across the United States and one from Canada were interviewed. The initial questions posed to them related to instrumentation they have available for use in response to a potential terrorist incident involving CWAs released into the air. Next were questions about the incident scene and decision-making process. Finally, questions were asked about maintenance and training issues. In summary, the interviews revealed that:

- A critical metric for ICs is false negative findings. ICs have indicated that false positives will sort themselves out, as follow-up analyses are always necessary to evaluate a finding importance.
- Instrument manufacturers' have sometimes oversold the capabilities of their instruments, resulting in the purchase of ineffective or inadequate instrumentation. Independent, third-party evaluation of instrument capabilities is an important need.
- Instruments used by first responders were originally designed for other purposes. ICs would like to see instruments specifically designed to meet first responder needs and specifications.
- Exotic chemicals such as CWAs (e.g., VX, GB, mustard) are viewed as a less likely terrorist threat than fertilizer/fuel bombs and large volume transporters of chlorine gas, gasoline, and other fuels.

The individual questions posed are listed below, followed by a short summary of the responses focusing on responses that pertain to the use of PIDs. Appendix B gives the complete responses of each IC. These agencies and ICs are:

- Charlotte, North Carolina, Fire Department, Chief Luther Fincher
- Dallas, Texas, Fire Department, Chiefs Steve Abraira and Eddie Burns, Jr.
- Fairfax County Battalion, Chief Bill MacKay, Incident Commander
- Idaho Falls, Idaho, Fire Department and Regional HAZMAT Response Team, Captain John Lund
- Los Angeles County, California, Fire Department , Deputy Chief Michael Bryant
- Raton, New Mexico, Fire and Emergency Services, Chief Dave A. Pasquale
- San Diego, California, Fire Department , Chief Jeff Bowman
- Washington, D.C., Fire Department, Lieutenant John Donnelly
- Winnipeg, Canada, Fire Paramedic Service, Chief W. H. (Wes) Shoemaker, Deputy Chief Ken Sim.

4.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

A variety of instruments are available to ICs for use in responding to potential vapor threats. PIDs were listed by most ICs as a critical first responder tool. Their typical use is for initial detection of unknowns—PIDs are used upon first entry to a potentially contaminated area. ICs indicated that positive findings must be further analyzed to determine the volatile constituent that caused the positive finding.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Generally, ICs were concerned about the non-specificity of instruments such as PIDs, the possibility that false positives could be triggered by non-target analytes, battery life for long-term events, and lifespan and maintenance of bulbs. Several ICs noted that false positive findings require that more definitive tests be done and eventually sort themselves out, but at a cost of additional resources and time. Most ICs look upon PIDs as only one part of an overall strategy for evaluating a threat.

3. Do they provide more data than needed? Could they be simpler?

ICs provided a range of responses to this question. Many feel the information provided is adequate and the instruments simple enough to be effective. Some feel the instrumentation provides more than is required and they could be simpler. Others recognize that while they may not need the information, others in the response group do. Some instruments include safety levels that are not pertinent to first responders and this feature cannot be easily turned off.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

Additional information that needs to be identified by ICs includes a desire to definitively determine what contaminants are present and the capabilities for detecting radionuclides. No specific comments were made about the adequacy of detection capabilities or sensitivity of the instruments; however, many comments were made about large false positive rates, and one respondent was candid about manufacturers' overselling the capabilities of their instruments and the need for networking to determine what the capabilities really are.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

Most ICs indicated that while chemical warfare agents are of concern, they are more concerned about common industrial chemicals such as chlorine gas or various fuels (e.g., due to proximity of large rail yards).

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

IC responses varied from an indication that there are no media for which they do not have instrumentation to responses indicating media are not well covered by available instrumentation. Some ICs felt that some devices, such as Draeger tubes, were too complex for initial tests. Others indicated they are unable to evaluate water or to test for pathogens such as anthrax or warfare agents such as Sarin without outside help.

4.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

Positive tests are generally treated by ICs as an indication that action is required to evacuate and control access to the affected area and implement other precautionary measures. If Homeland Security threats are present, collaboration with other agencies is common. Follow-up sampling and analysis are also conducted with different methods following positive test results. Negative tests are treated cautiously—false negatives are of great concern. Follow-up sampling and analysis after a negative result is not well defined.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

Some ICs use follow-up testing or parallel testing with multiple instruments, as well as information about the nature of the threat, to address the probability of making an incorrect decision. Others have no plan.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

Most ICs indicated that the highest level of personal protective equipment (PPE) is used to address credible threats, but initial instrument readings also play an important role in PPE selection. Sometimes data obtained en route to the site were used for PPE selection; however, standard procedures seem to be in place and involve assuming the worst-case scenario.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

Responses ranged from lack of standard protocols, to use of common sense, to formal protocols for securing the site and calling in help from other agencies.

4.3 Decision Making Questions

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

Both informal and formal communication networks are in place in various locations, but nothing uniform across state, county, and federal agencies. As far as instrumentation, the primary source of information seems to be word of mouth, or casual discussions. Indications are that while sources of information such as conferences, courses, and trade magazines are available, there is no uniformly used mechanism for exchanging or sharing information, data, or experiences.

2. **Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?**

   Several respondents indicated they have a national source for specifications for detecting chemical agents and selecting instruments. Others indicated they have flexibility to select instruments based on what they believe will meet their needs.

3. **Do you have performance or data quality information on your instruments?**

   It would appear that most respondents rely on instrument manufacturers to provide information on instrument performance. Only one of the ICs indicated that they perform their own testing; most rely on tests performed by laboratories such as Edgewood.

4. **Who or what process determines if more in-depth agent analysis is needed at an incident scene?**

   In most cases, the incident commander, in consultation with other agencies, is responsible for making this call.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

   Responses ranged from state, local, or public health laboratories, or even the FBI, to candid statements that the source to turn to for more in-depth analyses is unknown or *ad hoc*. One responder felt that there should be a coordinated network.

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

   Most responders indicated that the IC makes the decision to get more in-depth analysis and no one instrument would be considered adequate to provide the needed information. Biopathogens are clearly of concern with respect to the capabilities of existing field instrumentation.

4.4 Maintenance and Training Questions

1. **Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?**

   In all cases, there is a program in place to evaluate when to replace or repair instruments, and to maintain their own instruments. Most rely on the manufacturer's recommendations to support this program.

2. **Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?**

   Calibration gases (in particular, hydrocarbons) and manufacturer-supplied standards are generally used; one respondent indicated that for weapons of mass destruction (WMD) agents, non-toxic challenge agents are available.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and user proficiency standards, demonstrations, or evaluations?

All ICs indicated that they have training programs in place, some of which is provided by the instrument manufacturers. General HAZMAT training is also in place.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

In most cases, ICs feel confident they have the expertise and knowledge required and have purchased and supplied a good array of instruments to their first responders. Others admit they have purchased some instruments that have not lived up to their expectations and they desire more objective data to help them. It is not clear whether the answers pertain to readiness for warfare agents or for more common industrial chemical spills and responses.

5. CONCLUSIONS AND PROPOSED NEXT STEPS

Incident commanders faced with possible hazardous chemical releases have very specific perspectives regarding their data needs and the instrument performance required to obtain these data. Their requirements, together with the discrepancies between manufacturers' instrument performance specifications and a limited third-party evaluation of PID performance, indicate a need for further efforts to provide suitable instruments and decision tools to incident commanders and first responders.

Given these findings, it appears that field personnel may not be fully prepared to make decisions as to hazards in the field and necessary actions to evaluate these hazards. Possible amelioratory actions range from quick and relatively easy fixes to efforts requiring significant additional effort. The following are possible follow-up actions to address these shortcomings:

- Refine the listing of chemical constituents to be addressed. Collect additional information about PID use for these chemicals.
- Compile standard procedures to complement the focus list of chemical constituents
- Develop a user decision context for PID use in the field
- Expand the decision context for PIDs to other instruments and decision scenarios
- Train DHS decision makers, incident commanders, and first responders in the use of these decision tools with specific field instruments
- Plan independent instrument performance validation tests with interpretation and reporting of the results
- Develop chemical standards at varying concentrations to demonstrate in real time the instrument performance in the field to complement the focus list of chemical constituents
- Develop and implement components of a decision-based and value-added quality assurance system to support field decision makers.

6. REFERENCES

Longworth, Terri L. et al., 1999, *Testing of Commercially Available Detectors Against Chemical Warfare Agents: Summary Report*, Soldier and Biological Chemical Command, AMSSB-REN, Aberdeen Proving Ground, MD 21010-5424, February 1999.

Longworth, Terri L. et al., 2001, *Preparedness Program: Testing of RAE Systems ppbRAE Volatile Organic Compound (VOC) Monitor Photo-Ionization Detector (PID) Against Chemical Warfare Agents Summary Report*, Soldier and Biological Chemical Command, AMSSB-RRT, Aberdeen Proving Ground, MD 21010-5424, September 2001.

Appendix A

Manufacturer's Data for Responding Companies

Appendix A

Manufacturer's Data for Responding Companies

This appendix presents the data gleaned from the manufacturer's responses to questions regarding

- Quantification limits and dynamic range of the instrument
- Estimates of the False Positive and False Negative rates
- Estimates of the expected precision and bias
- Compounds detectable
- Chemical or physical interferences
- Response time
- Temperature or humidity impacts on performance
- Ease of use
- Recording and reporting capabilities
- Maintenance requirements
- Standards provided with the instrument
- Estimate of ruggedness
- Ability to upgrade hardware and software
- Customer support
- Length of time to purchase
- Level of standardization for hand held computers, laptops, etc.
- Estimates of the field lifetime
- Range of costs for basic instrument and options
- Ability to decontaminate the instrument.

The definitions listed below were used while developing the performance descriptions in Tables A-1 and A-2. Some of these definitions are not included as categories in the tables because manufacturers do not have data in these areas.

Availability—Each vendor was asked how long it would take to obtain their PID.

Cost—The manufacturer's suggested retail cost for the basic instrument.

Customer Support—Type of training manuals, Web sites, technical assistance, or training courses offered by the manufacturer.

Dynamic Range—The range of values for which contaminants will be detected and measured. Includes a defined lower level and upper level of instrument response.

Ease of use—The skills and training required for proper device operation, including any specialized training required by the operators. Essentially all PIDs are reported as being easy to operate for first responders.

False Negative rate—Probability of the instrument failing to respond when the compound is present at or above the expected detection level. Without a controlled study, false negatives are difficult to quantify and any quantification under controlled conditions is likely to change in real-world matrices with multiple interferants.

False Positive rate—Probability of the instrument providing a compound response when the compound is not present. If the instrument is susceptible to electronic drift, this may provide for a false positive finding. In PIDs, false positives are generally associated with the presence of a non-target analyte and are difficult to quantify.

Field lifetime (battery, one-time use)—Operation time in the field based upon battery life.

Interference complications—Interference causes problems with detection of the compounds of interest. This could be interference from other compounds, environmental conditions such as smoke or dust, or instrument background noise.

Level of standardization—Compatibility of PID with standard interfaces and plugs. For example, does it plug into standard hand-held computers, laptops, etc.? Can it be used in conjunction with other devices?

Maintenance requirements—The maintenance needed for proper instrument operation. For example, the type of calibration and cleaning required.

Performance in range of humidity—The relative humidity range in which the instrument performs well. May include a defined humidity level at which instrument performance deteriorates.

Precision (variability, repeatability, etc.)—The degree of mutual agreement of independent measurements generated through repeated application of a process under specified conditions. Instrument precision is usually thought of as repeatability of a specific measurement and is often reported as relative standard deviation (RSD).

Range of contaminants detected—Number of different contaminants detectable by the defined instrumentation and its set-up, e.g., lamp energy. Some contaminants of interest are listed in Table 1 of the report.

Reporting capabilities—Format(s) for reporting data from the instrument. For example, can the instrument retain and periodically download data to databases by hard wire or wireless? Are standard computer graphics possible?

Response Factor—When a chemical constituent is ionized by a photoionization detector, it yields a current or response. This response is a characteristic property of a specific constituent that is influenced by its molecular structure. Response factors are different for all chemicals and a PID is calibrated against a standard, such as isobutylene gas, thereby yielding a response that is automatically corrected to the standard response factor instead of the individual compound concentration.

Response time—The amount of time required to produce at least a 90% contaminant response.

Ruggedness—Durability of the instrument. For example, are there likely device failures, what are the routine maintenance requirements and what type of repairs may be required? Has an instrument ruggedness test been performed?

Sensitivity—Sensitivity is the ability of an instrument to discriminate between small differences in analyte concentration. It can be discussed in terms of an instrument detection limit (IDL), a method detection limit (MDL), and as a practical quantitation limit (PQL). This performance measure is the lower limit of the dynamic range.

Upgradeability—Ability of the instrument to be upgraded to perform under a different set of conditions. Are there manufacturer components available to upgrade the instrument?

Weight—How much the field instrument, including battery pack, weighs.

The specifications, such as precision, for each instrument are given in Table A-1; additional information, such as cost, is given in Table A-2.

Table A-1. Data provided by instrument manufacturers (Part 1).[a]

Manufacturer/Instrument	Precision (variability, repeatability, etc.)	Dynamic Range	Response Time (sec)	Humidity Range	Reporting			Weight (lbs)	Battery Life in Single Field Use
					Display	Data Log	Wireless		
Aerion Technologies www.aimsafety.com									
AIM 450 PID	10%			0–80			Numerical LED	3.2	8
GrayWolf Sensing Solutions, LLC www.wolfsense.com									
Direct Sense TVOC-ppm Multi-Gas PID Monitor		0.1–5000 ppm	1 min	0–90					180
Direct Sense TVOC-ppb Multi-Gas PID Monitor		0.02–20	1 min	0–90					180
Industrial Scientific Corporation www.indsci.com									
VX500 Photo Ionization Detector		0.1–5000 ppm	3	0–90	Yes	1800	No	1.6	18
Ion Science, Ltd www.ionscience-americas.com/pages/first.htm									
FirstCheck 6000	5%	0.1–10000 ppm	1	0–99			LCD numerical and 20000 point data log	1.3	10 to 16
FirstCheck 5000	5%	0–10000 ppm	1	0–99			LCD numerical and 20000 point data log	1.3	10 to 16
Mine Safety Applications Company www.msanet.com									
Passport PID II Monitor									
Passport PID II Organic Vapor Monitor		0.1–10000 ppm		0–100			Numerical or graphical		
Sirius Multigas Detector	10% or 2 ppm whichever greater	0.1–2000	20 sec normal: 30 sec ppb range	0–95	Yes	Optional	LCD, data logging	1.45	6 to 11
Photovac, Inc www.photovac.com									
2020PRO Photoionization Monitor	10% or 2 ppm whichever greater	0.1–2000 ppm	3				LCD numerical, 15000 points	1.9	8

Table A-1. (continued).

Manufacturer/Instrument	Precision (variability, repeatability, etc.)	Dynamic Range	Response Time (sec)	Humidity Range	Reporting			Weight (lbs)	Battery Life in Single Field Use
					Display	Data Log	Wireless		
PID Analyzers, LLC www.hnu.com									
Model 102 PID analyzer	1%	0.1–3000 ppm	1		Yes	7000 point	No	1.9	
RAE Systems, Inc www.raesystems.com									
Area RAE	+/- 2 ppm or 10% @ <500 ppm	0.1–2000 ppm	10	0–95%rh	Yes	10000 point	Yes	8.5	18
Area RAE Wireless									18
MiniRAE 2000	+/- 0.5 ppm or 10% @ <2000 ppm	0.1–10000 ppm	3	0–95	Yes	10000 point	No	1.25	8
RAE Systems, Inc	+/- 0.5 ppm or 10% @ <500 ppm	0.1–2000 ppm	20	0–95	Yes	4000 point	No	0.5	8
ppbRAE	+/- 40 ppb or 10% of reading	0.001–2000 ppm	5	0–95	Yes	16000 point	No	1.3	8
MultiRAE Plus	+/- 2 ppm or 10% @ <500 ppm	0.1–2000 ppm	10	0–95	Yes	10000 point	No	1	8
Thermo Electron Corporation www.thermo.com									
Photovac 2020 PID Monitor	10% or 2 ppm whichever greater	0.5–2000 ppm	3	0–100		1000	No	1.75	10
TVA-1000B Toxic Vapor Analyzer	1%	0.1–2000 ppm					No	12	8

a. If space is blank, then data were not reported by the manufacturer.

Table A-2. Data provided by instrument manufacturers (Part 2)

Manufacturer/Instrument	Cost ($)	Maintenance Requirements	Ruggedness	Upgradeability	Customer Support	Availability	Level of Standardization
Aerion Technologies www.aimsafety.com							
AIM 450 PID							
GrayWolf Sensing Solutions, LLC www.wolfsense.com							
Direct Sense TVOC-ppm Multi-Gas PID Monitor	3,995.00	Weekly with isobutylene		Software components available		10–15 days	Needs PDA or laptop
Direct Sense TVOC-ppb Multi-Gas PID Monitor	3,995.00	Weekly with isobutylene		Software components available		10–15 days	Needs PDA or laptop
Industrial Scientific Corporation www.indsci.com							
VX500 Photo Ionization Detector	2,995.00	Monthly calibrate and clean lamp 40 hrs of use	Passed numerous drop tests at cold temperature	Software upgrade in field, hardware at factory.	7 days/week	7 day	PC via a data link accessory, $495.
Ion Science, Ltd www.ionscience-americas.com/pages/first.htm							
FirstCheck 6000	6,995.00	Annual factory calibration	Can survive 1 meter ATEX drop	IR link and upgradeable software	National and U.S. headquarters	Available/in stock	XP and IRDA interface
FirstCheck 5000	5,995.00	Annual factory calibration	Can survive 1 meter ATEX drop	IR link and upgradeable software	National and U.S. headquarters	Available/in stock	XP and IRDA interface
Mine Safety Applications Company www.msanet.com							
Passport PID II Monitor							
Passport PID II Organic Vapor Monitor							
Sirius Multigas Detector		Isobutylene calibration	Survived standard drop tests	Optional computer data logging	Toll free number	Available/in stock	MSA FiveStar LINK

Table A-2. (continued).

Manufacturer/Instrument	Cost ($)	Maintenance Requirements	Ruggedness	Upgradeability	Customer Support	Availability	Level of Standardization
Photovac, Inc www.photovac.com							
2020PRO Photoionization Monitor							RS-232
PID Analyzers, LLC www.hnu.com							
Model 102 PID analyzer							RS232
RAE Systems, Inc www.raesystems.com							
Area RAE	6,000.00	Weekly zero and calibration, one lamp 2–3 years @ $395	Used in field, can survive 3 ft to concrete	Software free, some hardware	24 hour phone	48 hr	RS-232 or USB
Area RAE Wireless							
MiniRAE 2000	3,245.00	weekly zero and calibration, one lamp 2–3 years @ $395	Used in field, can survive 3 ft to concrete	Software free, some hardware	24 hour phone	48 hr	RS-232 or USB
RAE Systems, Inc	1,450.00	weekly zero and calibration, one lamp 2-3 years @ $395	Used in field, can survive 3 ft to concrete	Software free, some hardware	24 hour phone	48 hr	RS-232 or USB
ppbRAE	6,000.00	weekly zero and calibration, one lamp per year @ $195	Used in field, can survive 3 ft to concrete	Software free, some hardware	24 hour phone	48 hr	RS-232 or USB
MultiRAE Plus	3,000.00	weekly zero and calibration, one lamp 2-3 years @ $395	Used in field, can survive 3 ft to concrete	Software free, some hardware	24 hour phone	48 hr	RS-232 or USB
Thermo Electron Corporation www.thermo.com							
Photovac 2020 PID Monitor							RS-232
TVA-1000B Toxic Vapor Analyzer							

a. If space is blank, then data were not reported by the manufacturer.

Appendix B

Interview Responses from Incident Commanders

Appendix B

Interview Responses from Incident Commanders

Incident commanders (IC) from across the United States and one from Canada were interviewed to learn their perspectives on instrumentation available for measuring hazardous vapor that might be present. The initial questions posed to them related to instrumentation they have available for use in response to a potential terrorist incident involving chemical agents released into the air. Questions were asked about the incident scene and decision-making process. Finally, questions were asked about maintenance and training issues. For each IC, the individual questions are given, followed by the response.

B-1. CHIEF LUTHER FINCHER, CHARLOTTE, NORTH CAROLINA, FIRE DEPARTMENT

Robert C. Gareri and Joseph D. Evans conducted this interview during February 2005.

B-1.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

We currently utilize four-gas air monitors, PIDs, colorimetric chips and tubes, weapons of mass destruction (WMD) test papers, and chemical agent detectors. These include:

a. Industrial Scientific TMX-412 and ITX meters

b. Industrial Scientific VX500 PIDs

c. Biosystems, 4 gas meters

d. Draeger tubes and chips

e. M-8 and M-9 Chemical test papers

f. Rae Systems Multirae 4 gas meters

g. Rae Systems Minirae PID

h. Smiths Detection APD 2000

i. Microsensor Systems SAW minicad.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Yes, they provide a wide array of detection capabilities and provide a starting point for the HAZMAT team to advise the IC on a hazard class or category.

a. We need long-term instrumentation for extended events with remote data transfer for standoff capability

b. Errors in interpretation of readings can occur if a wrong correction factor is utilized

c. Cross sensitivity of sensors to interference gases can cause problems

d. They are expensive to calibrate and maintain; for example, the APD 2000s must be sent to the manufacturer each year for calibration and radiological swipe tests

e. Lifespan of the electro-chemical sensors and PID bulbs

f. Cost of the simulant and calibration gas

g. Manufacture need to provide software updates to overcome problems with some instruments false positives.

3. Do they provide more data than needed? Could they be simpler?

We feel they provide accurate data for their specific intention. Meters could always be made simpler. The initial on-scene responders basically need an inexpensive go/no go meter with none of the bells and whistles. Our 4-gas meters provide the data based on Occupational Safety and Health Administration (OSHA)/National Institute of Occupational Safety and Health (NIOSH) standards. Time-weighted average (TWA) and short-term exposure limit (STEL) values are built into the 4 gas meters and most of the time this data is not needed by the IC. The newer meters allow the "hiding" of these readings for later retrieval if needed. If I could design the perfect meter it would be one that would go into alarm if it detected any atmosphere or condition where the firefighters bunker gear and air pack did not provide him the level of protection needed to keep him safe.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

It would be helpful to have telemetry from the hot zone that integrates into a real-time Global Information System (GIS) model for better determination of where the contamination is and where is it going. This telemetry could be tied into existing modeling systems such as Consequence Assessment Tool Set (CATS) and Hazard Prediction and Assessment Capability (HPAC).

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

a. We utilize a multitude of capabilities on multiple companies

b. All HAZMAT units carry multiple instruments from different manufacturers

c. Each Ladder Company carries a four-gas monitor. Engines are being upgraded to 4-gas capability. Radiation detectors have been ordered for all of our apparatus.

d. A laboratory-working group has been established and procedures are being developed at this time to decrease lag time for confirmation by using existing local laboratories.

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

a. For solid and liquid tests we can utilize a Sensor IR. This requires a high degree of training and competence to use.

b. PIDs give an indication that a volatile organic vapor (VOC) is present, but do not identify the specific VOC

c. Performance of the bio test kits shows a tendency to give false positives.

B-1.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

a. With a positive reading from the instruments, we isolate the area, have our personnel in proper personal protective equipment (PPE) with respiratory protection, determine the cause, and ventilate until the area is safe. Also additional meters or test equipment is utilized to verify the first meter readings.

b. With toxic industrial chemicals or VOC, we isolate and determine the specific chemical

c. We also research specific readings/chemicals for follow up from County Environmental Protection Agency (EPA) and Health Departments.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

We utilize different testing methods, meters, and manufacturers of instruments to confirm readings. Verification may be conducted by lab tests if necessary.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

Pre-arrival information, incident location, and on-scene evaluations figure into their response to incidents. They have the proper PPE up to the level of their training, HAZMAT Ops +. All engines and ladders have basic air monitoring capabilities. The HAZMAT team always carries all of their testing equipment with them, and they carry equipment to make Level A entries.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

We would request assistance from County EPA, County Health, and other appropriate agencies. For sick building syndrome, for example, we would advise the responsible party to contract with an industrial testing company through County EPA and County Health. The IC, if he has reason to believe WMD/Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE), has the ability to call additional resources to assist him on scene. These include the ALERT (Advanced Local Emergency Response Team), Regional hazardous material (HAZMAT) Teams, PHRST (Public Health Regional Surveillance Team), and other state resources.

B-1.3 Decision Making

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

a. Formally, we network through the state regional response teams and the state HAZMAT association

b. Informally, we use word-of-mouth and follow-up on negative reports of instrument or equipment failure

2. Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

We select instruments according to our needs and funds availability. However, we utilize all methods and reports of meter performance and testing that have been done by other agencies.

3. Do you have performance or data quality information on your instruments?

Some of our detection equipment has this information available. Most of this data, though, is provided by the manufacture themselves.

4. Who or what process determines if more in-depth agent analysis is needed at an incident scene?

The incident commander at a scene would make this decision, with the advice of and in consultation with the HAZMAT officers. For a suspected WMD, white powder, CBRNE or other suspected act, the FBI would be consulted or analysis turned over to them to run at the designated testing lab for our area.

5. What is the source of more in-depth analysis? Local, State, Federal, or National Lab?

State lab.

6. What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?

Potential biological agents: meters telling you that something is there and you are unable to identify what it is.

B-1.4 Maintenance and Training Questions

1. Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?

Yes, we have inventory control. We use docking/calibration stations for centralized data collection, maintenance records, tracking of repair, and meter sustainment costs.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

We use actual/bottled calibration gas for meters. The other WMD instruments have non-toxic challenge/testing materials with them that is used.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations or evaluations?

Yes, we have annual HAZMAT training for the firefighters. We utilize quarterly training for the HAZMAT Techs. We bring in outside expert and peer level instructors to assist in the training of our HAZMAT team. We have training officers who duties include keeping all of our personnel current and updated on required training and certifications that the Fire Chief and command staff determine that we need.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

As a department, the Charlotte Fire Department has access to a broad spectrum of knowledge and abilities. The HAZMAT team is highly trained and consists of two separate stations that man four pieces of apparatus. As new technologies come to market we constantly strive to evaluate and determine if they can assist the team.

B-2. CHIEF EDDIE BURNS, JR.
DALLAS, TEXAS, FIRE DEPARTMENT

Robert C. Gareri and Joseph D. Evans conducted the original interview with Steve Abraira during February 2005. Additional information was submitted by Eddie Burns Jr. in October 2006.

B-2.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

a. Colormetric tubes

b. Photoionization detection

c. Metal oxide sensors

d. We use the following brands: RAE, Draeger, AIM, Sensit, Smiths, Ludlum, Alexeter.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Yes.

a. Battery life too short (charging issues)

b. Requires calibration (gas, costs, training, expiration)

c. Readout may be confusing or poorly displayed

d. Costs for repair

e. Expiration of sensors or test strips.

3. Do they provide more data than needed? Could they be simpler?

Data is adequate. Simpler operation is always desirable.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

No additional information.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

Unknown.

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

Not applicable.

B-2.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

A positive test allows us to develop our response plan and site safety plan. It allows us to develop our decontamination (DECON) plan and select PPE. A negative test still requires us to perform additional testing to attempt to classify the contaminant.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

We will conduct similar tests to attempt to analyze the contaminant. When this fails, we rely to lab analysis.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

First responders in our department are trained to make observations from afar and call for backup from the Hazardous Materials Team. The Team will develop a response plan based on what they think the commodity is. Observations include container configurations, material safety data sheets (MSDS) information, user information, signs and/or symptoms of contaminated victims, etc. The PPE selection is based on information provided from the above. Instruments will be selected on what we think the material is or what hazard class we think it is. We always test for radiation, lower explosive limit (LEL), pH, WMD in all incidents, unless we have specific commodity information.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

Of course. You cannot rely solely on instrumentation. We will obtain samples for lab analysis. We would attempt to get more information from a user, shipper, or manufacturer of the material. When sick or dead individuals are present, in addition to toxic industrial chemicals (TICs), one must consider WMDs.

B-2.3 Decision Making

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

It is an informal network. We have an individual in our department who determines which instruments require further evaluation from the Hazardous Materials Team. This individual attends trade shows, and meets with vendors to keep up on technology.

2. Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

We determine which are appropriate based on which instruments will meet our needs.

3. **Do you have performance or data quality information on your instruments?**

Data quality.

4. **Who or what process determines if more in-depth agent analysis is needed at an incident scene?**

The HAZMAT IC.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

Local contract lab—private and public. However, we have sent samples to Federal testing centers.

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

I do not think the technology exists for one instrument to perform all required analysis.

B-2.4 Maintenance and Training Questions

1. **Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?**

Yes. As instruments are sent in for repair, we take the recommendation of the sales or repair representative as to either repair or retire the instrument. We have numerous instruments that experience circuit board malfunctions. These repairs are costly, thus we will replace the instrument.

2. **Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?**

We use specifically calibration gas for test performance. All instruments are calibrated after each use and then monthly.

3. **Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?**

The HAZMAT team provides all refresher training for instruments dispersed throughout the department. Additionally, we have a great factory repair and sales force who stand by all of our needs. We host training sessions for outside as well as internal departments.

4. **Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?**

Yes.

B-3. CHIEF BILL MACKAY
FAIRFAX COUNTY BATTALION, INCIDENT COMMANDER

Dr. Dean Neptune conducted this interview on January 10, 2005, over the telephone with Fairfax County Battalion Chief Bill MacKay, Incident Commander for the Hazardous Materials Special Operation Team, 703/246-4388. Chief MacKay is due to retire shortly and will take a position with the Fairfax County Office of Emergency Management, as a civilian employee, reporting to Mr. Doug Bass, 703/280-0584 the office head. This Emergency Management Office coordinates the various other county offices that may become involved in a hazardous incident.

B-3.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

The following instruments are available for use with the Fairfax County Hazardous Materials Team for response to air borne release of chemical or biological constituents: Rees PID, Military Test Kit Wet Chemistry 256, field deployable Inficon GC/MS, GasTech Monitors for O_2, CO, HS_2, and Combustible Gases, SAM 235 Radionuclide Detector for α, β, γ detection, Smiths Detection Travel IR (currently only works for solid samples) APD2000 and Surface Acoustical Wave Minicad.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

False positive findings, instruments designed for laboratory or military use and not first responders, instrument sometimes represent yesterday's technology or unproven technology for this specific use, expensive, false negatives have often not been evaluated, significant maintenance or calibration requirements, and gas chromatography (GC)/mass spectrometry (MS) requires a technician with significant training to operate the instrument.

3. Do they provide more data than needed? Could they be simpler?

Sometimes the instrument design attempts to do more than needed by the first responder with information such as indicating what protective clothing the responder needs to wear, data logging, and specific type of acid when usually only acid is adequate information for most acids.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

Manufacturers that are not always fully candid regarding instrument capabilities and limitations currently use networking amongst colleagues who have purchased the instrument to find out the true capabilities of instruments. A truly independent party evaluation of instruments considering field performance using conditions established by first responders would be an important step in overcoming this deficiency, rather than bench top performance.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

Exotic chemical and agents are seen by this IC as not the largest threat, but more likely industrial chemicals that are more readily available and useable for a terrorist action, such as chlorine gas or even fuels. Metro Washington D.C. is somewhat unique in that no large rail yards, chemical plants, or refineries are nearly as often found in other metro areas, so this observation may be only correct for Washington.

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

Media are currently not well covered by available instrumentation.

B-3.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

This is a cause for great concern that something has been missed and typically they look for symptoms in exposed individuals or wildlife for additional information. An apparent false negative is of greatest concern especially if exposed individuals do not immediately present symptoms. For biological agents, samples are sent for further confirmation if the situation warrants.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

Letters are provided to the potentially exposed individuals indicating the types of symptoms they should look for over the ensuing several days or weeks and who to call if they are presented. This approach, however, does lead to high rates of pseudo-symptomatic calls from these individuals.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

Protocol is established for all responses and staff is certified according to this protocol, i.e., hope for the best, assume the worst.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

See above response to Question 2 in this section. Typically this IC would not leave the scene under these circumstances and may often call in additional expertise to help sort out the concern that something is potentially being missed. No formal protocol other than a common sense approach.

B-3.3 Decision Making

1. **Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?**

   Washington Council of Governments (COG) meets monthly where information exchanges often occur. Also attend the Fire Department Institute conference where similar exchanges occur. Worth noting is Chief MacKay observation that many courses, for fee from private concerns, are being offered these days that could also be had without fee from various governmental institutions.

2. **Are specifications for detecting chemical warfare agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?**

   Typically, Fairfax Country defines a need (informal specifications) and then looks for potential sources to fill the need. There are a few formal specifications like Underwriters Laboratories, Inc. (UL) approved and the like.

3. **Do you have performance or data quality information on your instruments?**

   Typically ask the instrument manufacturer for performance specifications. Of greatest concern is rate of false positive and negative findings, instrument sensitivity, and potential for interferences from other chemical constituents.

4. **Who or what process determines if more in-depth agent analysis is needed at an incident scene?**

   See above comments on related questions. Usually if more laboratory support is deemed necessary the Fairfax County Health Department is now engaged and if criminal concerns are an element of the decision than the FBI is engaged. Samples are handled as evidence for court today, i.e., chain of custody.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

   If more laboratory support is determined necessary then these samples are sent to the Laboratory Response Network (LRN) in Richmond, VA and there the determination is made if further, more-specialized laboratory support is necessary. At this point the Fairfax County Health Department and perhaps other departments are engaged as well as the Federal Bureau of Investigation (FBI).

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

   If a biological sample culture is needed and if individuals are expressing symptoms, but no chemical constituent(s) are observed then samples are sent for further analyses.

B-3.4 Maintenance and Training Questions

1. Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?

Instruments as they are obsolete or cannot be repaired and consumable test replaced in advance of their shelf life expiration. Need to decontaminate instruments has not arisen to date.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

Yes, for the APD 2000 and do have some knows but do not have challenge materials for every instrument or test.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?

Fairfax County is instituting proficiency standards in the near future. Training now is typically limited to that initially provided by the instrument manufacturer and on the job training of staff.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

Chief MacKay indicated that the county has purchased what he referred to as "white elephants" and they would greatly benefit from a "Consumers Report" type source of information that was generated to meet the specific needs of first responders as the using audience.

B-4. CAPTAIN JOHN LUND IDAHO FALLS, IDAHO, FIRE DEPARTMENT AND REGIONAL HAZMAT RESPONSE TEAM

Matthew G. Watrous conducted this interview in January 2005 in person with Captain John Lund, Regional HAZMAT Response Team Captain, 208-529-1211.

B-4.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

The HAZMAT teams carry the 4-gas meter, colorimetric tubes, photoionization detectors (PID), gas infrared instrument, liquid/solid infrared instrument, Haz Cat kit, and ion mobility spectrometer (APD 2000), radiation monitors, and a RAMP system for bio threats.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Yes.

Likes his equipment, but would like to know what else is out there, he does not have time to find other information.

3. Do they provide more data than needed? Could they be simpler?

Do not provide more than needed.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

No knowledge about competing products.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

Perform similarly to all Idaho teams.

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

Not applicable.

B-4.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

First priority is always getting people out of harm's way. Incident commander makes decisions based on all information available. If positive, evacuate if appropriate. If negative, look at other information. If people are showing symptoms, evacuate anyway.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

Bridge calls with state level or calling in additional help after location is cleared of people.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

From standards—State level, NFPA 472 has some HAZMAT, OSHA 1910.120, EPA has some influence.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

Civil support team can respond with mobile laboratory.

B-4.3 Decision Making

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

Rely on a person at the state level for selecting instruments. He uses the Selected Equipment Lists and Approved Equipment Lists.

2. Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

Rely on a person at the state level for selecting and purchasing instruments. He uses the Selected Equipment Lists and Approved Equipment Lists.

3. Do you have performance or data quality information on your instruments?

Rely on a person at the state level for selecting and purchasing instruments. He uses the Selected Equipment Lists and Approved Equipment Lists.

4. Who or what process determines if more in-depth agent analysis is needed at an incident scene?

Incident Commander.

5. What is the source of more in-depth analysis? Local, State, Federal, or National Lab?

101st Civil Support Team has a mobile lab. State lab is available as fixed facility.

6. What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?

Not applicable.

B-4.4 Maintenance and Training Questions

1. Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?

Tied to the State budget.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

Had a guy that did calibrations, but retired and no one to fill role.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?

Training occurs at time of purchase by vendor. On the job training by fellow team members after initial training.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

Rely on a person at the state level for selecting and purchasing instruments. He uses the Selected Equipment Lists and Approved Equipment Lists. He solicits input from the field. The decision maker in the field does not feel he has enough knowledge or information to help in this area, but the state level decision maker is confident in his abilities to supply his guys with the right equipment.

B-5. DEPUTY CHIEF MICHAEL BRYANT
LOS ANGELES COUNTY, CALIFORNIA, FIRE DEPARTMENT

Robert C. Gareri and Joseph D. Evans conducted this interview during February 2005.

B-5.1 Technical Questions on Instrumentation

1. **What vapor detection instruments and tests do you currently use?**

   Multi-gas meters, colorimetric tubes, and gas specific instruments.

2. **Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.**

   Yes.

   Multi-gas meters yield little specific information on toxicity; training can be intensive and some meters are expensive.

3. **Do they provide more data than needed?**

   Not necessarily. If anything, less than desired.

   Could they be simpler?

   No. We desire qualitative and quantitative information. Some units are too simple, rendering suspicion in its results.

4. **What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?**

   No comment.

5. **What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?**

   None.

6. **Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?**

   No.

B-5.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

(Positive finding): Responder protection, including turn-back and re-grouping as necessary, accelerated life-saving response (rapid extraction) and consideration of DECON. (Negative finding): Verification of findings by alternate methods.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

Use of alternative methods of detection.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

They follow protocols learned from First Responder Operational (FRO) training in hazardous materials response and terrorism consequence management.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

Decontamination and triage, treatment, and transportation for the sick. The dead are re-examined for more evidence prior to removal from the scene.

B-5.3 Decision Making

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

This department relies on special operations units to do this. It is both formal and informal.

2. Are specifications for detecting chemical warfare agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

National.

3. Do you have performance or data quality information on your instruments?

Some, not all.

4. Who or what process determines if more in-depth agent analysis is needed at an incident scene?

Local health department official or law enforcement decision based on protocols created by fire, health, and law representation.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

   Local, unless otherwise directed.

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

   Circumstances (i.e., injuries), facilities where the incident occurred (e.g., Federal), and the need to have a more controlled environment that labs provide that field detection cannot provide.

B-5.4 Maintenance and Training Questions

1. **Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?**

   Yes, adherence to manufacturer's recommendations, recommendations from independent calibration personnel, and periodic review of instrumentation effectiveness.

2. **Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?**

   Some, not all.

3. **Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?**

   Some, not all. It is nevertheless desired to have more than a user manual. Proficiency is based on the minimum standards as provided by agencies such as National Fire Protection Agency (NFPA), California Code of Regulations (CCR), Title 19, CFR 11910.120q, et al.

4. **Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?**

   FRO personnel rely on Special Operations personnel and local health department authorities to provide guidance.

B-6. CHIEF DAVE A. PASQUALE RATON, NEW MEXICO, FIRE AND EMERGENCY SERVICES

On January 28, 2005, Mr. Daniel Michael discussed the survey with Chief David Pasquale, Raton, New Mexico (505-445-2708). Chief Pasquale is in charge of both the Raton Fire and Emergency Services and the New Mexico Regional Hazardous Materials Response Team and is, therefore, very familiar with instrumentation for first responders. In preparation for further discussions, Mr. Michael sent the list of questions to Chief Pasquale who provided in depth responses in writing on February 2, 2005.

B-6.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

We use the standard vapor test equipment that most HAZMAT teams use: combustible gas detectors with sensors for O_2, LEL, CO and 1 additional gas. We also use colorimetric tubes for qualitative and quantitative results. Our team also deploys areaRAES which are four gas + PID for entry. These units have built in transmitters which allow command to see all conditions in the hot zone. In addition to the standard technology, we also employ the Sabre 2000 which uses Ion Mobility Spectrometry (IMS) technology. This instrument is capable of detecting chemical weapons, drugs, and explosives. The AP2C is used for chemical weapon detection. We also have on order the GAS ID. This device uses infrared spectroscopy to analyze samples and identify the vapor.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Most of the instruments provide enough information.

Most short comings would be battery life and calibration issues.

3. Do they provide more data than needed? Could they be simpler?

Depending on the instrument some provide too much information for the operator. In most cases the information is needed by command.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

We are happy with the equipment and information.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

I think our procedures are more at the level of operation that you would see with the CSTs. We have tried to adopt as much of their procedures as possible to allow for a seamless transfer of operations or joint missions.

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

It depends on the testing to be done. We routinely test soil for hydrocarbon levels using the PIDs. Water can be tested for pH, etc. Specific tests are available but not routinely carried by HAZMAT teams.

B-6.2 Incident Scene Questions

1. What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?

It depends on the call and the suspected material. We work with State Environmental Department and handle most spills without outside help. If it is related to Homeland Security, we work with other agencies such as the postal inspectors in order to share all results and info. If needed we will suggest further testing by labs.

2. What follow-up steps are taken to avoid the possibility of a false positive or false negative?

If it is a credible threat, we will advise further testing. We are very confident though in our equipment and we are willing to base most decisions on our test results.

3. Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?

All personnel are trained to the technician level. By the use of standard operating procedures (SOPs) personnel have the knowledge to select the appropriate gear.

4. Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?

We have never had that situation. If we did, we would request outside assistance, probably the New Mexico Civil Support Team.

B-6.3 Decision Making

1. Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?

We do network with other ICs but nothing formal.

2. Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

You have the ability to select based on your knowledge and the level of expertise of your personnel. There should be a minimum standard, possibly from Homeland Security for all levels of response teams, from first responders to technician level teams. This should include simple detection devices such as M8-M9 paper for all first responders to high end detection for teams.

3. Do you have performance or data quality information on your instruments?

Most detection devices make that information known to the end users, mainly for liability issues.

4. Who or what process determines if more in-depth agent analysis is needed at an incident scene?

The incident commander on the advice of the HAZMAT officer.

5. What is the source of more in-depth analysis? Local, State, Federal, or National Lab?

Good question. The answer should be a network of approved labs all accessible to ICs. The truth, nobody knows. We have experienced this first hand. Even State agencies have no clue!

6. What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?

I am sure some day in the future additional testing will not be needed. Right now the field personnel would need at least two qualitative tests with negative results. Depending on the material 2 types of tests may not be available. For example, with our Sensir IR we can identify the presence of a biological. When we go to test with an assay strip we may not have the required spore count to test positive. That would require the assistance of a lab.

B-6.4 Maintenance and Training Questions

1. Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?

There are weekly, monthly, quarterly and annual maintenance, testing and calibration for all instruments including rad. We are always looking for new equipment and adding that to our arsenal.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

Yes, we do have some test materials supplied by the manufacturers.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?

All personnel must have a minimum of 40 hours per year of continuing education credits. In all reality most end up with much more. When new equipment is purchased we either have the manufacturer supply the preliminary training or we do it in house. Also, personnel attend a minimum of two exercises per year.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

I feel confident that we have assembled one of the best assortments of test equipment for any team in the Southwest. We have also supplied first responders in the County with basic test equipment that will assist them in making the appropriate decisions. We encourage all responders that when in doubt, call us.

In addition we have policies on unknown responses. In this case, a full array of detectors is used, including rad, O_2, CGI, PID, and CO.

In regard to Homeland Security, I feel strongly there is a need for standardization nationwide. If you look back to the days of civil defense, kits were distributed around the nation, which contained 3 radiation detection devices and dosimeters. New York, Florida, Texas, everyone had the same equipment. For basic responders, fire, Emergency Management System (EMS), and law enforcement the same could be done for WMD. Simple solutions such as "smart paper," M8, M9, etc. could be used. These types of devices along with awareness and operations level training would provide the first line of defense. The second need is to standardize the equipment used by technician level teams. From APRs to detection equipment we must standardize to provide the availability of a national response. We have tried to do this so our technicians can interface with the New Mexico Center for Specialized Training (NMCST) and share equipment and resources. This should be done coast to coast.

B-7. CHIEF JEFF BOWMAN SAN DIEGO, CALIFORNIA, FIRE DEPARTMENT

Robert C. Gareri and Joseph D. Evans conducted this interview during February 2005.

B-7.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

Combustible Gas Indicators—Gastech 402/ 201 and Innova for LEL, oxygen, hydrogen sulfide, and carbon monoxide.

Draeger Tubes and Sensidyne Tubes for specific gasses

Draeger CMS Chips for various specific gases

Photo Ionization Detector—Multi Rae and Mini Rae for unknown vapors

JCAD—Surface Acoustic Wave

APD 2000—Ion Drift for irritants and nerve agents.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Yes, if the gases are detected the instruments give us the information that is needed to make a safe and prudent decision.

Limited substantive analysis, false positives, expensive to purchase, maintain, repair, and calibrate. The PID instruments have a limitation in that if the vapor/gas is above the ionization potential of the bulb in the instruments, then they will not be detected. If a material that can be detected by the instrument is detected, it will let you know that something is there, but not necessarily what. Further analysis must be considered.

3. Do they provide more data than needed? Could they be simpler?

No. Most of the instruments listed provide enough information to make a cautious decision. The Draeger and Sensidyne tubes will give you a qualitative reading of the vapor present in a given location if sampling done according to direction. We are more interested in the presence of a specific vapor/chemical rather than a qualitative analysis, other factors need to be considered for that (e.g., Air flow, source of the leaks, etc.). Could they be simpler? These instruments are relatively easy to use for the level of technology they provide. Most of the instruments that we are using are relatively easy to operate and read by a simple color change or a preset alarm.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

We need a radiological monitor that identifies the isotopes it detects. APD gives many false positives. Radiation pagers would be more useful if they provided direct reading. It would be nice to have a simplified organic vapor analyzer that would specifically identify an unknown with a known footprint.

5. **What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?**

Hazard categorization (Haz Cat) via field chemistry testing kit for powders and chemicals. The Mesosystems air sampler for use with bioassay tickets. These tests and procedures are not unique, but are relatively new for us. We use tried and true technology to help us make educated decisions about chemical sensing, using various instrumentation to detect.

6. **Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?**

The Draeger tubes are too complicated to use in Level A PPE.

B-7.2 Incident Scene Questions

1. **What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?**

This question is very general. If protective measures are needed prior to mitigation of a leak or spill, then those become a priority. Prior to entering into a potentially hazardous environment, as much information about the incident is obtained so that proper PPE can be determined. We always don the proper level of PPE and follow guidelines with a suspected chemical prior to identification. Full Incident Command System setup, backup team in place, DECON in place, site safety and action plan prepared, etc. With a positive finding we follow Standard Operating Guidelines (SOGs) to mitigate the incident, with a negative finding we employ redundant tests to confirm.

2. **What follow-up steps are taken to avoid the possibility of a false positive or false negative?**

We employ the use of different tests and monitors to confirm finding (never rely on one test). Retest to confirm. We also work very closely with and utilize the expertise of our Local Department of Environmental Health HAZMAT personnel to confirm our findings. Performing some investigative work with a site representative is also very useful in determining the cause for a positive reading. Multiple instrumentation sampling may prove out a false positive. If there are no signs and symptoms, a false negative is hard to eliminate.

3. **Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?**

We access several sources of chemical information prior to entering the scene. Much of this research is performed en route to the scene using the initial response information. Reference sources include TOMES software, MSDSs, ERG book, Condensed Chemical Dictionary, etc. We usually take an array of instruments (pH and radiation first) to try and identify. We also sample unknown and perform Haz Cat test to determine hazard class. With an unknown chemical we default to the highest level of respiratory with splash PPE (Level B), unless incident factors lead to a risk analysis that indicate full vapor protection (Level A).

4. **Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?**

After taking all steps as outlined in number one above, we would gather as much information from the scene, other emergency response agencies, the diagnostic input from medical personnel regarding the exposed patients, and the occupants, rely on team and peer experience and expertise, and make the best decision possible on the given situation.

B-7.3 Decision Making

1. **Do you participate in a formal or informal network of ICs in communities, states or regions for information exchange regarding instrumentation or test performance, reliability, and utility?**

Informal information exchange take place at training courses (California Specialized Training Institute [CSTI]) when HAZMAT team members statewide spend time together learning and sharing. Another excellent site for networking in California is the Annual Continuing Challenge Conference in Sacramento. HAZMAT Teams send members from all over the Country. Information is exchanged, opinions on instruments are shared, and vendors display a wide range of instruments, which allows attendees to handle equipment, ask questions, and determine if instrument meets current needs. Some local and regional groups also meet and exchange information. Our Local Emergency Planning Committee (LEPC) and County Fire Chiefs HAZMAT Section are examples.

2. **Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?**

Much of the chemical detection equipment that we have received over the past few years are items that are approved for purchase through Federal Grants for Terrorism preparedness. We as locals do not have input on the specifications. But we do get to select from the list of approved equipment and the specifications and tests they have are useful.

3. **Do you have performance or data quality information on your instruments?**

Yes, this information is provided for the instruments we have.

4. **Who or what process determines if more in-depth agent analysis is needed at an incident scene?**

The circumstances of the incident. Injuries, fatalities, environmental damage, public health risk, crime scene, credible threat, all these factors are considered. The Fire Department, Health Department, Law enforcement, or combination of any of these agencies might make the decision.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

Our local Public Health Lab, the Center for Disease Control (CDC) in Atlanta.

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

The circumstances of the incident. Injuries, fatalities, environmental damage, public health risk, crime scene, credible threat, all these factors are considered. The Fire Department, Health Department, Law enforcement, or combination of any of these agencies might make the decision. What more could an instrument provide? Ease of use in field with more in depth results. The ability to specifically identify unknowns quickly and accurately in the field.

B-7.4 Maintenance and Training Questions

1. **Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?**

Somewhat. The equipment, its ongoing maintenance, repair and calibrations are all very expensive. Our HAZMAT Team does an excellent job of caring for the equipment they have, this allows for a long service life from individual instruments. A replacement schedule is in place, but the operating budget sometimes forces maintenance, calibration, repair, and replacement needs to be deferred. Some useful instrumentation and testing technology is available, but beyond our ability to purchase.

2. **Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?**

Limited availability on some instruments. Surrogates not routinely purchased. Calibration gasses routinely utilized. Improvised surrogates used in house to a small degree.

3. **Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?**

In house training aids developed for equipment. Regularly scheduled training sessions for team members to practice with equipment. Domestic Preparedness Equipment Technical Assistance group has provided several training sessions to our team over past few years. CSTI, and Continuing Challenge provide training opportunities for equipment. Vendors will sometimes provide training to department members when equipment is purchased.

4. **Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?**

Yes. Our team is very good at testing and trying out new equipment as it comes available for purchase. We have acquired a diverse cache of instruments and tests which we are confident provide us with the tools to evaluate and handle situations as they come up. This ability has evolved over the years as a result of extensive field experience in responding to hazardous materials incidents, coupled with relevant education and training.

B-8. LIEUTENANT JOHN DONNELLY WASHINGTON, D.C. FIRE DEPARTMENT

Dr. Keith Daum conducted this interview on March 16, 2005 over the telephone with Washington D.C. Fire Chief John Donnelly (202-345-6850). Mr. Donnelly is responsible for hazardous incidents in all of the Washington D.C. area.

B-8.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

We currently use the following detectors:

a. MSA Sirius

b. AIM 604 Four gas

c. Scott SA-2000 Four gas

d. ATD 2000

e. CAMS

f. Drägger tubes and chips

g. pH paper

h. Hapsite GC/MS

i. Rae Systems Multirae 4 gas meters

j. MSA Safe Site

k. AP2C

l. Sensit Hxg3.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

Instruments are part of an overall strategy. Each provides useful information.

Other than the Hapsite and the single gas meters, nothing takes a sample and conclusively tells us what we have.

3. Do they provide more data than needed? Could they be simpler?

At this location, every incident is treated as if it is a potential chemical agent attack. In these cases, you want as much data as possible. Instruments could always be made simpler.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

Some detectors have huge false positive problems (e.g., FIS, SAW, PID). False positives in preliminary analyses are identified and corrected during subsequent analyses with more specific instruments. False negatives in preliminary analyses can be effectively controlled by using several instruments with different properties to analyze the same sample. A more complete database for GC analysis of unknowns would be useful.

5. **What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?**

   Because of the location, every incident is treated as if it is a potential chemical agent attack.

6. **Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?**

   None.

B-8.2 Incident Scene Questions

1. **What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?**

   The question seems to imply a single meter with a positive reading. In that case we would look at the other meters for clarification. We would also look to the scenario for cues and if necessary collect a sample and send to an FBI lab.

2. **What follow-up steps are taken to avoid the possibility of a false positive or false negative?**

   False negatives in preliminary analyses can be effectively controlled by using several instruments with different properties to analyze the same sample. False positives in preliminary analyses are identified during subsequent analyses with more specific instruments. A more complete database for GC analysis of unknowns would be useful.

3. **Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments, and test kits to bring into the field?**

   Initially, information provided by preliminary instruments is used determine the level of personal protective equipment to wear. In cases where a first responder's life might be in danger, the responder is limited to staying the time of one bottle of breathing air. We have a policy that allows first responders to make rescues and recon in fire fighter protective clothing, but incorporates DECON policies and no go situations.

4. **Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?**

   Prior to metering our first responders are trained to react to signs and symptoms. Actions taken would follow a scripted set of remedial actions centered on evacuation and decontamination.

B-8.3 Decision Making

1. **Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?**

   This group is part of the Metropolitan Washington Council of Government (COG) Fire Chief's HAZMAT subcommittee. We are also part of the Regional COG.

2. **Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?**

   We usually have the option of having an instrument on loan before making a purchase decision. We use information from the Department of Homeland Security (DHS) Certified Equipment List and from Edgewood Lab at Aberdeen Proving Grounds. We also fund development of specific equipment directly.

3. **Do you have performance or data quality information on your instruments?**

   Most of the manufacturers of our detection equipment provide this information. We conduct our own tests to confirm.

4. **Who or what process determines if more in-depth agent analysis is needed at an incident scene?**

   At the scene, the incident commander makes this decision. He seeks information as needed.

5. **What is the source of more in-depth analysis? Local, State, Federal, or National Lab?**

   Additional confirmation comes from the Joint Terrorism Task Force (JTTF) or other sources as needed.

6. **What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?**

   This is made by the Incident Commander.

B-8.4 Maintenance and Training Questions

1. **Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?**

   Yes, we have a program to monitor and replace instruments as needed.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

We usually use manufacturer provided standards and training agents.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?

Yes, we send personnel to manufacturer training programs and also have our own in-house training program. We have a contract with the Office of Domestic Preparedness in Alabama to conduct courses.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

Yes, our staff can make these choices.

B-9. DEPUTY CHIEF W. H. (WES) SHOEMAKER, DEPUTY KEN SIM WINNIPEG, CANADA, FIRE PARAMEDIC SERVICE

Robert C. Gareri and Joseph D. Evans conducted this interview during February 2005.

B-9.1 Technical Questions on Instrumentation

1. What vapor detection instruments and tests do you currently use?

Industrial Scientific and MSA gas analyzers.

2. Do these instruments or tests provide the data you need to make decisions about an incident? Name any specific shortcomings of the instruments.

These devices provide general information regarding hydrocarbon levels at an incident scene. They are unable to tell the IC exactly the hydrocarbon product and the precise concentration levels of the product. The IC relies upon other agencies with the expertise onsite to provide more detailed analyses. We do not have any devices to determine the presence of biological or radiological substances.

3. Do they provide more data than needed? Could they be simpler?

No and no.

4. What additional information regarding instrumentation or a test do you want or need that you are currently not receiving, e.g., test sensitivity, F (-) or F (+) rate, etc.?

Not sure other than more precision in the concentrations of the products themselves and the ability to detect other agents/substances.

5. What actions or procedures are performed or implemented that seem unique to your organization for chemical sensing?

Basic/Simple/General analysis is done by our service and followed up by more detailed analyses by agencies with greater expertise (e.g., we partner with the Provincial Department of Environment to do sampling of certain materials).

6. Are there media (e.g., air, water, soil) for which you do not have instrumentation or test kits, or their "performance" is insufficient, or the instrument or test is too complex for field use?

We are unable to perform and detailed water analyses; no ability to field test for the presence of biological agents (anthrax) or other substances (sarin gas, etc.) without the assistance of other agencies.

B-9.2 Incident Scene Questions

1. **What actions do you or your organization take with a positive instrument or test finding and likewise with a negative finding?**

   With a positive finding, we obviously take the necessary actions to control and secure the scene (establish perimeters, hot/warm/cold zones), evacuate if necessary, ventilate the structure, or other such activities so as to either control/contain the release of materials and ensure that personnel and civilians are not exposed to any unnecessary dangers.

   In the event of a false positive, the incident is still deal with in a precautionary fashion with repeat and follow-up testing to be certain.

2. **What follow-up steps are taken to avoid the possibility of a false positive or false negative?**

   Further testing with other agencies that have the necessary expertise.

3. **Based on initial incident situation reports, how do first responders in your organization choose the appropriate level and type of personal protective equipment, instruments and test kits to bring into the field?**

   Generally they over triage and where the highest level of PPE until they confirm safety of the product. The approach is also generally determined by consultation with the CANUTECH Emergency Response Guide and depending upon the incident and materials involved, other agencies may provide guidance. For example representatives from Chadham labs or the Federal Virology lab are often on-site or consulted by telephone to provide guidance in dealing with biological agents.

4. **Do you have a procedure for when your testing equipment finds nothing, but it is obvious there is something amiss e.g., sick or dead individuals?**

   Yes, secure the scene and request the assistance of other agencies with more sophisticated testing instruments.

B-9.3 Decision Making

1. **Do you participate in a formal or informal network of ICs in communities, states, or regions for information exchange regarding instrumentation or test performance, reliability, and utility?**

   Yes, we participate on an multi-agency Emergency Planning committee and in a specific working group that was established to deal with responses to new types of biological agents such as the "white powder" type calls; we have also had a couple of responses lately where it was alleged that the individual was culturing e boli and/or flesh eating bacteria. This working group is comprised of law enforcement, health authority (public health), federal virology lab, fire paramedic service personnel, and provincial department of environment.

2. Are specifications for detecting chemical agents standard from a national source or do you have the prerogative to select instruments or tests according to your specifications?

National source.

3. Do you have performance or data quality information on your instruments?

Yes, in-house service and maintenance technicians retain.

4. Who or what process determines if more in-depth agent analysis is needed at an incident scene?

Our IC who in these types of responses will be our Hazardous Materials Coordinator—often he/she consults with the other agencies on scene to make this determination.

5. What is the source of more in-depth analysis? Local, State, Federal, or National Lab?

Provincial (Chatham) laboratories and personnel from the federal Virology lab. Winnipeg is fortunate to have one of the few Level IV virology labs.

6. What data are needed to make the decision to get more in depth analysis? What more could an instrument provide?

Data as determined by other on-scene agencies with greater expertise. An instrument could provide more product specific information.

B-9.4 Maintenance and Training Questions

1. Is there a program in place in your organization for replacement of obsolete instrumentation or testing kits and equipment to ensure it is not beyond the usable shelf life or to ensure that it is properly maintained?

Yes.

2. Do you have non-toxic challenge agent materials (effective surrogates) and/or quantitative standards to evaluate instrument or test performance on a routine basis?

Yes. For hydrocarbon materials only.

3. Other than users' manuals, are there training courses for the operation of instruments or conduct of tests in your organization and also user proficiency standards, demonstrations, or evaluations?

Yes, our equipment technicians and hazardous materials facilitators receive training from the equipment manufacturer/supplier. They in turn, train other departmental personnel.

4. Do you have the knowledge to provide confidence in choosing instruments or tests to have on hand and decide which is appropriate for the situation at hand?

We seek input from industry/local experts as to which instruments or test to utilize.