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**DOMESTIC PREPAREDNESS PROGRAM:
TESTING OF DETECTORS AGAINST
CHEMICAL WARFARE AGENTS - SUMMARY REPORT**

UC AP2C Portable Chemical Contamination Control Monitor Collective Unit

Terri L. Longworth
Kwok Y. Ong

RESEARCH DIRECTORATE

May 2001

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Soldier and Biological Chemical Command, AMSSB-RRT, Aberdeen Proving Ground, MD 21010-5424

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13. ABSTRACT (Maximum 200 words) This report characterizes the chemical warfare (CW) agent detection potential of the commercially available UC AP2C Portable Chemical Contamination Control Monitor Collective Unit. These chemical agent detectors were tested against HD, GB and GA vapor at various conditions. This report is intended to provide the emergency responders concerned with CW agent detection an overview of the detection capabilities of these detectors.				
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PREFACE

The work described herein was authorized under the Expert Assistance (Equipment Test) Program for the U.S. Army Soldier and Biological Chemical Command (SBCCOM) Program Director for Domestic Preparedness. This work was started in May 2000 and was completed in August 2000.

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**DOMESTIC PREPAREDNESS PROGRAM:
TESTING OF DETECTORS AGAINST
CHEMICAL WARFARE AGENTS - SUMMARY REPORT
UC AP2C Portable Chemical Contamination Control Monitor Collective
Unit**

1 INTRODUCTION

The Department of Defense (DOD) formed the Domestic Preparedness (DP) Program in 1996 in response to Public Law 104-201. One of the objectives is to enhance federal, state and local capabilities to respond to Nuclear, Biological and Chemical (NBC) terrorism incidents. Emergency responders who encounter a contaminated or potentially contaminated area must survey the area for the presence of toxic or explosive vapors. Presently, the vapor detectors commonly used are not designed to detect and identify chemical warfare (CW) agents. Little data are available concerning the capability of the commonly used, commercially available detection devices to detect CW agents. Under the Domestic Preparedness (DP) Expert Assistance (Test Equipment) Program, the U.S. Army Soldier and Biological Chemical Command (SBCCOM) established a program to address this need. The Applied Chemistry Team (ACT), formerly known as the Design Evaluation Laboratory (DEL), at Aberdeen Proving Ground, Edgewood, Maryland, performed the detector testing. ACT is tasked with providing the necessary information to aid authorities in the selection of detection equipment applicable to their needs.

Several instruments were evaluated and reported during Phase 1 testing in 1998 and Phase 2 testing in 1999. Phase 3 continues the evaluation of available detectors, including the UC AP2C Portable Chemical Contamination Control Monitor Collective Unit from Proengin, France reported herein. In addition, Phase 3 evaluations include the SABRE-2000 from Barringer Corp., the ppBRAE Photo-Ionization Detector from RAE Systems, the SAW MiniCAD from MicroSensor Systems, Inc., and the CAM (Type L) from Graseby Dynamics Ltd., which will be reported separately.

2 OBJECTIVE

The objective of this test is to assess the capability and general characteristics of the UC AP2C Portable Chemical Contamination Control Monitor Collective Unit to detect chemical warfare agent vapors. The intent is to provide the emergency responders concerned with CW agent detection an overview of the detection capabilities of the instruments.

3 SCOPE

This evaluation attempts to characterize the CW agent detection capability of the UC AP2C. Due to time and resource limitations, the investigation is only concerned with Tabun (GA), Sarin (GB), and Mustard (HD). These representative CW agents are believed to be the most likely threats. Test

procedures follow the established Domestic Preparedness Detector Test and Evaluation Protocol based on the Phase 1 Test Report¹. The test concept was as follows:

- a. Determine the minimum concentration levels (Minimum Detectable Level, MDL) where repeatable detection readings are achieved for each CW agent tested. The military Joint Services Operational Requirements (JSOR)² for point sampling detectors served as a guide for detection sensitivity objectives.
- b. Investigate the humidity and temperature effects on detector response.
- c. Observe the effects of potential interfering vapors upon detector performance both in the laboratory and in the field.

4 EQUIPMENT AND TEST PROCEDURES

4.1 DETECTOR DESCRIPTION

Proengin Inc., 78210 Saint Cyr L'Ecole, France, is the manufacturer of the UC AP2C Portable Chemical Contamination Control Monitor Collective Unit. The manufacturer explains that the collective unit (UC) includes the vapor monitor (AP2C) and the liquid or solid substance sampler (S4PE). The AP2C is a flame spectrophotometer that uses a hydrogen burner to heat a sample allowing the elements to produce their characteristic spectral emissions for detection. The S4PE surface sampler is the evaporation system that allows sampling of liquids and solids by the detector. The Domestic Preparedness program procured three UC AP2C units. Two were included in the detector evaluations and randomly labeled A and B. The third unit was reserved for a backup where necessary. Figure 1 is a photograph of the AP2C monitor.



Figure 1. AP2C Monitor

The AP2C is a lightweight, hand-held point detector that is capable of detecting nerve and blister agents simultaneously. The manufacturer's Operating Instructions Manual³ states the temperature performance range from -32°C to $+55^{\circ}\text{C}$. The instrument weighs 2.09 kg including the 7.3V lithium battery pack and hydrogen storage device. The battery pack, which slides into a battery drawer, contains two LSH20, liquid cathode, lithium thionyl chloride batteries. According to the manufacturer, a battery pack will last for 24 hours at 20°C and 11 hours at 0°C .

The detector is easy to use with a simple on/off turn of the inserted hydrogen cylinder. The display lights will all flash on upon insertion of the cylinder. Then a blinking yellow 'WAIT' light indicates initialization of the instrument. During initialization, the unit is automatically pre-heated, the hydrogen circuit is purged, and the flame is ignited. The green 'READY' lights up when the unit is ready for use. This start up time is given in the operator's manual as less than 2 minutes at temperatures above 0°C and up to 15 minutes at temperatures below 0°C . A yellow 'H2' light warns the operator when the hydrogen cylinder is about to be depleted. The hydrogen cylinder provides approximately 12 hours of operation when fully charged. The heat from the flame decontaminates the internal surfaces, which allows fast recovery times.

A photocell measures the luminous variations of the flame emissions to provide the detection signal of substances in the air. A micro-processing controller board processes the electrical signal from the photocell to assess the hazard. GA and GB are detected by analyzing the phosphorous emission spectrum. HD detection relies on the emission spectrum of sulfur. Alternating internal light filters for phosphorus and sulfur spectra detection allow both nerve and blister agent detection without the need of manually changing the detection mode.

There are two columns of five detection bars on the instrument display that indicate the detector's response by lighting one to five alarm bars. The first bar is yellow and the next four are red. Increasing number of red bars represent higher detected concentration. The left column represents "phosphorus (nerve)" detection and the right column represents "sulfur (HD)" detection. All five detection bars will be blinking when concentration exceeds the fifth level maximum detection setting. The operator's manual states that the hazard threshold for unprotected humans is reached as soon as the first red indicator lights. A buzzer is supplied with the detector that can be clipped onto the AP2C handle to provide an audible alarm signal corresponding to the visual response.

During normal vapor operation, sample air is drawn into the AP2C unit through the changeable "vapor-sampling" nozzle at a sampling rate of 80 liters per hour (1.33 liters per minute). The analysis airflow in the burner of the AP2C is 3.5 liters/hour (58 milliliters/minute).

The S4PE persistent substances sampling and evaporation system requires the AP2C nozzle to be changed before use. The "sampling pipe" nozzle, one of three types of nozzles supplied, is fitted to the AP2C in place of the "vapor-sampling" nozzle to enable liquid detection using the S4PE scrapers. The sampling pipe nozzle needed for S4PE use has a shorter stem than the vapor-sampling nozzle. The shorter stem length places the detector into a less sensitive detection mode for liquid detection, which is indicated by the flashing green "ready" light. The S4PE uses a 3.5V lithium battery and a replaceable scraper tip that is made from a small piece of flexible heat tape. The sample is manually collected using the scraper tip, then heat desorbed from the scraper by pressing a button. This vaporizes the collected sample to enable analysis by the AP2C.

The third nozzle is marked with a "red cross" and allows the S4PE surface sampler to be used while retaining the high sensitivity capability of the instrument similar to that of using the vapor-sampling nozzle. The "red cross sampling pipe" is intended for low-level detection for medical surveillance to monitor potentially contaminated or decontaminated surfaces (i.e., skin or clothing). Figure 2 shows the S4PE and the associated sampling tips and nozzles.



Figure 2. S4PE Surface Sampler and Associated Sampling Tips and Nozzles

4.2 CALIBRATION

Operating procedures were followed according to the operator's manual. The instrument sensitivity is pre-set at the factory. The manufacturer provides confidence sampler tips to perform functional checks to assure detection performance. The confidence sampler tip is used with the S4PE in place of the liquid sampler scraper tip. During the confidence check, response signals will occur within seconds for both alarm bar columns upon heating the simulant sample tip using the S4PE procedures. The confidence sampler tips contain chemicals that cause an AP2C response signal for both phosphorus and sulfur.

4.3 AGENT CHALLENGE

The agent challenges were conducted using the Multi-Purpose Chemical Agent Vapor Generation System⁴ with greater than 80% purity CW agent GA and available Chemical Agent Standard Analytical Reference Material (CASARM) grade CW agents GB and HD. Agent testing followed successful instrument start up and confidence check. The vapor generator system permits testing of the instrument with humidity and temperature-conditioned air without agent vapor to assure the background air does not interfere before challenging it with similarly conditioned air containing the CW agent vapor. With the instrument's inlet placed under the cup-like sampling port of the vapor generator,

the AP2C unit is exposed to the conditioned air for approximately one minute to establish a stable background and ensure that the instrument does not exhibit undesired responses to the air.

Agent challenge began when the solenoids of the vapor generation system were energized to switch the air streams from conditioned air only to similarly conditioned air containing the agent. Each detector was tested three times under each condition. The detectors were exposed to the agent vapor to determine the concentration and time for response for each of the bar levels. As each bar level was attained, the exposure time was intentionally extended two minutes, concentration kept constant, to determine if the bar level would not change. The time required after agent exposures until the instrument stopped responding was recorded as the recovery time.

The detectors were each tested with the agents GA, GB and HD at different concentration levels at ambient temperatures (22 °C to 28°C) at 50% relative humidity to determine the minimum detectable level (MDL). In addition, the detectors were tested at relative humidity conditions of <10% and >90%, and at temperature extremes of -30°C for GA and GB, 0°C for HD, and +55°C for the three CW agents to observe temperature and humidity effects. Temperature extremes were based on the manufacturer's stated operating range using agent concentrations that approximated the MDL. HD could not be tested below 0°C due to physical property limitations. Although HD freezes at approximately +15°C, the calculated HD volatility of 92 mg/m³ at 0°C easily produces a vapor concentration higher than the 2 mg/m³ JSOR detection criteria allowing the instrument to be evaluated at 0°C.

4.4 AGENT VAPOR QUANTIFICATION

The generated agent vapor concentrations were analyzed independently and reported in mg/m³, as well as in parts-per-million (ppm) units in the results tables. The vapor concentration was quantified by utilizing the manual sample collection methodology⁵ using the Miniature Continuous Air Monitoring System (MINICAMS[®]) manufactured by O. I. Analytical, Inc., Birmingham, Alabama. The MINICAMS[®] is equipped with a flame photometric detector (FPD), and it was operated in phosphorus mode for the G agents and sulfur mode for HD.

This system normally monitors air by collection through sample lines and subsequently adsorbing the CW agent onto the solid sorbent contained in a glass tube referred to as the pre-concentrator tube (PCT). The PCT is located after the MINICAMS[®] inlet. Then the concentrated sample is periodically heat desorbed into a gas chromatographic capillary column for subsequent separation, identification, and quantification. For manual sample collection, the PCT was removed from the MINICAMS[®] during its sampling cycle and connected to a measured suction source to draw the vapor sample from the agent generator. The PCT was then re-inserted into the MINICAMS[®] for analysis. This "manual sample collection" methodology eliminates potential loss of sample along the sampling lines and the inlet assembly when the MINICAMS[®] is used as an analytical instrument. The calibration of the MINICAMS[®] was performed daily using the appropriate standards for the agent of interest. The measured mass equivalent (derived from the MINICAMS chromatogram) divided by the total volume

(flow rate multiplied by time) of the vapor sample drawn through the PCT produces the sample concentration that converts into mg/m³.

4.5 SURFACE CONTAMINATION SAMPLE CHALLENGE

The UC AP2C has the capability to monitor surface contamination with the use of the S4PE Surface Sampler Probe. A limited side evaluation of this feature was conducted using GB and HD at room temperature. Liquid agent droplets on four types of surfaces including asphalt, concrete, fabric from the battle dress uniform (BDU), and wood were tested. Five drops (each drop contains 0.2 microliters) of neat agent were transferred onto approximately one cm² area of the respective surface to simulate a surface contamination concentration of 10 g/m². Fifteen or more minutes were allowed for the agent to soak into the surface. The surface was then swiped with the S4PE equipped with the sampling tip and analyzed with the AP2C fitted with the shorter sampling pipe nozzle. The S4PE tip was examined and again heat desorbed to assure no presence of residual agent after each challenge. If the tip was damaged, or still had residual agent present, it was replaced. Otherwise, the tip was reused for subsequent tests. The contaminated surface was swiped again with the S4PE and analyzed by the AP2C unit using the longer medical (marked with red cross) nozzle after approximately one hour for GB and two hours for HD, to observe if the residual agent remained detectable. This evaluation was performed using one S4PE per AP2C.

4.6 FIELD INTERFERENCE TESTS

The instruments were tested outdoors in the presence of common potential interferents such as the vapors from gasoline, diesel fuel, jet propulsion fuel (JP8), kerosene, Aqueous Film Forming Foam (AFFF, used for fire fighting), household chlorine bleach and insect repellent. Vapor from a 10% HTH slurry (a chlorinating decontaminant for CW agents), engine exhausts, burning fuels and other burning materials were also tested. The objective was to assess the ability of the instruments to withstand outdoor environments and to resist responding when exposed to the selected substances.

The field tests were conducted outdoors at M-Field of the Edgewood Area of Aberdeen Proving Ground in August 2000. These experiments involved open containers, truck engines and fires producing smoke plumes, which were sampled by the detectors at various distances downwind. The AP2Cs were carried to the smoke or fume test plume to achieve moderate but not exaggerated exposures (e.g. 0.5-2 meters for vapor fumes and 2-5 meters for smokes).

Confidence checks were performed on each detector at the beginning of each testing day and periodically between tests. The two units were exposed to each interferent for three trials, in general. Testing continued with the next challenge after the instruments were thoroughly recovered from prior exposure.

4.7 LABORATORY INTERFERENCE TESTS

The laboratory interference tests were designed to assess the effect on the detectors of vapor exposure from potential interfering substances. The substances were chosen based on the likelihood of their presence during an emergency response by first responders. Additionally, the laboratory interference tests were conducted to assess the ability of the detectors to detect CW agent in the presence of the selected vapor (diesel fuel or Aqueous Film Forming Foam (AFFF) liquid). For ease of generating 0.1% and 1% vapor concentrations in the laboratory hood, liquid AFFF was used.

The units were tested against 1% of the headspace concentrations of vapors of gasoline, JP8, diesel fuel, household chlorine bleach, floor wax, AFFF, Spray 9 cleaner, Windex, toluene and vinegar. They were also tested against 25 ppm NH₃ (ammonia). If the detector false alarmed at 1% concentration, it was tested at the 0.1% concentration of the substance. A dry air stream carries the headspace vapor of the substance by sweeping it over the liquid in a tube or through the liquid in a bubbler to prepare the interferent gas mixture. Thirty milliliters/minute or three milliliters/minute of this vapor saturated air was then diluted to three liters/minute with the conditioned air at 23°C and 50% RH to produce the 1% or 0.1% concentration of interferent test mixture, respectively. The 25 ppm ammonia was derived by proper dilution of a stream from an analyzed 1% NH₃ vapor (10,000ppm) compressed gas cylinder diluted with the appropriate amount of the conditioned air.

For the tests that included CW agent, the interferent test gas mixture was prepared similarly. The resultant stream of three liters/min of CW agent concentration was used as the dilution stream to blend in with the 3 or 30 milliliter per minute of the substance vapor to obtain the desired 0.1 or 1% mixture of the substance vapor in the presence of CW agent concentration. The two units were tested three times with each agent/interferent combination.

5 RESULTS AND DISCUSSION

5.1 MINIMUM DETECTABLE LEVELS

The minimum detectable level (MDL) for the two AP2C units tested are shown in Table 1 for each agent at ambient temperatures and 50% RH. The MDL values represent the lowest CW agent concentration that consistently produced a two bar response. The units detected G agents at approximately 0.02-0.03 mg/m³ and HD at 0.9 mg/m³ with two bar responses. The current military requirements for CW agent detection (Joint Service Operational Requirements [JSOR] for CW agent sensitivity for point detection alarms), the Army's current established values for Immediate Danger to Life or Health (IDLH), and the Airborne Exposure Limit (AEL) are also listed in Table 1 as references to compare the detector's performance. Army Regulation (AR) 385-61 provides IDLH and AEL values for GA/GB, and an AEL value for HD. Army regulation AR 385-61 does not establish an IDLH for HD due to concerns over carcinogenicity.

The AP2C units detected GA and GB at an order of magnitude below the JSOR and IDLH levels. HD was detected at slightly below the JSOR level. Lower MDL values represent better detection sensitivity. The AP2C's were unable to detect the AEL levels for GA, GB or HD.

Table 1. Minimum Detectable Level (MDL) with 2 Bar Response From AP2C at Ambient Temperatures and 50% Relative Humidity

AGENT	Concentration in milligrams per cubic meter, mg/m ³ , With parts per million values in parenthesis (ppm) and Response Times			
	AP2C MDL	JSOR*	IDLH**	AEL***
HD	0.93 (0.142) in 4-11 seconds	2.0 (0.300) in 120 seconds	N/A	0.003 (0.0005) up to 8 hours
GA	0.03 (0.004) in 9-36 seconds	0.1 (0.015) in 30 seconds	0.2 (0.03) up to 30 minutes	0.0001 (0.000015) up to 8 hours
GB	0.02 (0.003) in 6-73 seconds	0.1 (0.017) in 30 seconds	0.2 (0.03) up to 30 minutes	0.0001 (0.000017) up to 8 hours
<p>* Joint Service Operational Requirements for detectors. ** Immediate Danger to Life or Health values from AR 385-61 to determine level of CW protection. Personnel must wear full ensemble with SCBA for operations or full face piece respirator for escape. *** Airborne Exposure Limit values from AR 385-61 to determine masking requirements. Personnel can operate for up to 8 hours unmasked.</p>				

5.2 TEMPERATURE AND HUMIDITY EFFECTS

Tables 2, 3 and 4 list the range of response of the two AP2C detectors at various test conditions for HD, GA and GB, respectively. The results show the number of bars observed and the corresponding response time at the different concentrations. Response was usually quick, with an increase in the number of bars as the agent concentration was increased. Exposure times were extended to two minutes to assure that the response was the maximum bar response achievable for that concentration level. The MDL concentration exposure responses were used to determine the temperature and humidity effects.

Table 2. AP2C Responses to HD Vapor Concentrations at Various Conditions

Average Conditions		HD Challenge Concentration		Bar Response	Response Time (seconds)
Temp., °C	%RH	mg/m ³	ppm		
22	<10	0.8	0.12	1	12-22
		1.0	0.15	2	7-32
22	50	0.7	0.11	1	8-11
		0.9	0.14	2	4-11
		1.9	0.29	2-3	13-92*
		5.5	0.84	4	9-115*
		16.5	2.51	5	7-15
		164.0	24.97	5	1-5
22	90	1.0	0.15	2	11-36
0	0	1.2	0.17	2	10-84
55	18	0.9	0.15	2	3-21

*Unit B always responded < 23 sec and Unit A always responded >60 seconds at these conditions.

Table 3. AP2C Responses to GA Vapor Concentrations at Various Conditions

Average Conditions		GA Challenge Concentration		Bar Response	Response Time (seconds)
Temp., °C	%RH	mg/m ³	ppm		
25	<10	0.025	0.004	1	3-7
		0.034	0.005	2	9-36
25	50	0.01	0.002	Flashing 1	10-115
		0.02	0.003	1	14-34
		0.03	0.005	2	8-31
		0.12	0.018	3	29-84
		2.24	0.338	4-5	18-119
		12.00	1.809	5	7-39
22	95	0.03	0.004	2	12-60
-30	<10	0.12	0.015	1*-2	117-320
		0.43	0.053	3	17-20**
55	18	0.02	0.003	2	3-22

*Unit B alarmed 1 bar only for one out of three tests and both units required >2 minutes to alarm.

**Units A and B only tested one time each due to inlet freeze up.

Table 4. AP2C Responses to GB Vapor Concentrations at Various Conditions

Average Conditions		GB Challenge Concentration		Bar Response	Response Time (seconds)
Temp., °C	%RH	mg/m ³	ppm		
22	<10	0.02	0.003	1	4-11
		0.03	0.005	2	13-47
		0.04	0.007	2	3-10
		0.10	0.017	2	2-3
22	50	0.01	0.002	1	28-97
		0.02	0.003	2	6-73
		0.03	0.005	2	3-6
		0.11	0.019	3	31-66
		0.85	0.147	4	4-6
		2.34	0.405	5	6-11
		12.00	2.075	5	4-58
22	90	0.02	0.003	2	23-75
-30	0	0.17	0.024	No alarm*	>120
55	18	0.02	0.004	1-2	3-99

*Units A and B only tested one time each due to inlet freeze up. Unit B flashed 1 bar on and off during exposure.

Table 2 shows that the AP2C detectors demonstrated HD detection under all temperature and humidity conditions tested. Recovery times for HD exposure at all conditions and concentrations were less than 15 seconds. It appears that temperature and humidity had no adverse effect on HD detection.

Tables 3 and 4 show that instrument responses occurred within 2 minutes for GA and GB tests at all conditions tested except at the extreme cold temperature (-30°C). Problems occurred at -30°C when water vapor from hydrogen combustion would condense and freeze around the detector outlet, which interfered with the detection process. In addition, the units required longer start up times in the cold temperature. Humidity and high temperature seems to have no adverse effect on the instruments' nerve agent detection capability. Recovery times for GA and GB exposure varied with alarm response. A response up to 3 alarm bars required less than one minute to clear. However, if the response was 4 or 5 alarm bars, the required recovery time increased to greater than 4 minutes and as long as 11 minutes.

5.3 SURFACE CONTAMINATION TEST

Table 5 shows the results of the liquid surface contamination tests using the S4PE. Results indicate that the surface monitoring probe and nozzles were able to produce strong detection signals when the S4PE probe could reach the contamination. On rough surfaces such as asphalt, the ability for

the S4PE probe to reach the contamination is hindered once the agent has completely soaked in and the surface has dried.

The HD exposures, sampled with the “medical nozzle”, which were tested approximately two hours after the deposition of the agent, were not detected except in one incident. Perhaps most of the deposited agent was volatilized or soaked into the material such that the S4PE probe could not gather sufficient sample for detection.

Table 5. Liquid Surface Contamination Response Results

Surface	Unit	Liquid Nozzle		Medical Nozzle	
		GB Bar Response	HD Bar Response	GB Bar Response	HD Bar Response
Asphalt	A	3	NR	2	NR
	B	NR	NR	2	NR
Concrete	A	3	5	2	NR
	B	3	5	1	NR
BDU	A	5	5	5	5
	B	5	5	4	NR
Wood	A	3	5	3	NR
	B	3	5	2	NR

NR means No Response

Liquid Nozzle – Agent allowed to soak into surfaces for 15 minutes

Medical nozzle – Agent allowed to soak into surfaces 1 hour for GB and 2 hours for HD

5.4 FIELD INTERFERENCE

The results of interferent exposures are presented in Table 6. Any response means the detector showed agent detection response in the absence of CW agent when challenged with potential interferent substances. The ambient temperature and relative humidity levels during these tests were in the range of 27-32°C and 45-80% RH, with gentle wind. Confidence checks were successfully performed on both units throughout the field test evaluations.

The AP2C units alarmed for tests involving burning interferents and for the engine exhausts. Only one trial with each unit was accomplished for the doused fire smoke, and neither unit alarmed during that exposure. The alarm rates are calculated as 12 of 20 (60%) of the substances tested and 62 of the 116 trials (53%). Half of the detector responses showed HD and G detection, the other half showed HD only responses. Post field test responses against HD and GA challenges showed the AP2C units to have no adverse residual effects from the field tests. Response characteristics were similar to the pre-field test results.

Table 6. AP2C Field Interference Testing Summary

Interferent	Interferent Exposures AP2C Units A and B		
	Total Trials	Total Alarms	
		# of Bars	Response
Gasoline Exhaust, Idle	6	3*	H
Gasoline Exhaust, Revved	6	5	H
Diesel Exhaust, Revved	6	6	H
Gasoline Vapor	6	4	H
Diesel Vapor	6	0	
JP8 Vapor	6	0	
Kerosene Vapor	6	0	
AFFF Vapor	6	0	
Bleach Vapor	6	0	
Insect Repellent	6	0	
HTH Vapor	6	0	
Burning Gasoline Smoke	6	5	H and G
Burning JP8 Smoke	6	4	H and G
Burning Kerosene smoke	6	6	H and G
Burning Diesel Smoke	6	5	H and G
Burning Cardboard Smoke	6	6	H
Burning Cloth Smoke	6	6	H and G
Burning Wood Fire Smoke	6	6	H
Doused Wood Fire Smoke	2	0	
Burning Tire Smoke	6	6	H
TOTAL EXPOSURES and ALARMS	116	62	

*Intermittent 2 bar flash

5.5 LABORATORY INTERFERENCE TESTS

Table 7 presents the results of testing the detectors with conditioned air containing GB or HD in the presence of diesel fuel vapor or AFFF vapor. The tests were conducted at ambient temperatures (22°C) and 50% RH. The laboratory interference testing for agent detection capability indicates that both AP2C units were able to detect HD and GB in the presence of 1% diesel vapor or AFFF vapor with similar response levels and times as without the interferents.

Table7. Results of Laboratory Interference Tests with CW Agents

Agent	Interferent	Concentration		AP2C Response	
		mg/m ³	ppm	Bars	Seconds
GB	1% AFFF	0.03	0.005	2	5-10
GB	1% Diesel	0.03	0.005	2	5-11
HD	1% AFFF	1.5	0.23	2	3-4
HD	1% Diesel	1.5	0.23	2	3-4

Laboratory evaluations to determine if other potential interferent compounds would cause the detector to false alarm are summarized in Table 8. These tests did not include use of CW agent and were conducted at ambient temperature and 50% RH. The AP2C units did not false alarm to any of the substances at 1% of saturation except for gasoline. When gasoline vapor concentration was reduced to the 0.1% saturation level, the AP2C showed no bar response. Those substances that did not cause bar responses at the 1% level were not tested at the 0.1% level.

Table 8. Results of Laboratory Interference Tests without CW Agents

Substance	AP2C Response	
	1%	0.1%
AFFF	No Alarm	Not Tested
Bleach	No Alarm	Not Tested
Diesel	No Alarm	Not Tested
Floor Wax	No Alarm	Not Tested
Gasoline	2 Bars H	No Alarm
JP8	No Alarm	Not Tested
Spray 9	No Alarm	Not Tested
Toluene	No Alarm	Not Tested
Vinegar	No Alarm	Not Tested
Windex	No Alarm	Not Tested
Ammonia (25ppm)	No Alarm	Not Tested

6 CONCLUSIONS

Conclusions are based solely on the results observed during this testing. Aspects of the detectors, other than those described, were not investigated.

Civilian first responders and HAZMAT personnel use Immediate Danger to Life or Health (IDLH) values to select levels of protection during management of an incident. The threshold sensitivity of the AP2C monitor was found to exceed the IDLH sensitivity requirements and the current JSOR values for HD, GA and GB at all conditions tested. The AP2C units have also demonstrated rapid and dependable detection and recovery from HD, GA and GB exposures.

The instruments are sensitive and can detect CW agents quickly at all humidity and temperature extremes tested. The UC AP2C also has the capability to detect liquid surface contamination using the S4PE. Although it had difficulties detecting the residual contamination from porous surfaces such as asphalt under the tested conditions, the sampler represents an efficient means to collect, and deliver the sample to the instrument for analysis.

The controlled laboratory environment tests with potential interferent substance vapors showed the AP2C falsely responded to 1% saturation of gasoline vapor. Other tested substances, as well as gasoline vapor at the lowered concentration (0.1%), did not adversely affect the AP2C.

The field interferent testing, however, showed many responses to engine exhausts and the moderately smoky environments, indicating that the instrument could be expected to give false CW detection responses during smoky emergency situations when there may not be actual CW agent vapor present.

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