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DOMESTIC PREPAREDNESS PROGRAM: TESTING OF M90-D1-C CHEMICAL WARFARE AGENT DETECTOR AGAINST CHEMICAL WARFARE AGENTS SUMMARY REPORT

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13. ABSTRACT (Maximum 200 words) This report characterizes the chemical warfare (CW) agent detection potential of the commercially available M90-D1-C Chemical Agent Detector. These 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 1999 and completed in July 1999.

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TABLE OF CONTENTS

TABLES

FIGURE

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DOMESTIC PREPAREDNESS PROGRAM: TESTING OF M90-D1-C CHEMICAL WARFARE AGENT DETECTOR AGAINST CHEMICAL WARFARE AGENTS - SUMMARY REPORT

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. 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 Design Evaluation Laboratory (DEL) at Aberdeen Proving Ground, Edgewood, Maryland, performed the detector testing. DEL is tasked with providing the necessary information to aid authorities in the selection of detection equipment applicable to their needs.

Several detectors were evaluated and reported during Phase 1 testing in 1998. Phase 2 testing in 1999 continues the evaluation of detectors including the MIRAN SapphIRe Portable Ambient Air Analyzer, MSA tubes, the APD2000, and the M90-D1-C Chemical Warfare Agent Detector.

2. OBJECTIVE

This report characterizes the CW agent detection potential of the commercially available M90-D1-C Chemical Warfare Agent Detector. It is intended to provide the emergency responders concerned with CW agent detection an overview of the detection capabilities of these detectors. This report is one of several reports on the Phase 2 evaluations of detectors conducted during 1999.

3. SCOPE

This evaluation attempts to characterize the CW agent vapor detection capability of the M90-D1-C detector. The agents used were Tabun (GA), Sarin (GB), and Mustard (HD). These were considered representative CW agents because they are believed to be the most likely threats. Test procedures followed those described in the Phase 1 Test Report[1]. The test concept was as follows:

a. For each selected CW agent, determine the minimum concentration levels (Minimum Detectable Level, MDL) where repeatable detection readings are achieved. The military Joint Services Operational Requirements (JSOR) for point sampling detectors served as a guide for detection sensitivity objectives.

b. Investigate the humidity and temperature effects on detector response.

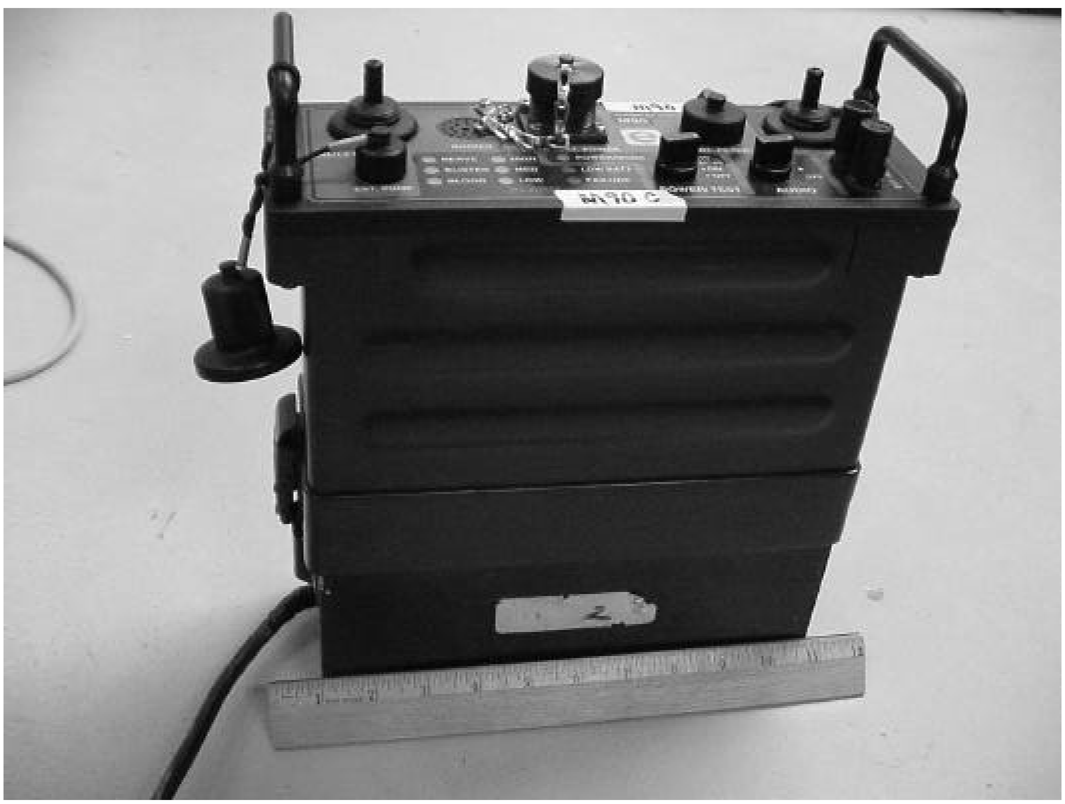
c. Observe the effects of potential interfering vapors upon detector performance both in the laboratory and in the field.

4. EQUIPMENT AND TEST PROCEDURES

4.1 DETECTOR DESCRIPTION

Environic Oy of Finland manufactures the M90 detectors. Three M90-D1-C units were loaned to the Domestic Preparedness program for inclusion in the detector evaluations. Figure 1 is a digital photograph of M90-D1-C detector. Two units were tested in conjunction with two APD2000 detectors manufactured by Environmental Technologies Group (ETG). The third unit was reserved for a backup where necessary. The M90-D1-C detector was added to the Phase 2 Plan because its availability coincided with the planned APD2000 testing and has similar operating characteristics.

Figure 1. M90-D1-C



The Chemical Agent Detection System, M90-D1-C, is a lightweight, man portable CW agent detector that weighs 15.7 pounds including the rechargeable battery pack. The detector operates on NiCd, Mg, or Li types of batteries or other 12 V DC power sources. It is an automatic warning device that responds to all relevant chemical warfare agents (nerve, blood, or blister) and can also be programmed for other types of compound vapor detection (e.g. chlorine, phosgene, etc.). When powered with a power supply, it operates continuously and no daily servicing is required.

The M90-D1-C Chemical Warfare Agent Detector employs advanced ion mobility spectrometry (IMS) detection techniques. The M90 detects and identifies CW agents based on ion mobility spectrometry. An irritant or CW agent in the air is drawn into the cell assembly where the molecules are ionized by an Americium radiation source. The ions are swept down the cell through an electric field created by a series of electrodes to produce an electronic signature. The M90 detector uses the "Advanced Signal Pattern Recognition Method" (ASPRM) to process and to identify the CW agent based on the generated ion mobility spectrum. Its IMS sensor is unique and differs from conventional IMS technology in that no cell membrane is used and thus "back flushing" of the cell is not required. Traditional IMS applications (e.g. APD2000) use cell membrane and back flushing to prevent cell overloading and improve clear down rates after exposure to "high" concentrations of contaminant.

The M90 detector also incorporates a semiconductor cell (SCCell) in addition to the ion mobility cell (IMCell) for its CW agent detection. This new, improved type of SCCell enables further enhancement of the agent detection capabilities of the M90-D1-C. Responses from the SCCell are combined with the responses from the IMCell to provide better agent identifications and interference rejections.

Similar to the earlier models of the M90-D1 detector, the M90-D1-C does not require an additional computer to function. However, coupling with a computer facilitates using the additional features of the detector. This detector can be adapted for other detection applications besides CW agents. Through the computer, the M90-D1-C detector can be programmed to detect additional compounds. The User Interface Program (UIP) allows such programming and assists in maintenance diagnostics. A computer is needed to conduct the built-in internal heat decontamination of the detector should it became grossly contaminated. The programmability of the detector allows easy detection optimization by an operator to meet mission requirements.

The M90-D1-C detector contains an interchangeable data library that can store up to sixty gas-class-teaching slots. The teachings are required for agent detection and identification. The detectors are taught to recognize different compound behaviors under different conditions. Each of the teachings occupies one slot. The detector's internal logic uses the combined IMCell and SCCell outputs to compare with the stored signature teachings. The detector will either trigger the alarm (if a vapor closely matches one of the teachings) or ignore the vapor response as an interference with a baseline update. Baseline updating is a way for the detector to compensate for potential baseline drifts.

The M90 is programmed to detect different classes (blister, blood, and nerve) of CW agents simultaneously. When one or more of the programmed teachings are matched, the detector will sound the alarm and light the indicator lights to indicate nerve, blister, or blood detection at either a low, medium or high concentration. The detector will alarm when the sampled vapor reaches a predetermined level and matches one of the signature teachings residing in the detector's library. The reference level response as low, medium or high detection is relative and determined according to the total response caused by the exposure.

Agent characteristics teaching files can be generated by exposing the detector to the vapor of interest, then uploading into computer files which enables the M90 detector to detect that vapor. Each file can be stored and retrieved later for down loading into other detectors as well. An individual detector can thus be customized for its intended application within minutes on an as needed basis.

The M90-D1-C operating specifications list the operational temperature range from -30°C to +52°C and the relative humidity range from zero to 95%. Also, according to the Instruction Manual[2], the NiCd rechargeable battery lasts for approximately 6 to 8 hours of operation at 20°C. Therefore, during the evaluations 110 Volt AC adapters were used to ensure that the detector performance would not be affected by poor battery condition.

4.2 CALIBRATION

Operating procedures were followed according to the Instruction Manual. No instrument calibration is required to place the M90-D1-C detector into operation. Assurance of the detection performance is verified daily by performing a confidence test. The manufacturer provides a simulant test sample kit with the detector. During this confidence check, an alarm will occur within seconds upon exposure to the respective simulant test sample tube. The simulant test kit contains two tubes. One tube confirms nerve agent detection capability when the switch is turned to the IMCell position. The other tube confirms blister agent detection capability corresponding to the SCCell switch position. The switch is returned to the normal operation position (ON) upon completion of the confidence checks and the detector is ready for use.

4.3 AGENT CHALLENGE

The agent challenges were conducted using the Multi-Purpose Chemical Agent Vapor Generation System[3] with Chemical Agent Standard Analytical Reference Material (CASARM) grade CW agents. The vapor generator permits preconditioning of a detector with humidity-conditioned and temperature-conditioned air before challenging it with similarly conditioned air containing the CW agent.

Agent testing followed successful detector start up. First, conditioned air at the desired temperature and humidity from the vapor generator system is sampled by the detector for approximately one minute to establish the stable background of the detector for the air at each condition. Agent challenge begins when the solenoids of the vapor generation system are 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 time that the detector was exposed to the agent vapor until it alarmed was recorded as the alarm time. In addition, times for clear down after the agent challenge were noted. This is the time required for the detector to stop alarming after the agent vapor flow ends.

The detectors were each tested with the agents GA, GB and HD at different concentration levels at ambient temperatures and low (<5%) relative humidity in an attempt to determine the minimum detectable level (MDL). The detectors were evaluated at relative humidity conditions of 50% and 90% at ambient temperatures. Testing at temperature extremes of -30°C for GA and GB, 0°C for HD, and +50°C for the three CW agents were also conducted to observe temperature and humidity effects. HD was only tested down to 0°C due to its physical property limitations. Although HD freezes at approximately +15°C, it has a volatility of 92 mg/ m^3 at 0°C that is considered potentially hazardous. It should be noted that 0°C is lower than the current JSOR that only requires HD detection down to +15°C.

4.4 AGENT VAPOR QUANTIFICATION

The generated agent vapor concentrations were analyzed independently and reported in mg/m^3. The vapor concentration was quantified by the manual sample collection methodology[4] 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 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. Here 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 the sample 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" procedure eliminates potential loss of sample through sampling lines and the inlet assembly in order to use the MINICAMS as an analytical instrument. The calibration of the MINICAMS is performed daily using the appropriate standards for the agent of interest.

4.5 FIELD INTERFERENCE TESTS

After the agent sensitivity tests, the units were tested outdoors in the presence of common potential interferents such as the vapors from gasoline, diesel fuel, jet propulsion fuel (JP8), kerosene, AFFF liquid (Aqueous Film Forming Foam 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 field tests were conducted outdoors at M-Field of the Edgewood Area of Aberdeen Proving Ground in July 1999. These were not laboratory tests but field experiments involving open containers, truck engines and fires producing smoke plumes, which were sampled by the detectors placed at various distances downwind. The detectors were placed at distances according to wind speeds and the nature of dissemination to achieve moderate but not exaggerated exposures to the potential interferent (e.g. 1-2 meters for vapor fumes and 2-5 meters for smokes). The objective was to assess the ability of the detectors to withstand outdoor environments and to resist false alarm indications when exposed to the selected "potential interference" substances.

A confidence check was performed on each detector at the beginning of each testing day to assure detector sensitivity. External particulate filters were used during smoky exposures as recommended by the manufacturer. Two M90-D1-C detectors were exposed to each interferent for three trials of one minute exposure per trial with approximately five minutes clear down time between trials. After every third trial, confidence sample checks were conducted. If the sensitivity deteriorated, the detectors were allowed more clear out time. No attempt was made during the day to determine the degree of cleanliness of the detectors in the field.

4.6 LABORATORY INTERFERENCE TESTS

These tests were designed to assess the effect on the detectors of vapor exposure from the representative substances. Additionally, the lab interference tests were conducted to assess the CW agent detection capability of the detectors in the presence of those vapors.

The M90-D1-C detectors were tested against "1% concentrations" of gasoline, JP8, diesel fuel, household chlorine bleach, floor wax, AFFF, Spray 9 cleaner, Windex, antifreeze, toluene, vinegar, and 25 ppm ammonia to observe potential interference with the detection reaction process. If the detector false alarmed at 1%, it was tested at "0.1% concentration" of each interferent. To prepare the interferent gas mixture, air at 20°C, <5% RH was saturated with interferent vapor by sweeping it over the liquid in a tube. Thirty milliliters or three milliliters of this vapor saturated air was then diluted to three liters of the conditioned air to produce the "1% concentration" or the "0.1% concentration" of interferent, respectively. The 25 ppm ammonia was derived by proper dilution of the 1% NH_3 vapor from an analyzed compressed gas cylinder.

For the tests using CW agent, the interferent test gas mixture was prepared by using air at 20°C, <5% RH that was saturated with diesel fuel or AFFF. AFFF and diesel fuels were chosen as representatives based on the likelihood of their presence during an emergency response by first responders. Three milliliters of this vapor saturated air was then diluted to three liters with the (20°C, <5% RH) conditioned air containing a prescribed concentration of CW agent from the agent generator to produce the "0.1% concentration" of interferent. Repeated tests were conducted on the two M90-D1-C units along with the two APD2000 units with test air containing CW agent plus interferent. The detection responses with conditioned air containing HD, GA or GB in the presence of 0.1% by volume of air saturated with diesel fuel vapor or AFFF vapor were recorded.

5. RESULTS AND DISCUSSION

5.1 MINIMUM DETECTABLE LEVELS

The minimum detectable level (MDL) for the two M90-D1-C detectors (A and B) are shown in Table 1 for each agent at ambient temperatures and low relative humidity (<5% RH). To establish the MDL, the agent concentrations were lowered until the detector did not alarm. The MDL values were recorded at the CW agent concentration exposure that produced slow, 1-2 minutes, but consistent alarms for three trials. The MDL concentrations are expressed in mg/m^3 and the equivalent parts per million (ppm) values are shown. The current military requirements for CW agent detection (Joint Service Operational Requirements [JSOR] for CW agent sensitivity for point detection alarms), the Army's established values for Immediate Danger to Life or Health (IDLH), and the Airborne Exposure Limit (AEL) are also listed as references to compare the detector's performance.

When compared to the JSOR and IDLH values, the MDLs of the M90-D1-C units for the CW agents tested are all at least an order of magnitude lower. Lower MDL represents better detection sensitivity. Army regulation AR 385-61 does not establish an IDLH for HD due to concerns over carcinogenicity. The M90-D1-C units would not detect at the AEL levels.

Table 1. Minimum Detectable Level (MDL) at Ambient Temperatures and Low Relative Humidity

AGENT	Concentration in milligrams per cubic meter, mg/m^3, With parts per million values in parenthesis (ppm)				
	Detector A	Detector B	JSOR*	IDLH**	AEL***
HD	0.033 (0.005)	0.22 (0.033)	2.0 (0.300)	N/A	0.003 (0.0005)
GA	0.010 (0.001)	0.010 (0.001)	0.1 (0.015)	0.2 (0.03)	0.0001 (0.000015)
GB	0.008 (0.001)	0.008 (0.001)	0.1 (0.017)	0.2 (0.03)	0.0001 (0.000017)

* Joint Service Operational Requirements for point sampling 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.

5.2 TEMPERATURE AND HUMIDITY EFFECTS

Table 2 lists the respective responses of the M90-D1-C detectors at various test conditions. The tests were conducted at ambient temperatures and RH conditions of approximately 0, 50 and 90%. The detectors were also tested at temperature extremes of –30°C (0°C for HD) and +50°C.

The M90-D1-C detectors successfully demonstrated CW agent detection at different temperature and humidity conditions. Alarm and clear down times usually occurred within seconds. Alarms occurred in less than 10 seconds for GA and GB tests at all temperature and humidity conditions. The detectors alarmed for HD in less than 10 seconds in all cases except the 50 and 90% RH, and 50°C conditions when they alarmed in <60 seconds.

Results listed in Table 2 indicate failure of detector A to alarm at the 50% RH, ambient temperature trial. It was necessary to use the backup detector C to replace detector A for the high (50°C) temperature test. It should be noted that detector A was used on another testing program involving gross exposures to various experimental decontamination solutions. The lingering residual effect was observed during the HD testing. The ill effect surfaced sequentially when the RH and the temperature were increased as evidenced in the high temperature tests where Detector C had to be used. Detector A returned to normal operation once the decontamination solution residues were baked out during the high temperature test. Subsequent evaluations using Detector A continued without observing additional ill effects.

Table 2. M90-D1-C Responses at Various Temperatures and RH Conditions

AGENT	Average Temperature °C	Relative Humidity %RH	Concentration		Detector A		Detector B	
			mg/m^3	ppm	Reference Level Reading	Alarm Time Range (seconds)	Reference Level Reading	Alarm Time Range (seconds
HD	20	<5	**0.03**	0.005	Low	31	No Alarm	-
HD	20	<5	**0.22**	0.033	Low	7-8	Low	9-13
HD	20	<5	**1.49**	0.225	Medium	3-7	Medium	2-7
HD	20	<5	**2.16**	0.327	High	6-7	Medium	6-7
HD	20	<5	**55.0**	8.30	High	5-6	High	5
HD	20	50	**1.94**	0.293	Medium	51-59	Low	53-54
HD	20	50	**2.20**	0.333	No Alarm	-	Low	53
HD	20	>90	**1.74**	0.263	Low	51-53	Low	56-59
HD	0	0	**1.81**	0.255	Low	10	Medium	8-9
HD	50	0	**1.68**	0.280	Low *	54-56 *	Low	6-10
GA	20	<5	**0.010**	0.001	Low	94-122	Low	22-51
GA	20	<5	**0.100**	0.015	Low	6-9	Low	7
GA	20	<5	**5.70**	0.846	High	5-6	High	6

AGENT	Average Temperature °C	Relative Humidity %RH	Concentration		Detector A		Detector B	
			mg/m³	ppm	Reference Level Reading	Alarm Time Range (seconds)	Reference Level Reading	Alarm Time Range (seconds
GA	20	50	**0.100**	0.015	Low	4-7	Low	7-9
GA	20	>90	**0.112**	0.017	Low	8	Low	6-8
GA	-30	0	**0.110**	0.014	Low	10	Medium	7
GA	50	0	**0.084**	0.014	Low	6	Low	6-7
GB	20	<5	**0.008**	0.001	Low	14-53	Low	29-51
GB	20	<5	**0.092**	0.016	Low	6-7	Low	5-6
GB	20	<5	**33.0**	5.70	Medium	5	Medium	5
GB	20	50	**0.140**	0.024	Low	5	Low	5-6
GB	20	>90	**0.070**	0.012	Low	7	Low	7
GB	-30	0	**0.060**	0.008	Low	15-16	Low	7-8
GB	50	0	**0.080**	0.015	Low	6-7	Low	5-6

* Replaced detector A with detector C for this trial because detector A was showing residual effects from the gross exposure of an experimental decontamination solution in another test program.

5.3 FIELD INTERFERENCE

The results of the detector "false alarms" during the interferent exposures are presented in Table 3. False alarms mean the detector alarmed in the absence of CW agent. The ambient temperature and relative humidity levels during these tests were in the range of 26-36°C and 53-91%RH, with gentle wind. Both detectors false alarmed (Blister High) to all diesel and kerosene vapor trials. Also, for all trials both units false alarmed (Nerve Low) to AFFF. The detectors also false alarmed one out of six trials for the revved gasoline engine exhaust (Blister Low) and the idle diesel engine exhaust (Nerve Low). The false alarm rates are calculated to 6 of 21 (28.5%) substances and 26 of 122 trials (21%).

Table 3. Field Interference Testing Summary

Interferent	M90-D1-C Detectors A and B, One-minute Interferent Exposures	
	Total Trials	Total False Alarms
Gasoline Exhaust, Idle	6	0
Gasoline Exhaust, Revved	6	1
Diesel Exhaust, Idle	6	1
Diesel Exhaust, Revved	6	0
Kerosene Vapor	6	6
Kerosene on Fire	6	0
JP8 Vapor	6	0

Interferent	M90-D1-C Detectors A and B, One-minute Interferent Exposures	
	Total Trials	Total False Alarms
Burning JP8 Smoke	6	0
Burning Gasoline Smoke	6	0
Burning Diesel Smoke	6	0
AFFF Vapor	6	6
Insect Repellent	2	0
Diesel Vapor	6	6
Gasoline Vapor	6	0
HTH Vapor	6	0
Bleach Vapor	6	0
Burning Cardboard	6	0
Burning Cotton	6	0
Burning Wood Fire Smoke	6	0
Doused Wood Fire Smoke	6	0
Burning Rubber	6	0

Post field test responses against HD and GA challenges showed the M90-D1-C detectors to have no adverse residual effects from the field tests. The units alarmed for the agents with similar response levels when tested against HD and GA at similar pre-field test conditions.

5.4 LABORATORY INTERFERENCE TESTS

Table 4 presents the results of testing the detectors with conditioned air containing GA, GB, or HD in the presence of diesel fuel vapor or AFFF vapor. The laboratory interference testing for agent detection capability indicates that detectors A and B were able to detect and identify the CW agents in the presence of these interferents only at the 0.1% of head space saturation level. These interferents caused false alarms at higher saturations, including the field tests, and therefore cannot be tested conclusively against agents. Each test was repeated three times and the reference level is shown.

Table 4. Results of Laboratory Interference Tests with Agents

Agent	Interferent	Concentration		M90-D1-C Alarm Response			
		mg/m^3	ppm	Detector A		Detector B	
GA	0.1% AFFF	**0.07**	0.0104	Nerve	Low	Nerve	Low
GA	0.1% Diesel	**0.1**	0.0148	Nerve	Low	Not Tested*	
GB	0.1% AFFF	**0.07**	0.0120	Nerve	Low	Nerve	Low
GB	0.1% Diesel	**0.07**	0.0120	Nerve**	Low	Nerve	Low
HD	0.1% AFFF	**1.7**	0.2570	Blister	Medium	Blister	Medium
HD	0.1% Diesel	**1.7**	0.2570	Blister	Medium	Blister	Medium

* Interferent caused false alarm (Blister Low), therefore not agent tested.

** Interferent caused false alarm (Nerve Low) for one of the three trials.

Laboratory evaluations to determine if other potential interferent compounds would cause the detector to false alarm are summarized in Table 5. These tests did not include use of CW agent. If an alarm occurred with the interferent at the 1% saturation level, the interferent was reduced to 0.1% saturation and tested again. Detector A alarmed for 10 out of 12 substances tested at the 1% concentration level while detector B alarmed for 7 of the 12 tests. The false alarm rates were less frequent at the 0.1% concentration level. Those substances that did not cause false alarms at the 1% level were not tested at the 0.1% level. Detectors A and B false alarmed for 50% of the interferents tested at 0.1% saturation. Diesel vapor results at the 0.1% level are included in this list, but they were obtained during the agent plus interference testing.

Table 5. Results of Laboratory Interference Tests without Agents

Interferent Only	Detector A Reference Levels				Detector B Reverence Levels			
	1%		0.1%		1%		0.1%	
AFFF	Nerve	Low	No Alarm		Nerve	Low	No Alarm	
Antifreeze	Nerve	Low	No Alarm		Nerve	Low	No Alarm	
Bleach	Nerve	Low	No Alarm		Nerve	Low	No Alarm	
Diesel	No Alarm		Nerve*	Low	No Alarm		Blister**	Low
Floor Wax	Nerve	Low	Nerve	Low	Nerve	Low	Nerve	Low
Gasoline	Blister	Low	No Alarm		No Alarm		Not Tested	
JP8	Nerve	Low	Blister	Low	Nerve	Low	Blister	Low
Spray 9	Nerve	Low	Nerve	Low	Nerve	Low	Nerve	Low
Toluene	No Alarm		Not Tested		No Alarm		Not Tested	
Vinegar	Blister	High	Blister	Low	Blood	Low	Blister	Low
Windex	Nerve	Low	Nerve	Low	No Alarm		Not Tested	
Ammonia	Blister	Medium	Not Tested		No Alarm		Not Tested	

* Interferent caused false alarm (Nerve Low) for one of the three trials.

** Interferent caused false alarm (Blister Low), therefore not agent tested.

6. CONCLUSIONS

The M90-D1-C detectors have demonstrated CW agent vapor detection for HD, GA and GB. The threshold sensitivity is better than the current JSOR military requirements for a point sampling alarm at all conditions tested.

Civilian first responders and HAZMAT personnel use Immediate Danger to Life or Health (IDLH) values to determine levels of protection selection during consequence management of an incident. Army Regulation (AR) 385-61 provides IDLH and AEL values for GA/GB, and an AEL value for HD. AR 385-61 does not establish an IDLH for HD due to concerns over carcinogenicity. The M90-D1-C detectors were able to detect G agents to their IDLH values at all temperature and humidity conditions tested. However, the detectors are unable to detect to the AEL values for HD, GA or GB.

The detectors are sensitive and can reliably detect CW agents within seconds at different humidity and temperature extremes. The minimum detectable levels were all at least an order of magnitude better than the JSOR values for GA, GB, and HD; and the IDLH values for GA and GB. The two detector units produced consistently similar responses at all conditions tested.

The detector, however, appears to be affected by many commonly found substances used in the interferent tests. Tests in the controlled laboratory environment and results from the field tests showed many false alarms. The findings during this evaluation indicate that the detector could be triggered into frequent undesired alarms in the absence of chemical agent vapor. Under the uncertain conditions of emergency response, this could cause confusion.

Given the primary importance for a detector is its ability to detect the presence of dangerous substances, such as the CW agents, the less than desired false alarm rates are a secondary concern. Although false indications are nuisances, the bottom line is that these detectors do offer fast and sensitive detection warnings for the CW agents tested.

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