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Validation of the Working Dog Advanced Threat Assessment System (WD ATAS) – Quick Look Report

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The U.S. Army Combat Capabilities Development Command Chemical Biological Center is developing a Working Dog Advanced Threat Assessment System (WD ATAS) to address current and emerging threats that are not contained within the standard issue DoD canine explosives detection training aid kit. The WD ATAS would allow for the rapid production of additional canine detection training aids while eliminating many of the issues associated with manufacture, packaging, transport, handling, custody, access, storage, replacement, and disposal of current canine explosive training aids containing bulk material. To address these complex issues, the WD ATAS combines two current technologies: the training aid delivery device (TADD) and inkjet-printed coupons. The goal is to provide inkjet-printed explosive coupons safely contained within TADDs to mimic the odor profile of their bulk counterparts despite utilizing significantly less explosive material.

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PREFACE

The work described in this report was authorized under project no. BL2, task no. TO1, and program element no. 622144 for the U.S. Army Next Generation Combat Vehicles Cross-Functional Team (Warren, MI). The work was started in September 2022 and completed in October 2022.

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This report has been approved for public release.

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EXECUTIVE SUMMARY

DEVCOM CBC is developing a Working Dog Advanced Threat Assessment System (WD ATAS) to address current and emerging threats that are not contained within the standard issue Department of Defense canine explosives detection training aid kit. The WD ATAS would allow for the rapid production of additional canine detection training aids while eliminating many of the issues associated with manufacture, packaging, transport, handling, custody, access, storage, replacement, and disposal of current canine explosive training aids containing bulk material. To address these complex issues, the WD ATAS combines two current technologies: the training aid delivery device (TADD) and inkjet-printed coupons. The goal is to provide inkjet-printed explosive coupons safely contained within TADDs to mimic the odor profile of their bulk counterparts despite utilizing significantly less explosive material.

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VALIDATION OF THE WORKING DOG ADVANCED THREAT ASSESSMENT SYSTEM (WD ATAS) – QUICK LOOK REPORT

1. INTRODUCTION

U.S. Army explosive detection canines are trained to recognize odors with the aid of a standardized canine explosive scent kit (CESK). A CESK consists of a standardized series of contained bulk explosive material commonly referred to as training aids. The fielded CESK is currently undergoing its first evaluation and update since 1972 to contain more field relevant threat odors, though it is not feasible for the kit to contain all possible threat odors since novel threats are rapidly emerging.

Because the CESK contains bulk levels of explosive materials, there can be issues associated with the manufacture, packaging, transport, handling, custody, access, storage, replacement, and disposal of current canine explosive training aids. The U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC) has developed a Working Dog Advanced Threat Assessment System (WD ATAS) to address current and emerging threats that are not incorporated within the standard issue Department of Defense canine explosives detection training aid kit. The WD ATAS will also reduce the inherent risk associated with procuring and transporting bulk quantities of explosive materials. Additionally, the WD ATAS would allow for the rapid production of additional canine detection training aids while eliminating many of the issues associated with a kit containing bulk levels of canine explosive training aids.

The WD ATAS combines two current technologies to provide an alternate option to using bulk quantities of explosives in the CESK: the training aid delivery device (TADD) and inkjet printed chemicals on inert substrates. Inkjet deposition methodologies were developed by DEVCOM CBC under the Army Explosives Forensics Advanced Technology program in support of the Next Generation Combat Vehicle – Foundational Technologies. Inkjet printing deposition techniques can be used to deposit small quantities of chemicals on inert substrates. The goal of the WD ATAS is to combine the technology of inkjet printed explosive coupons and the Training Aid Delivery Device (TADD) to create a training aid that mimics the odor profile of their bulk counterparts despite utilizing significantly less explosive material. This is made possible due to the surface area of a chemical being more vital to the quantity of odor released versus changing the mass of the contained material.

A Lackland Institutional Animal Care and Use Committee approved Test and Evaluation with Operational Military Working Dogs (MWD) Protocol (#2021-05) was used to determine if MWDs trained to detect bulk potassium chlorate could also detect potassium chlorate inkjet printed coupons containing various quantities of target material.

A test and evaluation (T&E) was performed with a small cohort of MWDs to determine what an appropriate printing density of potassium chlorate (PC) on coupons was for odor recognition in dogs previously imprinted using bulk levels of target material. A total of three (3)

MWD teams participated in the first iteration of the test held on 27-28 September 2022 at Aberdeen Proving Ground, MD.

A second iteration of this T&E was performed similarly to the first T&E held in September 2022, but with a larger cohort of MWDs. A total of eight (8) MWD teams participated in this test held on 25-28 October 2022 at Aberdeen Proving Ground, MD.

2. MATERIALS AND METHODS

All target materials were contained within TADDs (SciK9, LLC; See Figure 1). Target materials for the T&E included bulk PC (Sigma Aldrich; 25 gram (g) and 2.5 g) and inkjet printed PC coupons with the following approximate mass loadings: 20 mg, 2 mg, and 0.2 mg (or 200 µg) printed on 50mm Whatman cellulose filter paper, Grade 4 (See Figure 2). TADDs containing inkjet printed PC coupons either contained one or two coupons of each mass loading amount.

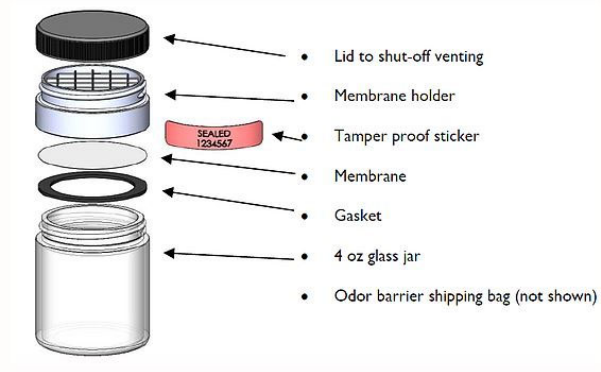

Figure 1: Training Aid Delivery Device (TADD) Components

Figure 2: Potassium Chlorate contained within TADDs (L to R: 25g, 2.5g, 20mg printed coupon)

Control items were also utilized in the test to ensure MWDs were alerting to the specific odor of the target material and not a background odor contained within the overall odor picture. Controls consisted of empty TADDs, TADDs containing unprinted Whatman paper, TADDs containing Whatman paper that underwent the printing process, and articles used to manipulate test items such as gloves and deionized water wipes.

Individual target items and controls were contained within stainless steel shaker cans and placed within Tactical Directional Canine Systems (TDK9) scent carousels as shown in Figure 3.

A single scent wheel containing 6 stainless steel shaker cans constituted one trial. Within a trial, the trial could be blank meaning no target item was present (i.e. a mixture of control items and empty cans).

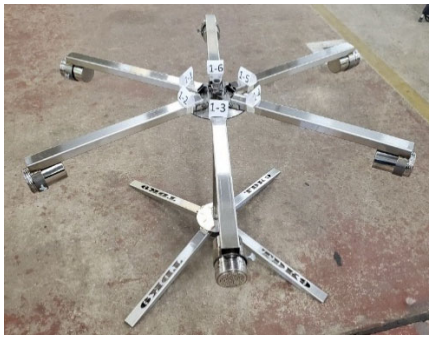

Figure 3: TDK9 Scent Carousel

A series of 5 scent carousels were used during the odor recognition test, as shown in Figure 4. This series of 5 scent carousels constituted a single session. Each canine team ran each session individually, without knowing the location of any target items beforehand. A test administrator watched each canine team from behind blinds, as shown in Figure **4**, to prevent inadvertent signaling to the team as to which trials/cans were targets. The average blank percentage (trials that did not contain a target item) was 30% for the September T&E and 18% for the October T&E.

Figure 4: Odor Recognition Test Layout

Each team was instructed to sample odor from each can in a trial before deeming a trial blank and moving to the next trial in the session. If a canine alerted to a can, the handler would communicate the alert to the test administrator, and the test administrator would confirm whether the canine had alerted to a target item. If a canine alerted to a target item, the handler would then reward the canine; if the canine had an alert on a non-target item, then canine would be scored with a miss (false alert). The handler would then make the decision to either continue to search the trial for a target, or move on to the next trial in the session. The test administrator recorded all handler confirmed alerts to both target and non-target items.

3. RESULTS

3.1 Target Detection Rates

Table 1 summarizes the percent detection for each target item from the September iteration of the T&E. This T&E was comprised of three (3) canine detection teams. Statistical analysis was not performed due to the limited nature of this data set.

Table 1: September Target Detection Rates

Target Item	**Total**	
	Alert/Exposures	**Percent Detection**
25 g PC	2/6	33%
2.5 g PC	21/22	95%
2 x 20 mg PC on Whatman paper in TADD	13/14	93%
20 mg PC on Whatman paper in TADD	5/8	63%
2 x 2 mg PC on Whatman paper in TADD	16/16	100%
2 mg PC on Whatman paper in TADD	12/12	100%
2 x 0.2 mg PC on Whatman paper in TADD	13/13	100%
0.2 mg PC on Whatman paper in TADD	10/11	91%
Total	**92/102**	**90%**

summarizes the percent detection for each target item from the October iteration of the T&E. This T&E was comprised of eight (8) canine detection teams. All participating MWDs had a sensitivity of 83% (95% CI 78-87%). All participating MWDs correctly alerted on 82.6% of targets (219 alerts on 265 attempts), and these results are statistically significantly better than random guessing (p-value < 2.2e-16). All individual MWDs with a sufficient number of trials outperformed random guessing.

Table 2 summarizes the percent detection for each target item from the October iteration of the T&E. This T&E was comprised of eight (8) canine detection teams. All participating MWDs had a sensitivity of 83% (95% CI 78-87%). All participating MWDs correctly alerted on 82.6% of targets (219 alerts on 265 attempts), and these results are statistically significantly better than random guessing (p-value < 2.2e-16). All individual MWDs with a sufficient number of trials outperformed random guessing.

Table 2: October Target Detection Rates

Target Item	Total	
	Alert/Exposures	Percent Detection
2.5 g PC	43/56	77%
20 mg PC on Whatman paper in TADD	67/82	82%
2 mg PC on Whatman paper in TADD	66/75	88%
0.2 mg PC on Whatman paper in TADD	43/52	83%
Total	**219/265**	**83%**

3.2 False Alert Rates for Non-Target Items

Statistical analysis was not performed due to the limited nature of this data set.

Table 3 summarizes the false alert rate for each non-target item from the September iteration of the T&E. This T&E was comprised of three (3) canine detection teams. Statistical analysis was not performed due to the limited nature of this data set.

Table 3: September False Alert Rates

Control Item	Total	
	False Alerts/Opportunity	Percent Detection
Gloves	2/145	1%
Deionized Water Wipes	4/145	3%
TADD	26/145	18%
TADD with Whatman Paper	24/145	17%
TADD with Printed Whatman Paper	35/145	24%
Empty Cans	3/43	7%
Total	**95/768**	**12%**

Table 4 summarizes the false alert rate for each non-target item from the October iteration of the T&E. This T&E was comprised of eight (8) canine detection teams. All participating MWDs had a specificity of 94% (95% CI 92-95%).

Table 4: October False Alert Rates

Control Item	Total	
	False Alerts/Opportunity	Percent Detection
Gloves	58/320	18%
Deionized Water Wipes	2/288	1%
TADD	7/263	3%
TADD with Whatman Paper	12/320	4%
TADD with Printed Whatman Paper	22/320	7%
Whatman Paper Only	0/32	0%
Empty Cans	6/112	5%
Total	**107/1655**	**6%**

4. DISCUSSION

When working dogs teams become certified to detect an odor, the metric that is typically used to determine whether a detection team has adequate discrimination of target odor over non-targets is to achieve over a 90% alert rate on target items while having a 10% or less false alert rate on non-target items. Many of the detection rates and false alert rates from both T&Es fall in line with teams who hold certifications, therefore indicating that coupons could be a viable option to use in training. Sections 4.1 and 4.2 discuss specific cases in which the detection rates or false alert rates fall outside of this benchmark.

4.1 Target Odor

4.1.1 First Iteration of T&E – September 2022

In the first iteration of the T&E, the three (3) detection canine teams that participated had previously participated in DEVCOM CBC T&Es that utilized TADDs and TDK9 scent carousels, therefore the format for testing was not novel, only the addition of printed coupons

was novel. Training was not provided prior to beginning the data collection due to the familiarity of each team with the test format, target odor, and target containment.

Twenty milligrams (20mg) of PC on Whatman Paper and 25g bulk PC had the lowest detection rates of 63% and 33%, respectively. This was likely due to the fact these items had the fewest number of overall presentations in the T&E; consequently, teams missing target items had a more profound effect on the overall detection percentage.

Teams were able to positively identify 2.5g of bulk PC 95% of the time, therefore teams not being able to detect 25g was not of concern as these samples were placed early in the T&E where incidences of false alert rates tend to be the highest while the MWDs are learning the "game" of the T&E.

Because the detection rates for the coupons was similar to the detection rate for the 2.5g bulk PC, it was determined that the selected target coupon amounts were in an appropriate range of detection for MWDs imprinted with bulk material.

4.1.2 Second Iteration of T&E – October 2022

For the second iteration of the T&E, the total number of target item types was reduced to increase the number of exposures each team had to each target item type. Because detection rates for two coupons of the same mass loading were similar to detection rates for their single coupon counterpart in the first iteration of the T&E, a single coupon per mass loading was used in this iteration.

Out of the eight (8) teams that participated, seven (7) teams had not been exposed to TADDs or TDK9 scent wheels, therefore teams were provided an opportunity to train prior to the data collection portion of the T&E. Teams were provided with 25g of bulk material contained within TADDs and empty TADDs to proof them off the odor of the containment of the target material.

Though slightly under the typical threshold of detection for canine teams that have certifications, the detection rate for all target items was 82.6%. With increased training, the rates of detection could be increased, but for a test and evaluation where these dogs do not typically train with target material as low as what was presented on coupons, this data indicates that the coupon levels presented could possibly be used as a maintenance tool in dogs previously imprinted with bulk levels of target material.

4.2 False Alerts on Non-Target Items

4.2.1 First Iteration of T&E – September 2022

In the first iteration of the T&E, non-target items with the highest false alert rates included TADDs with printed Whatman paper, followed by TADDs and TADDs containing Whatman paper, with detection rates of 24%, 18%, and 17%, respectively. The higher incidence

of false alert rates for these items are to be expected because prior to this T&E, these MWDs had not been trained to intentionally ignore these specific items. Odors from these non-target items make up a portion of the overall odor picture of TADDs containing printed Whatman paper, therefore a higher incidence of false alert rates to these particular items was to be expected.

In a typical training scenario, to prevent false alerts, MWDs would be trained to ignore the non-target portion of the odor picture. Over the course of the two-day T&E, the frequency of false alerts drastically decreased, therefore demonstrating the ability of the teams to specifically detect the target odor. It should also be noted that the overall false alert rate was 12% which is similar to the standard of less than 10% that certified teams achieve.

4.2.2 Second Iteration of T&E – October 2022

During the second iteration of the T&E, the non-target item with the highest false alert rate was gloves with a detection rate of 18%. Out of the false alerts on gloves, over half of those false alerts came from two (2) of the eight (8) teams. Gloves were not provided in the training scenario, therefore this may explain the higher false alert rate on that item specifically.

The next highest false alert rate came from TADDs containing printed Whatman paper with a false alert rate of 7%. In this T&E, these teams had not been trained to ignore the printed Whatman paper odor, hence the higher false alert rates on these items.

The false alert rates from the second iteration of the T&E were lower than the false alert rates from the first iteration this T&E and is likely because there was an initial training session provided during the second iteration of the T&E. Consequently, canines were able to learn to discriminate between target odor and odor from the containment device prior to the start of the data collection portion of the T&E.

It should also be noted that the overall false alert rate was 6% which is similar to the standard of less than 10% that certified teams achieve. With training, false alerts on non-target items could be decreased even further.

5. PATH FORWARD

Based on the results from the first two iterations of this T&E, the path forward is to perform a third iteration of this T&E during the Maneuver Support, Sustainment, Protection Integration eXperiments 2023 event at Fort Leonard Wood, MO from 3-7 April 2023. The goal of this exercise is to provide a larger data set collected from more detection canine teams to provide additional data to determine if there is a statistical difference in detection rates between bulk PC and coupons containing the three mass loadings previously tested. This information will provide additional insight to MWD program stakeholders as to whether inkjet-printed coupons could be utilized as a training maintenance tool within areas that may not allow for use of bulk counterparts.

With continued success of MWDs being able to detect coupons, an additional operational working dog T&E could be a next step to determine the canine limit of detection of the explosive

threats on the coupons contained within the TADD. Continued research could be also conducted to expand out to additional threat materials.

Additional information can be obtained by contacting the Olfactory Sciences Team at usarmy.apg.devcom-cbc.mbx.olfactory-sciences@army.mil.

ACRONYMS AND ABBREVIATIONS

CESK	Canine Explosive Scent Kit
MWD	Military Working Dog
PC	Potassium Chlorate
TADD	Training Aid Delivery Device
T&E	Test and Evaluation
TDK9	Tactical Directional Canine Systems
WD ATAS	Working Dog Advanced Threat Assessment System

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