# **REPORT DOCUMENTATION PAGE**

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13. ABSTRACT (Maximum 200 words)					
The original concept of the Phase II+ funding was to support integration of ICx Agentases's chemical weapons (CW) sensing materials into the Fido XT Explosives Detector system. It was determined however that despite marked advances in the enzymatic detection technology through the prototype, significant further work was needed before the Agentase materials would be sufficiently mature for integration. In place of CW detection, the radiation detection capabilities of ICx Radiation (another sister company of Nomadics under ICx Technologies) was selected instead as the intended integration of technologies.					
The Interceptor is a mature, han	dheld radiation detector with gan	ima and neutron detection capab	ilities, and upgraded models also		
complimentary to the Fido XT	Given the maturity of the Internal	ptor, and the significantly lower	expected cost of integration.		
funding was split between the Fido XT upgrade and further R&D efforts on the CW badge prototype, with a view to furthering the					
technology to a point where integration may be considered favorable.					
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Enclosure 1

Nomadics, Inc. an ICx company





www.nomadics.com

Contract No:

Project:

Period Covered:

Contractor:

Principal Investigator:

Program Manager:

Contracting Officer's Repre

Date:

The Fido® the Interna and this



#### Introduction

The original concept of the weapons (CW) sensing mater developed that utilized the e and interrogated. It was detection technology throug Agentase materials would be

The CW detector required re such, the size of the original the flow cell of the CW syst liquid feeds with bubbles technological hurdle to overc of the initial funding.

Through discussion with the radiation detection capabili Technologies) would be select is a mature, handheld radiati models also have the option maturity of the Interceptor maturity of the Interceptor, between the Fido XT upgrad furthering the technology to

Towards the end of the proj customer, towards additional

Testing of the phenyl quinol Phase II SBIR, against addit inorganics, was conducted w Additionally, a platform for o targeted towards development

All work on this funding awa reviewed with the customer satisfied in large tasks 1 a detection technology that



miniaturization of the CW integration was applied to medium.

# Summary of Work Undertak

- 1. Explosives / Cher
- 2. Explosives / Radi
- 3. Expanded Suite o
- 4. Fido XT Data Ban



# Explosives / Chemical Weap

Project Expenditure: \$225k

# Outline

The Agentase handheld CD p however, the dimensions of t day detracted from the viabi real-time, as it required a 5 Accordingly it was accepted would result in a more usefu platform.

The concepts that were con included;

- replacement of the fluorophore.
  - fluorescence change, for a laden polym increased res
- replacement of the p
  - fluorescent
    fluorescent v
    route for rea
- construction of small polymer sponge mass
  - development
    fully engage



#### Preliminary Concept Work

Using a 490 nm LED, an appr (pH 7) fluorescein solution v power of roughly 40 nW was (in a few minutes) to appro substrate to form acetic a fluorescein decreases with de worked in principle.

To measure the fluorescent long), it was sized such it v transfer pipette. This prod sponge used in the original p the 490 nm LED (~5 mW o appropriate filter set, the me substrate, it was observed th the same magnitude of sign volume.







It was decided to build a bre variety of fluorescent dyes a simple as possible acquire of flexibility to investigate the

Two Harvard syringe pumps and a small Sensidyne air p excitation, and a Newport of controllable, and the reading excitation, and emission filt software that controls the allowing for complete user co



The new flow cell was de required. It was theorized completely, and therefore, a the sponge should take less sites, and should therefore b liquid reagent per cycle, redu

The favored version of the fl polymer. The flow cell wa



probing fluorescence. With able to provide several 100 m





#### Fluorescein Results

Using the new flow cell de production—fluorescence ded indicating that cycle times achievable. Liquid reagent (rinsing solution), and utilizin 2.3 mL. A 1 minute cycle tim

#### Fluorogenic Results

Several fluorogenic enzyme resorufin butyrate, indoxyl iodide. Due to availability, indicates that resorufin bu autohydrolyze and become f unsuitable for the sensor as c





Figure 4 - Fluorescence fro

Indoxyl acetate was fairly s generated fluorophore conce solution. N-methyl indoxyl a

Several different rinse soluti seems to have a very strong bleach) have been ruled out, the enzyme.

The fluorogenic approach w however, it was hypothesize enzyme. Cleaved (fluoresce wool (obtained from Restek nominal amount of buffer so silica.

# Ratiometric Fluorescent Dye

Given the difficulty with th proposed to return to invest ratiometric measurement wo concerns regarding intensity



measurement, These fluores substrate, acetylcholine chlo change in pH.

In addition to repeating th combination of fluorescein/t fluorescein and pyranine hav as it was desired to review t combination of fluorescein a pH dependent fluorescence Additionally, the combinatio two separate excitation maxi additional complications in t switching between the excita







The need for alternative dy research efforts on a separa dyes, as they were shown to because the emission spectr changes in pH (Figure 5). At pH=6.8, the intensity of 580 the intensity of the 640 nm p



Figure 6 - Response of AC

The response of the AChE-co observed in bulk solution wit of buffer containing acetylch determined. It took at least concentration was 1mM, and buffer concentration was 0.1 mixture did not change from

The observed change in ph diffusion limitation into the anticipated fast reaction. I when the interaction is set-u



# Reduced Volume Flow-Cell

A new smaller-dimen polyurethane sponge require detection cycle. The smaller analyte, and the more inherer reagents. The new flow cell The smaller dimension sm fluorescent interrogation set power meter used for emissi was replaced by an Ocean Op pass filters were changed to a











As the funding of the proje through continuously, as mo the absence of this additiona 1) was then passed through system before the "buffer"  $\mu$ of substrate (buffer contain  $\mu$ l/min. The system was then at 6  $\mu$ l/min, before an additi

Fi

Figure 8 details the ratiom optimized, a 10% drop in bas and return to "baseline" afte was successful at demonstra sponge in the bulk solution, v — response ■ buffer ▲ substrate



Future Efforts Considered

Looking forward towards pro required system component generated The assembly depi in red), to permit the ease of









Focused on the flow cell cap band-pass filtered to detect liquid streams (buffer and su the tube, and the presence outputs from the two photothe current bench-top set-up



Figure 10 - Assembly dr



# Explosives / Radiation Integ

Project Expenditure: \$175k

#### Outline

The original concept of the I weapons (CW) sensing materi advanced in the enzymatic prototype, further work was with Fido XT. It was ther capabilities of ICx Radiation

#### Accomplishments

In discussion with ICx Radiat product line, it was concluc combination of size, power modified gamma detector v configured to operate under controller of the Fido XT, assembly. In a parallel eff dimensions of the gamma rac

An interface module was de module consisted of a custon CZT board on a schedule, an data was processed and simp details. The data stream de second) and a radiation dose real time whereas dose rate a more accurate evaluation o





Figure 11 - The orginal cor detector product (righ

The Fido XT, interface modul together. The assembled pr article. The firmware for bo side by side operation, and i any electromagnetic interfe reasons, the integrated syste further testing required at h capabilities of ICx Nomadics' modified Fido, which show additional status screen for sources such as <sup>22</sup>Na, <sup>60</sup>Co, nucleotide demonstrated class













#### Discussion

The first planned integration dose rate readings to enhanc taken into account the chan between ICx Radiation and IC and radionucleotide identific an engineering and parts bo



delivery of the modified net concerns regarding the viat heavily on the processor lim dosimeter. Additionally the environment, and modification the library would need to be timeframe of the funding, an projects detailed below.





# Expanded Suite of Explosiv

Sub-Project Expenditure: \$35 Outline

In Phase I of this program assurance via fluorescence-b Phase II, development conti using these reactive fluoresc high sensitivity and a unique

The RFRs provide dark field agent and fluorescent when with a simple optical system sarin, soman, and tabun, how to synthesize, was developed

This molecule, shown in Fig (thus called PQS). The sens industrial chemicals (TICs) s protonation of the PQS, as s change in the structure of characterizing the performan TICs shows strong responses less than ten seconds for the large responses at PEL conce Info Card are shown in Figur







During testing of alternative structure currently utilized



Ammonium Nitrate based ex evaluate one of the PQ-based of this contract; for its capa and to perform some prelim conjunction with Ammonium Nitric Acid (HNO<sub>3</sub>) that is compound. ANFO is compose

#### Accomplishments

The PQS reporter was prepa (PMDMS) was also included characteristics on the silanize solution. As a dark field re flares dropped in intensity, After exposure, baselines did has focused upon increasing exposure

#### Initial PQS Concentration Ser

To demonstrate the reporter Ammonium Nitrate mixed at to the Fido. By spiking a knd methanol solvent to dry, a re to 10 exposures of a given m 100ng HNO<sub>3</sub> doses and the temperatures (Tip=145°C, Po was approximately 10 second versus Ch2 sensitivity depend





Generally, the series responses of the 10ng of Nitu However, if based on first hi 10ng HNO3 first dose respons than 1ng for HNO3 or AN, the

PQS Sensitivity to ANFO and To verify that the reporter v Fuel Oil (ANFO) was mixed displays responses from PQS allowed to dry, and presente each mass, a separate capil another nitrate based binar capacity seen. Since the rep from each mass tested is mos







If the results from all serie compared on the basis of th ANFO, AN, and Urea Nitrate t









		ANFO		
	HNO3	Ammonium	AN	UN
Analyte	Nitric	Nitrate Fuel	Ammonium	Urea
Mass	Acid	Oil	Nitrate	Nitrate
1ng	10	0.8	0.2	2.9
10ng	105	35	30	10
100ng	428	176	195	164
1000ng		897		229

Т



Data Consistency - Aging of R

Much of the preliminary da determined to be stale. Th (Phenyl Quinoline in CHCl<sub>3</sub> ar was later discovered that th solution were much higher t capability to recover were s figures depict the response f report, was taken, along wi clearly different, the absolut





To date, it has not determine and longer rise/fall times of with CHCl<sub>3</sub>, reaction of the F on alternative funding sugge recovery occurs even in the s the combined mixture of the

Another indication of aging exposure to target material increase in brightness, with freshly mixed solutions, the typically significantly larger.



#### Fido XT Data Bank and Algo

Sub-Project Expenditure: \$50

#### Outline

The purpose of this effort wa files and blank trace files f laboratories. The database collected including such info and over twenty other param for the evaluation of automa

The following steps were play

- 1. Create an organized
- 2. Create the necessary
- 3. Derive a method for
- Create an applicatio the files into the union
- 5. Add modify/update f
- 6. Create an applicatio algorithm developer
- 7. Deploy sample algori
- 8. Test algorithms agair

#### Accomplishments

Given the short duration of project, with the results de level object of the database of which has documented ins table. Figure 21 below show







To uniquely identify and stor then moved them into a sec File Table (MFT) in the dat location. Figure 22 details stores a backup copy of all t approach to data redundan majority of the data will s database, with more being a

<u>File Edit View Favorites Tools Help</u>

🔄 TraceData



 
 Master -- Cleaned.csv

 Master -- Orig.csv

 JD5502A0F7E81D41ACC89EBC52B95BAD.csv

 J0059BAC9DC217C40A13D5A2E8827A7A.csv
 50BDB9F4603407001A16587EF1DEE00D.csv ED44637673160233549925423BCD909.csv C162BE515810A9AFEF0504EA5698EA38.csv 32500727FE403EE800DCFA37CE50957CF.csv 0D8987CCA05074D45E28968F6BC9B2B4.csv C0F4BCA177040A467F235CC3766AC85B.csv 5AB853C1587D6BC8DE265E51C677E8E7.csv 3173A1980FC37D2C8EBE834759909F153.csv EAC45296195039EC92907B8C8CE10345.csv BE841C1D6A0C2E607F2FE0242BB05E2A.csv FD9BBE605A45F03E98C79DF188B0BB0D.csv C569E6DDB3DFAA05E98F879693DB9785.csv F05E360DC8C17495A1DABC27D0AA19BC.csv D4D71B36E48BBA8E655119525C1F72FA.csv BDDC64B20E573CF5D615CDA7A40844117.csv 693E9230D7CA0DB9DB2DBA84728D4BE3.csv ■ 093C925007CR00059DD2D0R4726040C3:CSV ■ F40A0DA3AD18051F494636016DD5315D.csv ■ 2A3C468703A9A852AB8492B07895C040.csv BDF3BA6D6615AC02CCC0C129866D0CC77.csv BF9F80181E9FD36C1E843BE7BAAA465B.csv AAD88DF3358888BAF4FACE65346A0A750.csv D503EC5221EE209757C68350F6B94459.csv

Size	Туре	Date Modified 👻
3,574 KB	Microsoft Office Exc	4/28/2008 3:55 PM
515 KB	Microsoft Office Exc	3/13/2008 5:17 PM
798 KB	Microsoft Office Exc	3/13/2008 2:16 PM
52 KB	Microsoft Office Exc	12/4/2007 2:45 PM
52 KB	Microsoft Office Exc	12/4/2007 2:43 PM
52 KB	Microsoft Office Exc	12/4/2007 2:40 PM
52 KB	Microsoft Office Exc	12/4/2007 2:39 PM
52 KB	Microsoft Office Exc	12/4/2007 2:37 PM
52 KB	Microsoft Office Exc	12/4/2007 2:36 PM
52 KB	Microsoft Office Exc	12/4/2007 2:35 PM
52 KB	Microsoft Office Exc	12/4/2007 2:33 PM
52 KB	Microsoft Office Exc	12/4/2007 2:31 PM
52 KB	Microsoft Office Exc	12/4/2007 2:29 PM
52 KB	Microsoft Office Exc	12/4/2007 2:27 PM
53 KB	Microsoft Office Exc	12/4/2007 2:25 PM
53 KB	Microsoft Office Exc	12/4/2007 12:33 PM
53 KB	Microsoft Office Exc	12/4/2007 12:32 PM
52 KB	Microsoft Office Exc	12/4/2007 12:30 PM
53 KB	Microsoft Office Exc	12/4/2007 12:28 PM
53 KB	Microsoft Office Exc	12/4/2007 12:27 PM
53 KB	Microsoft Office Exc	12/4/2007 12:26 PM
53 KB	Microsoft Office Exc	12/4/2007 12:24 PM
54 KB	Microsoft Office Exc	12/4/2007 12:23 PM
54 KB	Microsoft Office Exc	12/4/2007 12:20 PM
53 KB	Microsoft Office Exc	12/4/2007 12:18 PM
53 KB	Microsoft Office Exc	12/4/2007 12:16 PM
54 KB	Microsoft Office Exc	12/4/2007 12:12 PM

The application created for e to facilitate simple entering expression engine for extract files and harvests as much of entry.





#### Discussion

Given the late nature of the was stopped after the creati insufficient funding to suppo



the efforts and maintain the further and future tests.

#### Discussion and Further Wor

The CW prototype has under is smaller, faster to respond The core technology is less achievements. The real-time that has been developed with

The combined radiation/exp regular Fido XT, and gamma the radiation specifications t

The additional work on expa engineering of the Fido XT p products. Work on the PQS interest it has generated. In evaluation.