Urban Operational Experimentation hosted by the
National Urban Security Technology Laboratory (NUSTL)

BioFlash-E Report

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Executive Summary

BioFlash-E underwent operational experimentation on July 30, 2015, at a New York City Police Department's facility at Floyd Bennett Field in Brooklyn, New York. First responder evaluators from law enforcement and fire departments in New York, New Jersey, and Massachusetts took part in this event.

BioFlash-E, produced by PathSensors Incorporated, collects, and analyzes atmospheric aerosol samples for a suite of biological pathogens. PathSensors indicates BioFlash-E is currently used for biological agent monitoring at fixed locations, and it offers the BioFlash-E in configurations that can be transported, set up, and operated by a single person. The absence of a real-time ability to detect and identify airborne biological agents at field deployments was identified as a significant capability gap by first responders participating in the Project Responder 4 study [1], thus the BioFlash-E was selected for the operational experimentation as a device that can potentially fill this gap.

A PathSensors representative provided participating first responder evaluators with a presentation about the technology and science underlying the BioFlash-E. The representative then demonstrated how to operate the instrument. First responder evaluators experimented with the BioFlash-E to gain first-hand experience of the instrument's features and capabilities. After the session, evaluator comments were collected. Additionally, comments from both observers and evaluators were collected during a debrief session. Following the debrief session, evaluators provided additional feedback via a brief questionnaire form.

The evaluators appreciated the ease of use of the BioFlash-E and its ability to quickly detect and identify biological agents. There were a number of suggestions for enhancing the BioFlash-E for first responder operations. While the version of the BioFlash-E that was tested can be readily transported and operated by one person, evaluators suggested two different approaches to enhancing its use in field operations. One suggestion was for the manufacturer to reduce the size and weight of the current unit, making it can be easily worn and operated; the other suggestion to achieve the same result was for the manufacturer to provide a wearable aerosol-sampling device to be used in conjunction with the current model of the BioFlash-E. Evaluators considered the two-week shelf life of the BioDiscs used in conjunction with the BioFlash-E to be somewhat problematic. They felt that due to the unpredictability of field operations, expired BioDiscs might often be discarded unused, which would lead to a high long-term operating expense given the cost of individual BioDiscs. They suggested that lengthening the shelf life of the BioDiscs, if possible, would be advantageous. Some responders stated that they would be unable to use the BioFlash-E or other instruments with rapid biological agent detection and identification capability, without thorough performance testing. There were similar comments from the New York City Department of Health and Mental Hygiene during the planning of the BioFlash-E operational experiment.

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1 Introduction

The BioFlash-E is a portable biological aerosol collection, detection and identification instrument developed by PathSensors, Incorporated. PathSensors indicates that its current use is for biological agent monitoring at fixed locations, and it offers the BioFlash-E in configurations that can be transported, set up, and operated by a single person.

BioFlash-E was evaluated on July 30, 2015 during the Department of Homeland Security Science and Technology Directorate's (DHS S&T) Urban Operational Experimentation (OpEx) event, hosted by the National Urban Security Technology Laboratory (NUSTL). This event brought together first responders and product developers to experiment with emerging technologies in operational conditions. The New York City Fire Department, New York City Emergency Management, New York City Police Department (NYPD) and Port Authority of New York and New Jersey subject matter experts supported the OpEx, selected the technologies, and worked with NUSTL scientists to plan the experimentation scenarios and arrange test venues. Responders from these agencies and members of the First Responder Resource Group experimented with the technologies and provided feedback and observations. Table 1 lists all of the technologies that were included in this event. Technologies assessed during this event were selected with input from local first responder agencies and met capability gaps identified in the Project Responder 4 National Technology Plan for Emergency Responder to Catastrophic Incidents (1).

Table 1. Technologies Included in OpEx 2015

Product Name Manufacturer	**Description**
Situational Head Up Display Avon Protection Systems	Micro liquid crystal display (LCD display with full color widescreen layout built into face shield
Tridion™-9 PerkinElmer	Portable Gas Chromatography/Mass Spectrometry (GC/MS) system that provides identification of volatile and semi-volatile organic hazards in the field in less than three minutes
BioFlash-E Biological Identifier PathSensors	Portable and rapid aerosol sample collection and identification of up to 16 biological threat agents
Fido B2 IBAC FLIR	Networked array of portable biosensors
Internet of Things for First Responders BAE Systems	Networked sensors that use a long-range wireless protocol capable of concrete penetration to send signals through a network aggregator
Knight Robot/HAZPROBE WM Robots	All-terrain robot with a manipulator arm, cameras, and a boring and inspecting device that can drill through walls for bomb tech personnel to inspect suspect abandoned vehicles or objects
RepKnight ADI Technologies	Monitors and analyzes social media with geolocation feature

Product Name Manufacturer	Description
X-Ray Scanning Rover Smart Imaging Systems	An x-ray scanner integrated into a custom-built robot that is designed to rapidly screen suspicious left-behind bags or parcels on the ground

1.1 Purpose

The BioFlash-E operational experiment intended to provide first responder evaluators with an opportunity to learn about the BioFlash-E, experiment with it in a hands-on fashion and obtain feedback about its use for first responder applications. The feedback from first responders should provide PathSensors with information useful in optimizing the BioFlash-E for field use by first responders, and help inform S&T about responder needs to guide future homeland security investments in this technology area.

1.2 Objective

This experimentation is designed to allow first responders to experience the use of BioFlash-E in operational settings and provide feedback and suggestions to PathSensors, so the product features and capabilities may be enhanced for first responder operations in future developments.

1.3 Responder Capability Need

The ability to detect biological agents in real time is one of the capability needs identified by first responders participating in the Project Responder 4 study. BioFlash-E is a technology that could address this capability need during incidents potentially involving biological agents.

1.4 Prototype Description

The BioFlash-E, see Figure 1, is a biological aerosol collection, detection and identification instrument that is available in three configurations: (1) a tabletop instrument; (2) a portable instrument that is integrated into a wheeled carrying case; and (3) a rack-mounted instrument for installation in a vehicle-based laboratory. Evaluators tested the portable version was during OpEx; it weighs 35 pounds and operates over a temperature range of 50 to 104 °F, and is designed to be easily decontaminated. It operates on standard AC power sources with a power consumption of 60 watts. The instrument requires minimal user training (less than 15 minutes) to operate. The user interface consists of a sealed touch pad and a liquid-crystal display (LCD) screen; if a biological agent is detected, audio and visual alarms are produced and the name of the detected biological agent is indicated on the LCD screen. The BioFlash-E has an RS-232 port used to send analysis results to a central location or remotely initiate sampling.

Figure 1. BioFlash-E

Samples are collected on a disposable BioDisc, see Figure 2, which is manually loaded into the BioFlash-E prior to the start of a user-determined sample collection period. Using a cell-based immunoassay technique, biological agents are identified and analysis results reported within three minutes of the completion of sample collection. BioDiscs contain a series of test chambers that produce light when a specific biological agent is detected; a light sensor detects this light output and identifies the biological agent based upon which test chambers produce light. An individual BioDisc can be configured to identify any six of 21 biological threat agents for which BioDisc-based immunoassay tests have been developed. Among the biological agents that can be detected are: anthrax, botulism, plague, ricin, smallpox and tularemia.

Each BioDisc contains 16 test chambers: two for each of six biological agents (the analyses are performed in duplicate to ensure a low false-positive rate), a positive and negative control test chamber, and two-sample archiving chambers that are used to store collected aerosols for subsequent analysis by laboratory-based methods.

Figure 2. BioDisc

The sample collection and biological agent identification procedure is automated and typically initiated manually via the touchpad, but can also be initiated by a user at a remote location or by some other biological agent sensor device. When sampling is initiated, ambient air is drawn through the BioDisc at a flow rate of about 500 liters per minute. The flow path of the air sample through the BioDisc is designed to cause aerosol particles in the 1 to 10 microns size range to fall out of the air stream and adhere to clear plastic windows in the test chambers on the edge of the disk. At the end of the sampling period, the BioDisc spins at a high rate, releasing biosensor

cells to mix with collected aerosol particles in the test chambers. These cells are bioengineered to produce light if the target pathogen they are designed to detect is in contact with them, and a photomultiplier tube that monitors the BioDisc's test chambers detects the light. BioDiscs contain live cells and must be stored in a refrigerator. They are usable for 10 days after delivery from PathSensors when kept at a temperature of between 36 and 46 °F. BioDiscs must be warmed up for 30 minutes prior to use and then must be used within 24 hours. According to PathSensors, the manufacturer's suggested list price of the BioFlash-E is approximately $35,000 and BioDiscs cost approximately $100 each.

2 Experimentation Design

A detailed description of the experiment design can be found in the BioFlash-E experimentation plan [2]. The experimentation scenario was developed to simulate biological agent detection using BioFlash-E with input from responders, the manufacturer and the NUSTL OpEx team.

2.1 Event Design

The basic concept was to provide the first responder evaluators with an opportunity for hands-on operation of the BioFlash-E to assess its potential as a real-time biological agent detector and identifier for first responder operations. The first responder evaluators interacted with the PathSensors representative during the hands-on experimentation session to ensure they had a thorough understanding of the instrument's features and capabilities. The experimentation session went well with no major changes to the test plan. After initial remarks by the experimentation director, including a brief safety discussion, first responder evaluators heard a presentation on the BioFlash-E by a Pathsensors representative on the features and capabilities of the BioFlash-E, and received training on how to operate this instrument.

2.2 Summary of the Operational Experimentation

On July 30, 2015, five first responder evaluators from the NYPD, the Port Authority of New York and New Jersey Police Department and the Boston Fire Department (Massachusetts) participated in a hands-on experimentation with the BioFlash-E at the NYPD's Floyd Bennett Field facility. The NUSTL experimentation director and two NUSTL data collectors were present to observe and take notes to capture the first responders' comments. Each evaluator had the opportunity to go through the entire sample collection process, to include loading BioDiscs into the instrument, initiating sampling and viewing analysis results. The BioDiscs used during these experiments were designed by PathSensors to indicate a particular outcome, i.e., the presence of a specific biological agent or the absence of any biological agents, for demonstration purposes. No biological agents were used during these experiments, nor were any of the BioDiscs capable of detecting actual biological agents. At the end of the hands-on experimentation period, the NUSTL experimentation director led a group discussion to elicit additional evaluator feedback for the NUSTL data collectors. Also, the evaluators filled out a

short questionnaire to provide additional feedback. The questionnaire consisted of several questions about specific product features and provided space for the evaluators to provide written remarks about any aspect of the BioFlash-E that the first responders considered relevant to its use.

3 Results

Data collectors recorded evaluator recommendations, comments and concerns during the operational experimentation and debrief sessions. At the end of the debrief session, evaluators completed a questionnaire about specific product features and provided comments regarding the applicability of the BioFlash-E for first responder purposes. The information, gathered using these methods, is presented below.

3.1 User Feedback

Generally, evaluators liked the BioFlash-E's ability to quickly detect and identify biological agent aerosols. They felt that the BioFlash-E had an intuitive operating interface, with a touchpad that worked well, and an easily readable display screen. Analysis results were easily understood and the audio and visual alarms were considered suitable. The evaluators provided a number of suggestions to optimize the BioFlash-E for field use by first responders, as discussed below.

The current version of the BioFlash-E, although transportable by a single person, cannot be operated while carried or worn due to its size and the need for a 120-volt AC power source. Several responders recommended that PathSensors produce a version of the BioFlash-E that could be operated while carried, and indicated that the weight of such an instrument would have to be less than 10 pounds. Other evaluators recommended that PathSensors offer a portable aerosol sampler as an accessory to the BioFlash-E. The portable sampler would be used to collect aerosol samples on BioDiscs, which would then be brought to a centrally located BioFlash-E instrument for analysis. Evaluators felt that the portable sampler should be produced by PathSensors to ensure compatibility with the BioFlash-E. It was also suggested that the BioFlash-E should be able to produce data on a more continuous basis, perhaps by making it possible to load several BioDiscs into the instrument that would then be used sequentially to automatically analyze aerosol samples at pre-programmed time intervals.

Some evaluators considered the cost of BioDiscs, the need to keep them refrigerated before use and their relatively short refrigerated storage life to be drawbacks. Responders stated that field operations could occur at locations where refrigeration was unavailable, with the result that unused BioDiscs would have to be discarded. In addition, they anticipated that their operations were inherently unpredictable, and so it would be difficult to predict how many BioDiscs to keep on hand, once again leading to unused BioDiscs having to be discarded. Responders felt that BioDiscs with a significantly longer shelf life than the current 14 days was desirable; a three-month shelf life was suggested as a desirable feature. Smaller organizations in particular might not have the financial resources to afford to keep BioDiscs on hand in the quantities they might require.

Some technical changes that could likely be implemented easily were suggested. Currently, it is necessary to connect a netbook computer to the BioFlash-E to change the sampling time settings. Responders felt this was too awkward and suggested the option to set the sampling time via the touchpad user interface. Responders also recommended that the BioFlash-E have a wireless communication capability in addition to the current RS-232 connection.

Responders from one organization noted that while PathSensors indicates that the BioFlash-E has been tested by independent organizations, additional testing would probably be required to prove the BioFlash-E analysis results are comparable in quality to existing laboratory methods before their organization would use an instrument of this type. This echoes feedback received during the planning of this operation experiment, as discussed below.

An additional source of feedback came from the New York City Department of Health and Mental Hygiene (NYCDOHMH). During the planning of the BioFlash-E operational experiment, NYCDOHMH was briefed on the BioFlash-E operational experiment. It declined to send personnel to participate as observers or evaluators, but provided important comments about the possible use of instruments like the BioFlash-E within New York City, New York. While this feedback was obtained outside of the actual BioFlash-E operational experiment, it is reported here because it points out a possibly significant obstacle to be overcome before instruments such as the BioFlash-E could be deployed in New York City and perhaps in other locations, as well. According to NYCDOHMH, all biological agent-monitoring activities within New York, New York, must be based on accredited, laboratory-based, analysis methods. Therefore, at present time, NYCDOHMH, as a matter of policy, would not use real-time biological agent detection and identification instruments like BioFlash-E, nor would their use be permitted by municipal agencies acting under the jurisdiction of NYCDOHMH.

4 References

1. Project Responder 4: 2014 National Technology Plan for Emergency Response to Catastrophic Incidents (July 2014). Prepared for Department of Homeland Security by the Homeland Security Studies and Analysis Institute, Falls Church, Virginia (http://www.homelandsecurity.org/) Publication Number RP13-17-02.
2. Urban Operational Experimentation Plan for the BioFlash-E. July 2015. OpEx-T-PL-6 NUSTL.

5 List of Acronyms Used

DHS	-	Department of Homeland Security
LCD	-	Liquid Crystal Display
NUSTL	-	National Urban Security Technology Laboratory
NYPD	-	New York City Police Department
NYCDOHMH	-	New York City Department of Health and Mental Hygiene
S&T	-	Science and Technology Directorate