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The cover photo and images included herein were provided by the National Urban Security Technology Laboratory.
FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercially available equipment and systems and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency response equipment.
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: “What equipment is available?” and “How does it perform?” These knowledge products are shared nationally with the responder community, providing a life-and-cost-saving asset to DHS, as well as to federal, state, local, and tribal responders.

The SAVER Program is managed by the National Urban Security Technology Laboratory (NUSTL). NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, coordinating with other organizations, and ensuring flexibility and responsiveness to first responder requirements.

NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear, and explosive weapons detection; emergency response and recovery; and related equipment, instrumentation, and technologies. To support this effort, NUSTL in collaboration with DHS’ Transportation Security Laboratory, conducted a comparative assessment of handheld explosives trace detectors to provide emergency responders with information on currently available equipment, which fall under AEL reference number 07ED-01-IMOB titled Trace Detector, Explosive, Handheld.

For more information on NUSTL’s SAVER Program or to view additional reports on handheld explosives trace detectors or other technologies, visit www.dhs.gov/science-and-technology/SAVER.
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Science and Technology Directorate
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E-mail: NUSTL@hq.dhs.gov
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Authors:
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EXECUTIVE SUMMARY

In May 2019, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of handheld explosives trace detectors (HETDs) at the Transportation Security Laboratory (TSL) in Atlantic City, New Jersey. Four detectors were chosen for the assessment based on selection criteria recommended by a focus group of first responders with experience using HETDs. Prior to the operational assessment, TSL conducted separate laboratory testing in 2018. The laboratory testing involved determination of detection performance for various explosives, blank substrate false alarm rate, and background substance false alarm rate.

The overall results of the operational assessment, which addressed 22 evaluation criteria in four SAVER categories: capability, deployability, maintainability, and usability and the overall results of the detection performance assessment are highlighted in the tables below. The ability of the detectors to meet vendor-specified sensitivity levels was not one of the evaluation criteria chosen by the focus group and hence does not influence the results of the SAVER scoring tool, which concentrates on human factors. Detection sensitivity for the various detectors was observed by the evaluators since the assessment involved spiking substrates with explosives in order to experience the operational aspects of the instruments while analyzing real samples. Analysis sensitivity during the operational assessment was similar to the results obtained during the laboratory testing conducted separately by TSL. A more detailed description of how the laboratory tests were performed is included in Appendix C. Detailed data related to the explosives detection performance testing conducted by the Transportation Security Laboratory is available to law enforcement agencies upon request. Please contact NUSTL@hq.dhs.gov to request this data.

<table>
<thead>
<tr>
<th>Product</th>
<th>Overall Score</th>
<th>Overall</th>
<th>Capability</th>
<th>Usability</th>
<th>Deployability</th>
<th>Maintainability</th>
</tr>
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<tbody>
<tr>
<td>FLIR Detection Inc. Fido® X3</td>
<td></td>
<td>3.9</td>
<td>3.7</td>
<td>4.0</td>
<td>4.3</td>
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</tr>
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<td>2.8</td>
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<td>2.4</td>
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## Systems

<table>
<thead>
<tr>
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<th>Background Substance False Alarms</th>
<th>Blank Substrate False Alarms</th>
</tr>
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<tbody>
<tr>
<td>FLIR Fido X3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapiscan Detectra HX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bruker RoadRunner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smiths Detection Sabre 5000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Correct Alarms vs. False Alarms

<table>
<thead>
<tr>
<th>Correct Alarms</th>
<th>False Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50%</td>
<td>&gt;10%</td>
</tr>
<tr>
<td>51-74%</td>
<td>5-10%</td>
</tr>
<tr>
<td>75-100%</td>
<td>&lt;5%</td>
</tr>
</tbody>
</table>

A note on the Rapiscan products included in this assessment: Rapiscan System’s DETECTRA™ HX was included in laboratory testing; however, Rapiscan halted production of this product prior to the operational assessment. The MobileTrace—Rapiscan System’s replacement for the DETECTRA HX—was not available for the laboratory testing but was available for the operational assessment and replaced the DETECTRA HX.
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1.0 INTRODUCTION

Handheld explosives trace detectors (HETDs) are used by public safety organizations to screen public areas, packages, people, vehicles, luggage, clothing, and other items for trace residues of explosives and narcotics. The premise underlying the use of these instruments is that individuals handling explosives are likely to contaminate themselves with microscopic particles and transfer them to objects they contact.

These detectors can be operated in swipe or vapor sampling modes. When swipe sampling, the user wipes the surface of the object to be screened with a small swab to collect a sample of any explosive residues that may be present; this swab is then inserted into the detector and analyzed. When operated in vapor sampling mode, the instrument’s gas sampling inlet is held close to the object being screened and air is drawn into the instrument and analyzed.

During the assessment, HETDs were used only in swipe sampling mode. Detectors operating in swipe sampling mode can detect nanogram levels of trace explosive particles, which is far less than the levels typically found in a fingerprint of someone who has handled explosives. Analyses are typically completed in less than 30 seconds, and start-up times are usually less than 30 minutes. These HETDs can be powered by internal batteries, with operating times of several hours in normal use. HETDs are easily portable, making it possible to use them to screen passengers and luggage entering mass transit systems or to conduct on-board inspections of ships for explosives or narcotics.

From May 7 to May 9, 2019, the U.S. Department of Homeland Security (DHS), Science and Technology Directorate (S&T) National Urban Security Technology Laboratory’s (NUSTL) System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally oriented assessment of five HETDs at the Transportation Security Laboratory (TSL) in Atlantic City, New Jersey. Prior to the operational assessment, TSL conducted separate laboratory testing. The laboratory testing involved determination of detection performance for various explosives, blank substrate false alarm rate, and background substance false alarm rate. A more detailed description of how the laboratory tests were performed is included in Appendix C. An additional section relating to key observations from the laboratory testing that related to operational use was added to the individual detector assessment results in Section 4 of this report.

The purpose of this assessment was to obtain information on HETDs that would be useful to first responder agencies making operational and procurement decisions. This assessment was planned based on recommendations made by first responders with experience using HETDs who participated in a SAVER focus group held in February 2017 at TSL. The focus group report is publicly available on the SAVER website, www.dhs.gov/science-and-technology/SAVER.

1.1 EVALUATOR INFORMATION

Five emergency responders from various jurisdictions who have substantial experience using HETDs were selected to be evaluators for this assessment, see Table 1-1.
Table 1-1 Evaluator Information

<table>
<thead>
<tr>
<th>Evaluator</th>
<th>Years of Experience</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Service – Hazmat</td>
<td>30+</td>
<td>MD</td>
</tr>
<tr>
<td>Law Enforcement – Transit</td>
<td>25 – 30</td>
<td>NJ</td>
</tr>
<tr>
<td>Law Enforcement – Hazmat</td>
<td>20 – 25</td>
<td>VA</td>
</tr>
<tr>
<td>Law Enforcement – Counterterrorism</td>
<td>10 – 15</td>
<td>NY</td>
</tr>
<tr>
<td>Law Enforcement – Transit</td>
<td>10 – 15</td>
<td>NY</td>
</tr>
</tbody>
</table>

1.2 ASSESSMENT PRODUCTS

The HETDs included in this assessment are listed in Table 1-2. The detectors selected for assessment were identified through market research and selected according to product selection criteria identified by the focus group, including:

- Must be lightweight and able to be easily carried by one person, preferably with one hand
- Must contain a threat library with the minimum number of explosive spectra required by the user
- Must function correctly in both temperature-controlled environments and outdoors in bright sun and extreme temperatures
- Must be capable of being operated on internal battery power
- Must be able to perform mass screenings
- Must be able to analyze both vapor and swipe samples.
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product</th>
<th>Product Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruker Detection Corporation</td>
<td>RoadRunner</td>
<td></td>
</tr>
<tr>
<td>FLIR Detection Inc.</td>
<td>Fido® X3</td>
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<tr>
<td>Rapiscan Systems</td>
<td>DETECTRA™ HX</td>
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<tr>
<td>Rapiscan Systems</td>
<td>MobileTrace®</td>
<td></td>
</tr>
<tr>
<td>Smiths Detection</td>
<td>Sabre™ 5000</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Rapiscan System’s DETECTRA™ HX was included in the laboratory testing phase; however, its production was discontinued prior to the operational assessment. As such, the DETECTRA HX was not formally assessed, though evaluators performed some basic operations with it. Information related to the DETECTRA HX was gathered as a courtesy to responders using the detector and can be found in Appendix D. This detector was replaced in the operational assessment by Rapiscan System’s MobileTrace, which became available in 2019.
2.0 EVALUATION CRITERIA

NUSTL’s SAVER Program assesses products based on criteria in five established categories:

- **Affordability** groups criteria related to the total cost of ownership over the life of the product. This includes purchase price, training costs, warranty costs, recurring costs, and maintenance costs.
- **Capability** groups criteria related to product features or functions needed to perform one or more responder-relevant tasks.
- **Deployability** groups criteria related to preparing to use the product, including transport, set up, training, and operational/deployment restrictions.
- **Maintainability** groups criteria related to the routine maintenance and minor repairs performed by responders, as well as included warranty terms, duration, and coverage.
- **Usability** groups criteria related to ergonomics and the relative ease of use when performing one or more responder-relevant tasks.

The HETD focus group identified 25 evaluation criteria on which HETDs might be assessed and assigned each evaluation criterion to one of the five SAVER assessment categories. The focus group did not identify any criteria for the affordability category. Next, they assigned a weight for each evaluation criterion’s level of importance using a numerical weighting scale ranging from 1 to 5, with a ‘1’ indicating an evaluation criterion of minor importance and a ‘5’ indicating an evaluation criterion of utmost importance. The focus group also indicated the relative importance of the SAVER assessment categories using a percentage scale that totaled to 100 percent. These weights were factored into the calculation of numerical assessment scores using the formulas in Appendix A. The HETDs were assessed against the evaluation criteria identified by the focus group listed in Table 2-1. Evaluation criteria definitions can be found in Appendix B of this report.

Evaluation criteria for this assessment were developed following recommendations from the focus group with the following exceptions:

- The ability of the detectors to meet vendor-specified sensitivity levels was not one of the evaluation criteria chosen by the focus group and hence does not affect the results of the SAVER scoring tool which concentrates on human factors. However, detection sensitivity is discussed under the capability category in the assessment results section since the assessment involved spiking substrates with explosives in order to experience the operational aspects of the instruments while analyzing real samples. Analysis sensitivity during the operational assessment was similar to the results obtained during the laboratory testing conducted separately by TSL.
- The Included Accessories and Optional Accessories criteria, which the focus group assigned to the Deployability category, were not assessed as evaluation criteria; however, it was noted where critical accessories were not included in the base model. Pertinent information about optional accessories was also noted.
- The Level-1 Maintenance criterion, which refers to decontamination procedures the user can perform on their own without returning the detector to the manufacturer, was combined with the Decontaminability criterion. Both criteria were in the maintainability category. Both criteria involved cleaning steps needed to return the detectors to a ready state for analysis after exposure to explosives.
## Table 2-1 Evaluation Criteria

<table>
<thead>
<tr>
<th>SAVER CATEGORIES</th>
<th>Capability</th>
<th>Usability</th>
<th>Deployability</th>
<th>Maintainability</th>
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<tr>
<td>Overall Weight</td>
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### Evaluation Criteria

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<th>Durability</th>
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<table>
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<tr>
<th>Alarm Threshold Adjustability</th>
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<th>Ease of Battery Replacement</th>
<th>Consumables</th>
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<tr>
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<table>
<thead>
<tr>
<th>Power Options</th>
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<table>
<thead>
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<th>Data Logging Capability</th>
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<table>
<thead>
<tr>
<th>Ability to Modify Library</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Weight: 2</td>
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</tr>
</tbody>
</table>
3.0 ASSESSMENT METHODOLOGY

The HETD assessment began with a safety briefing, followed by familiarization sessions and an overview of the assessment plan. The five evaluators were then paired into two teams. Through a series of rotations, each team sequentially assessed the HETDs. Each HETD was assessed in a three-part process consisting of a start-up/initialization session, hands-on operational scenarios and a product rating and score adjustment session, as described below. All assessment activities took place under the guidance of NUSTL and TSL personnel.

3.1 START-UP/INITIALIZATION SESSION

During this session, a representative from each HETD manufacturer was assigned a conference room to set up their equipment and provided the evaluators with an overview of their instrument’s features and capabilities and training on how to operate the detector. The evaluators gained experience in sampling and running analyses, as well as knowledge on how long the instrument could be operated when fully charged, duration of charging, battery types, data storage capacity, training availability and cost, data transfer methods, warranties offered, how to view data files, alarm threshold adjustment, explosive library access and modification, and information on technical support timelines.

At the end of the start-up/initialization session, evaluators prepared the detectors as if they were starting a shift, which included powering on and warming up the detectors, verifying that the detectors were properly calibrated, and ensuring the detectors were ready for operational analysis activities. They also determined what consumables—test swabs, filters, test samples, etc.—were needed for each operational scenario.

3.2 HANDS-ON OPERATIONAL SCENARIOS

This portion of the assessment consisted of two scenarios: a security checkpoint screening and vehicle screening. NUSTL and TSL staff members guided each evaluator team through the tasks performed at each station. HETD manufacturer representatives remained in their respective conference rooms to provide as-needed technical support regarding instrument operations.

Figure 3-1 Start-Up/Initialization Sessions
Smiths Detection representative conducting the start-up/initialization session for the Sabre™ 5000 Unit (Left); and FLIR Detection Inc. representative conducting the start-up/initialization session for the Fido X3 (Right)
3.2.1 SECURITY CHECKPOINT SCREENING SCENARIO

Evaluators performed activities simulating the checkpoint screening that occurs before a major event. Evaluators used the sampling media required by each HETD to sample different substrates, including vinyl coated polyester, zippers, wood, polycarbonate, black vinyl, acrylonitrile butadiene styrene (ABS) plastic, high-density polyethylene (HDPE), and polypropylene, which were spiked with quantities of explosives that were representative of the manufacturers’ claims. The sample collection efficiency of swabs can vary depending on the type of substrate. All five tiles of the ABS plastic were spiked; the other substrates were randomly spiked. Evaluators were asked to test different substrates that were randomly spiked with explosives, and they were all asked to sample five test surfaces of spiked ABS plastic to check for repeatability. Sampling the randomly spiked substrates helped determine if any false positive alarms would be triggered by the HETDs, i.e. when there were no explosive particles present, would the system provide a false positive identification and simultaneously, could the system correctly identify an explosive particle from the randomly spiked substrates.

The evaluators performed the verification process recommended by the manufacturer and were asked to note how often the verification procedure had to be run and if this affected the detector’s ability to process samples. They sampled various items that would be seen during a security screening, including but not limited to mobile phones, radios, and cameras. Evaluators assessed the ease of operating each HETD in different light environments as well as while wearing gloves.

Throughout this scenario, evaluators adjusted detector settings, including the alarm sensitivity and alarm type, to determine how easily these could be adjusted in the field. They were asked to note the clear-down time of the detector. Clear-down time is the time needed for a detector to recover from an alarm through a repeated sequence of automated cleansing to clear out the residual sample from the instrument until the signal is reduced below a set threshold and the system has returned to a ready state to continue operations.

Figure 3-2 Security Scenario
Table with substrates and various items that would be seen during a security checkpoint screening (Left); Evaluator using an HETD to analyze a sample as a NUSTL staff member collects feedback (Center); and results displayed from the sample (Right)
3.2.2 VEHICLE SCREENING SCENARIO

Evaluators performed activities simulating screening a vehicle suspected of having transported explosives. The test vehicle was a TSL truck used for transporting explosives and had known areas of trace explosive contamination. These activities were performed in a parking lot outside at the TSL venue.

Evaluators collected samples from the steering wheel, door handles, keys, tires, and trunk while wearing gloves. The first responders were asked to evaluate the readability of the screen in sunlight, the ease of adjusting settings, including the alarm sensitivity to ensure they were able to detect the level of explosives present and the configurability of the alarm to determine how well the detector could be operated covertly. They were also asked to note the clear-down time of the detector.

Figure 3-3 Vehicle Used for Screening Scenario
The TSL vehicle used for the vehicle screening scenario (Left); Vehicle with front doors open with the interior front cabin visible (Center); and the rear storage area of the vehicle (Right)

Figure 3-4 Vehicle Screening Activities
An evaluator swiping the vehicle's rear storage area (Left); an evaluator using an HETD to analyze a sample collected from the vehicle as the NUSTL Test Director observes (Center); an evaluator collecting a sample from the vehicle's front interior cabin (Right)
3.3 PRODUCT RATING AND SCORE ADJUSTMENT SESSION

Each evaluator was issued a folder containing product information and specifications. Evaluators used the following 1 to 5 scale to rate the criteria for each product:

1) The product meets none of my expectations for this criterion.
2) The product meets some of my expectations for this criterion.
3) The product meets most of my expectations for this criterion.
4) The product meets all my expectations for this criterion.
5) The product exceeds my expectations for this criterion.

Refer to Appendix B for evaluation criteria definitions. Each instrument was initially rated right after the hands-on operational scenario. The evaluators were encouraged to provide written feedback on each of the evaluation criteria and to provide additional comments regarding the advantages and disadvantages of each HETD. Once assessment activities were completed, evaluators had an opportunity to review and edit their criteria ratings and comments. At the end of assessment activities, an overall assessment score was calculated for each HETD using the scoring formulas provided in Appendix A. In addition, evaluator comments for each HETD were reviewed and summarized for this report.

4.0 ASSESSMENT RESULTS

Overall assessment scores for the products ranged from 2.4 to 3.9. Table 4-1 provides the overall assessment and category scores for each instrument. Calculation of the overall assessment scores used raw, non-rounded, category scores.

<table>
<thead>
<tr>
<th>Product</th>
<th>Overall Score</th>
<th>Overall</th>
<th>Capability</th>
<th>Usability</th>
<th>Deployability</th>
<th>Maintainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLIR Detection Inc.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fido® X3</td>
<td>3.9</td>
<td>3.7</td>
<td>4.0</td>
<td>4.3</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Rapiscan Systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MobileTrace®</td>
<td>3.5</td>
<td>3.6</td>
<td>3.1</td>
<td>3.9</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Bruker Detection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporation RoadRunner</td>
<td>2.9</td>
<td>3.0</td>
<td>2.5</td>
<td>3.4</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Smiths Detection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sabre™ 5000</td>
<td>2.4</td>
<td>2.7</td>
<td>2.3</td>
<td>2.5</td>
<td>1.9</td>
<td></td>
</tr>
</tbody>
</table>

Approved for Public Release
Table 4-2 graphically represents the evaluation criteria ratings for each HETD model using colored, shaded circles. A fully shaded green circle represents the highest rating, while an unshaded red circle represents the lowest rating. Refer to Appendix B for evaluation criteria definitions.

<table>
<thead>
<tr>
<th>Category</th>
<th>Evaluation Criteria</th>
<th>Fido® X3</th>
<th>MobileTrace</th>
<th>RoadRunner</th>
<th>Sabre™ 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capability</td>
<td>Explosives Library</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Alarm Threshold Adjustment</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Power Options</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Alarm Configurability</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Reachback</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Data Logging Capability</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Usability</td>
<td>User Interface</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Start-Up Time</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Ergonomics</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Data Transfer</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Battery Life/Indicator</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Ease of Use</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Ability to Modify Library</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Deployability</td>
<td>Verification</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Ease of Battery Replacement</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Storage Case Quality</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Covertness</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Durability</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Consumables</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Decontaminability</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td></td>
<td>Warranty</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>
The values in Table 4-3, Key Specifications, were provided by manufacturers and are not the result of assessment activities.

### Table 4-3 Key Specifications

<table>
<thead>
<tr>
<th>Key Specification</th>
<th>Fido® X3</th>
<th>MobileTrace®</th>
<th>RoadRunner</th>
<th>Sabre™ 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price (MSRP, GSA)</td>
<td>MSRP $22,450, GSA $21,487</td>
<td>MSRP $33,000</td>
<td>GSA $32,400</td>
<td>GSA explosives only $22,601</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GSA explosives, narcotics and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CWA/TIC $25,592</td>
</tr>
<tr>
<td>Warranty duration</td>
<td>1 year</td>
<td>1 year</td>
<td>1 year (extended available)</td>
<td>1 year</td>
</tr>
<tr>
<td>Detector technology</td>
<td>TrueTrace™ fluorescence</td>
<td>Ion trap mobility spectrometer™</td>
<td>Ion mobility spectrometer</td>
<td>Ion mobility spectrometer</td>
</tr>
<tr>
<td>Threat detected</td>
<td>Explosives</td>
<td>Explosives, narcotics</td>
<td>Explosives, narcotics</td>
<td>Explosives, narcotics, CWA/TIC</td>
</tr>
<tr>
<td>Ionization source</td>
<td>Non-radioactive ionization</td>
<td>Non-radioactive ionization</td>
<td>Non-radioactive high energy</td>
<td>Sealed 15 milliCurie Nickel-63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>photo ionization</td>
<td>with NRC exemption</td>
</tr>
<tr>
<td>Detector size</td>
<td>14.5 x 4.5 x 2.8 inches</td>
<td>16.1 x 6 x 12.4 inches</td>
<td>13 x 13.5 x 5 inches</td>
<td>14.4 x 4 x 4.5 inches</td>
</tr>
<tr>
<td>Weight (with battery)</td>
<td>3 pounds</td>
<td>9.4 pounds</td>
<td>7.7 pounds</td>
<td>7 pounds</td>
</tr>
<tr>
<td>Display</td>
<td>3.5-inch color screen</td>
<td>3.5-inch color LCD touchscreen</td>
<td>4.3-inch color touchscreen LCD</td>
<td>3.5-inch TFT color LCD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>panel</td>
<td></td>
</tr>
<tr>
<td>Start-up time</td>
<td>3 to 5 minutes</td>
<td>25 minutes</td>
<td>25 minutes</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Alarm type</td>
<td>Visual, audible, vibrational</td>
<td>Visual, audible</td>
<td>Visual, audible</td>
<td>Visual, audible</td>
</tr>
<tr>
<td>Analysis time</td>
<td>10 seconds</td>
<td>11 seconds</td>
<td>25 seconds</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Battery configuration</td>
<td>Lithium-ion</td>
<td>Lithium-ion, hot swappable</td>
<td>Lithium-ion, hot swappable</td>
<td>Lithium-ion</td>
</tr>
<tr>
<td>Battery life</td>
<td>8 hours</td>
<td>4 hours</td>
<td>3.5 hours</td>
<td>4 hours</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>14°F to 122°F</td>
<td>14°F to 131°F</td>
<td>32°F to 104°F</td>
<td>32°F to 104°F</td>
</tr>
<tr>
<td>Operating relative humidity %</td>
<td>5 to 95 non-condensing</td>
<td>0 to 95 non-condensing</td>
<td>1 to 90</td>
<td>0 to 95 non-condensing</td>
</tr>
<tr>
<td>Sensitivity (Manufacturer’s literature)</td>
<td>Picogram to nanogram for certain explosives</td>
<td>Nanogram</td>
<td>Nanogram to microgram</td>
<td>Nanogram</td>
</tr>
</tbody>
</table>
The following sections present assessment results, including the performance detection of three HETDs as well as observational information from the laboratory testing related to their operational use, and the operational performance of four HETDs that are commercially available. Some features that could not be evaluated at the assessment were reported based on past experiences of some evaluators.

4.1 FLIR DETECTION INC. FIDO® X3

The FLIR Fido X3 received an overall assessment score of 3.9. This detector uses FLIR’s patented TrueTrace™, a multi-channel fluorescence-based technology, and a non-radioactive ionization source to identify explosives by class using both vapor and particulate sampling. The four classes include military explosives, nitrates, nitro compounds, and peroxides. In swipe sampling mode, only military, nitrates, and peroxides can be detected. According to the manufacturer some of the individual explosives detected include: Trinitrotoluene; 2-methyl-1,3,5-trinitrobenzene (TNT), Ethylene glycol dinitrate (EGDN), 2,4-Dinitrotoluene / 2,6-Dinitrotoluene (DNT), Pentaerythritol tetranitrate; [3-nitrooxy-2,2-bis(nitrooxyethyl) propyl] nitrate (PETN); 1,3,5-trinitro-1,3,5-triazinane (Semtex), 1,3,5-trinitro-1,3,5-triazinane/Octogen; 1,3,5,7-tetranitro-1,3,5,7-tetrazocane (RDX/HMX), Nitroglycerine (NG), Triacetone triperoxide; (3,3,6,6,9,9-Hexamethly-1,2,4,5,7,8-hexaoxacyclononanme) (TATP), and some powders. The detector’s dimensions are 14.5 x 4.5 x 2.8 inches, and it weighs 3 pounds.

Two rechargeable lithium ion (Li-ion) batteries, which last up to eight hours under normal conditions and require four hours to charge, are included in the kit; they are not hot-swappable, i.e. they cannot be replaced while the instrument is running. Data storage includes 3,500 hours of continuous storage. Data can be transferred to a personal computer via a universal serial bus (USB) cable or through WiFi and manufacturer supplied software. Visual, audible, and vibrational alerts are available. Operator and administrator user levels can be set up, with the administrator level requiring a password. Start-up time is three to five minutes from cold and approximately 10 seconds from sleep mode. Analysis time is approximately 10 seconds. More than 10 training tutorials can be accessed through the help tab on the detector’s screen.

The following sections summarize the assessment results for the SAVER categories.

4.1.1 CAPABILITY

The Fido X3 received a capability score of 3.7. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Overall, the Fido X3 was unable to detect explosives of interest to the responders. During the vehicle screening scenario, the Fido X3 only found the most contaminated areas and rarely alarmed when intentionally spiked surfaces were sampled.

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ii This method uses amplified fluorescence polymer quenching of electronically conjugated polymer films, to greatly amplify the quenching produced by previously used monomeric polymers, allowing for greater explosives detection sensitivity.
The approximate level of material on these spiked samples fell within the ranges specified by the manufactures, see, Table 4-3. The Fido X3 also failed to detect explosives on a range of explosive contaminated articles such as phones, cameras, and audio recorders. The detection threshold was lowered to increase detection sensitivity during the testing, which did not lead to an increase in positive identifications. Verification samples were successfully run throughout the testing.

This instrument classifies explosives into categories/families and provided a measure of relative source strength, some of the evaluators would have preferred a display of the specific explosive being detected.

Explosives Library—The Fido X3 did not allow the user to access and view the explosives in the manufacturer supplied library. There was only one library available to the user that could not be modified to add additional explosive compounds. If a new threat is defined, the manufacturer will use data collection and algorithm development to update the existing library with a firmware release. While most evaluators thought the ability to modify libraries was unnecessary, one evaluator believed the inability to modify the library was a drawback.

Alarm Threshold — The alarm threshold can only be changed in administrator mode, which many of the evaluators found to be a useful feature. The alarm threshold for each category of explosives can be adjusted independently. This can also be done in the field with the administrator mode password. Most responders found adjusting the alarm threshold to be a straightforward procedure.

Power Options — The Fido X3 comes with two rechargeable batteries and can operate from a wall outlet. A vehicle charging adaptor is also included with purchase. Most responders were satisfied with the power options available. One responder suggested that a docking station for battery recharging be included. The batteries were not hot-swappable, which all the responders would have preferred.

Alarm Configurability — All the responders found it easy to change the type of alarm (visual, audible or vibrational) produced by the detector, which could be done at the user level. Evaluators were pleased that a vibrational alarm was available and that the audible alarm could be muted from the main screen.

Reachback — There are no formal procedures set up to facilitate reachback for the Fido X3. Users can consult technical support to help review data. An evaluator familiar with the detector said feedback from technical support was sometimes delayed. This was reported based on past experiences and not tested as part of the assessment.

Data Logging Capability — The Fido X3’s data logging capabilities including the 8-gigabyte memory card, which could hold up to 20,000 files, the information in the files and the lack of file overwriting were highly rated by the evaluators. The lack of file overwriting, where no file name will ever repeat, was a valuable feature from an evidentiary standpoint as it can increase confidence in data validity. Files could be browsed and viewed on the device as well as on software installed on personal computers. One evaluator said the data needed for legal or supervisory reviews, including the file number, date, time, and actual data, were all in one place and easy to locate.
4.1.2 USABILITY

The Fido X3 received a usability score of 4.0. Evaluator feedback relating to evaluation criteria in this category is summarized below.

User Interface — The layout of buttons allowed for easy operation with one hand and while wearing gloves. The detector was light, comfortable, and well balanced. One evaluator noted that a pouch for test swabs would be useful to make the instrument truly operational with one hand. There was a difference of opinion on the level of difficulty involved in navigating through menus. Two evaluators, who have experience using this detector, found it easy to navigate through menus and perform an analysis, while another two evaluators found menu navigation cumbersome, not intuitive, and requiring a great deal of scrolling to reach the desired destination. Screen readability was adequate in low light but posed some difficulty in bright light, with one evaluator noting that it was difficult to see the alarm levels in bright sunlight.

Startup Time — The evaluators were satisfied with the 3 to 5-minute start-up time from a cold start, with one evaluator noting that it was significantly quicker than most of the other HETDs that have a minimum start-up time of 15 minutes for a cold start.

Data Transfer — Evaluators appreciated that there were two options for data transfer, to a computer through a USB cable or WiFi to manufacturer supplied software.

Battery Life/Indicator — The 8-hour operating time specified by the manufacturer for fully charged batteries would be useful for field operations. One evaluator reported the battery life in extremely cold weather was less than two hours based on personal experience. The battery life indicator was clearly visible.

4.1.3 DEPLOYABILITY

The Fido X3 received a deployability score of 4.3. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Verification — All of the evaluators found the verification process of the Fido X3 to be simple and quick, they also valued the clear screen instructions. It was necessary to analyze a verification sample at start up, every hour, after a power clean, and after a significant hit.

Ease of Battery Replacement — The Fido X3 kit comes with a spare battery that was easy to install. It was not hot-swappable, which the evaluators would have preferred for continual use.

Optional Accessories — The swipe wand, which should aid in swiping surfaces, must be purchased as an accessory. One of the evaluators found the wand helpful for reaching difficult-to-reach spots but had trouble inserting the swab into the instrument while using the wand. One evaluator familiar with instrument said he did not use the wand for this reason.

Figure 4-2 Evaluator and NUSTL Data Collector Shielding an HETD
Covertness — The evaluators found that the Fido X3 could be operated covertly. It was easy to mute alarms, turn vibrational alarms on and off, adjust alarm volumes and adjust the backlight and contrast. This could be done from one screen at the user level.

4.1.4 MAINTAINABILITY

The Fido X3 received a maintainability score of 3.9. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Durability — Evaluators found the Fido X3 met their needs for durability based on its rating to withstand a 1-meter drop. Product literature indicates that the Fido X3 conforms to military standard (MIL-STD) 810G for shock, vibration, temperature, and humidity and has an Ingress Protection (IP) rating of 54 for dust ingress and water resistance.

Consumables — Two of the evaluators were satisfied with the number of consumables needed to operate the Fido X3. Verification samples, sensing elements and swabs need to be purchased. Two evaluators were concerned about the $7.50-cost of sensing elements, which are only expected to last six to eight hours during normal operations.

Decontaminability — A maintenance kit containing spare parts, cleaning aids, and tools is included with purchase. There are videos loaded onto the instrument describing how to perform basic maintenance functions and how to power clean the unit. The clear-down time for the Fido X3 after contamination was considered reasonable and the process straightforward by most evaluators.

Training — One-day operator training at the FLIR’s Stillwater, Oklahoma, facility is included in the price of all units. Two-day administrator training at the customer’s facility is available. The evaluators found these training options were sufficient. The evaluators found the on-device tutorials to be extremely helpful as no additional equipment was needed to view these resources.

Warranty — FLIR offers a 1-year service warranty with purchase of the system. The warranty includes technical support, training, repair service, and maintenance. One evaluator with personal experience found the customer service helpful with a quick turnaround time and referenced a single file issue being addressed within one day.

4.1.5 DETECTION PERFORMANCE OBSERVATIONS FROM LABORATORY TESTING

Operational mode warnings were not active during the first day of testing – this issue corrected itself after the unit was restarted.

Detection rate seemed to decrease after ~75 samples.

The verification pen would not alarm after first QC check every day.

Two different sensing elements were shipped with system although only one type was ordered.

Some sensing elements did not appear to have the same polymer.
4.2 RAPISCAN SYSTEMS MOBILETRACE®

The MobileTrace received an overall assessment score of 3.5. It is a dual-mode handheld detector, detecting both explosives and narcotics, which uses Rapiscan Systems patented ITMS™ (Ion Trap Mobility Spectrometry) technology. Dual modes allow for the detection of both negative and positive ions simultaneously, which allows for the detection of a greater range of substances than other detectors. Manufacturer literature indicates it can reach nanogram detection levels. According to the manufacturer representative, the explosives detected included: TNT, Nitrates, PETN, Semtex, RDX/HMX, TATP, and Black Powder (BP). The device contains an indication of source strength. A hardened MobileTrace is available that meets military standards. Sample acquisition is through particle swipe and vapor sampling. The detector’s dimensions are 16.1 x 6 x 12.4 inches, and it weighs 9.4 pounds with the battery. It has a 1-gigabyte storage capacity, and data can be transferred via ethernet or a USB cable. There are three user levels (operator, maintenance, and administrator) for access control. Warm-up time from a cold start is approximately 25 minutes, and analysis is typically completed in less than 11 seconds. The MobileTrace is not affected by changes in temperature but is sensitive to changes in barometric pressure, per the manufacturer. The detector can operate on alternating current (AC), a vehicle adaptor, or battery power. Two rechargeable Li-ion batteries are included, which operate for up to four hours each when fully charged. Batteries are hot-swappable. The explosives library can be adjusted by the user to accommodate the user’s needs. Clear-down time is less than one minute. Alarm thresholds can be changed by calling the manufacturer for a password that changes daily. The detector has visual and audible alarms.

The following sections summarize the assessment results for the SAVER categories.

4.2.1 CAPABILITY

The MobileTrace received a capability score of 3.6. Evaluator feedback relating to evaluation criteria in this category is summarized below.

The MobileTrace could detect explosives on the spiked substrates, articles, and contaminated areas that were tested in the two operational scenarios. Evaluators were pleased with its ability to detect a variety of explosives. There was consistency in results among the various responders when analyzing the same samples.

Explosives Library — Evaluators were generally pleased with the explosives libraries on the MobileTrace and with the levels of control available. Evaluators found it easy to view which explosives were present and valued the ability to turn specific threats off and on, which provides them the capability to address specific needs quickly in the event of an emergency situation.
Alarm Threshold — Evaluators found it straightforward to adjust the alarm thresholds, which required a password that changed daily. The detection threshold’s sensitivity could be changed in increments of 25, 50, 75 and 100 percent. Some evaluators appreciated that explosives detected at a low confidence level were displayed on a separate section of the display screen.

Power Options — The MobileTrace operates on AC, vehicle adaptor, and rechargeable batteries, which met most evaluator’s expectations. The batteries were hot-swappable, making them ideal for field work. The unit had a charging station, which allowed users to have a fully charged spare battery available.

Alarm Configurability — The MobileTrace did not meet all evaluators’ expectations for alarm configurability because the detector did not have a vibrational alarm and the auditory alarm could either be turned on or off with no other adjustment to sound level available.

Reachback — Evaluators believed MobileTrace’s reachback capabilities could be improved by establishing response time parameters. There was no formal procedure or timeframe for the resolution of spectral analysis problems, which could make it difficult to use in the field where a rapid response would be required.

Data Logging Capability — Data storage on the MobileTrace met evaluators’ expectations. The 1-gigabyte of data that could be stored on the detector was sufficient.

4.2.2 USABILITY

The MobileTrace received a usability score of 3.1. Evaluator feedback relating to evaluation criteria in this category is summarized below.

User Interface — Two evaluators found the graphical user interface (GUI) and menu navigation to be complicated and non-intuitive. They noted the font size was too small and the screen was difficult to use with gloved fingers. They believed it would be necessary to use a stylus, which can be difficult to keep track of because it is not attached to the instrument. Two evaluators agreed the instrument was easy to use with menus that were straightforward. All but one evaluator said that the screen was difficult to read in sunlight, even when shielded. Additionally, the instrument had no backlight and screen brightness was not adjustable.

Start-up Time — Evaluators wanted shorter start-up times—ideally less than 10 minutes—than the 20- to 30-minute cold start they experienced. The unit had to go through an overnight bake-out (i.e. the removal of contaminants by heating the ion mobility spectrometry (IMS) tube to a high temperature) after being shut down for any length of time, which some evaluators found cumbersome.

Ergonomics — The evaluators found the MobileTrace to be a heavy, bulky instrument, but it could be carried fairly comfortably with the shoulder strap. The evaluators described it as a well-balanced detector with a low center of gravity, which some users prefer over other top-heavy models, but one evaluator said it could become heavy during extended use.

Data Transfer — Most evaluators felt that the MobileTrace’s data transfer capabilities could be improved. The detector’s manufacturer representative indicated that data could be transferred by ethernet and USB connectivity. Evaluators also wanted the ability to transfer data by WiFi or Bluetooth.
Battery Life/Indicator — The instrument run time of four hours on a fully charged battery did not meet two users’ expectations as they want a battery to last a full eight hours.

The other three evaluators stated that since the batteries are hot-swappable, it made up for the shorter runtime. All the evaluators felt the battery life indicator needed improvement. The indicator did not work correctly during the assessment, resulting in the instrument shutting down while the indicator displayed 25-percent battery life remaining.

4.2.3 DEPLOYABILITY

The MobileTrace received a deployability score of 3.9. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Verification — Verification must be performed every eight to 24 hours. The detector prompts the user when a new verification is required. Evaluators were generally satisfied with the MobileTrace’s verification procedure.

Ease of Battery Replacement — The MobileTrace uses rechargeable Li-ion batteries that are hot-swappable. Evaluators found them quick and easy to change. The storage case was a standard Pelican case that met expectations.

Covertness — Evaluators found it useful for covert operations that the MobileTrace’s audible alarm could be shut off and the screen could be dimmed. However, the detector did not offer other features that evaluators said would assist with covert operations such as a vibrational alarm or volume control of the auditory alarm.

4.2.4 MAINTAINABILITY

The MobileTrace received a maintainability score of 3.2. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Durability — There is a hardened version of the MobileTrace available that meets military standards for durability; however, the manufacturer stated that the military presently uses the unhardened version and finds it durable enough for their use. Some evaluators would prefer if the detector met MIL-STD 810G drop and vibration specifications.

Consumables — The manufacturer estimated that consumables would cost $1,500 to $2,000 per year. Preventative maintenance for the MobileTrace can be done at the user level, and the cost of the supplies needed for maintenance are included in the cost of consumables estimate. Three evaluators stated that too many consumables were needed, including positive and negative dopants, membranes that need to be changed monthly, a desiccant, standards, gloves, and swabs.

Decontaminability — Evaluators were generally pleased with the decontaminability features of the MobileTrace. Clear-down time was generally less than a minute and most samples needed only one blank to clear while a few hotter samples required multiple blanks to return to the ready state.
Training — Eight hours of training costs approximately $3,000, with the price varying by location. Rapiscan Systems offers a one-year return to factory warranty, which was considered typical by the evaluators.

4.2.5 DETECTION PERFORMANCE OBSERVATIONS FROM LABORATORY TESTING

This system was not available when detectors were being purchased for the assessment, therefore laboratory testing was not conducted.

4.3 BRUKER DETECTION CORPORATION ROADRUNNER

The RoadRunner received an overall assessment score of 2.9. The RoadRunner is a handheld detector, which uses IMS technology with a non-radioactive, high-energy photo ionization source and an internal calibrant. It can detect explosives and narcotics and can be operated in swipe and vapor sampling modes, with the swipe mode being used the majority of the time. Users can choose to analyze explosives, narcotics, or both at start up. The detector’s dimensions are 13 x 13.5 x 5.0 inches, and it weighs 7.7 pounds with the battery pack. The RoadRunner’s user interface consists of a 4.3-inch color screen display and a status light emitting diode. The unit has visual and audible alarms. Explosives detected include PETN, RDX, TNT, Ammonium Nitrate (NIT), Urea NIT, TATP, Hexamethylene triperoxide diamine (HMTD), Nitroglycerine (NG), 2,4,6-TrinitrophenylmethylNitramine / Tetryl (TET), 2,3-dimethyl-2,3-dinitrobutane (DMNB), BP, EGDN, DNT, Erythritol tetranitrate (ETN), Black powder/Sulfur (BP/S), and narcotics according to product literature. Data can be exported to a personal computer via a USB cable or by Ethernet. It uses one Li-ion rechargeable battery that is hot-swappable. Runtime for a fully charged battery is about 3.5 hours, and the battery can be recharged in three hours. A battery charger is included. The RoadRunner has three user levels: operator, superuser, and administrator. The detector takes approximately 25 minutes to warm up from a cold start, and an analysis takes less than 25 seconds, resulting in the name of the substance identified without an indication of source strength.

The following sections summarize the assessment results for each SAVER category.

4.3.1 CAPABILITY

The RoadRunner received a capability score of 3.0. Evaluator feedback relating to evaluation criteria in this category is summarized below.

All the evaluators using the RoadRunner found that it alarmed on a large percentage of spiked articles. Evaluators received consistently correct identifications when all five samples of a particular substrate were analyzed. During the vehicle scenario, many reasonable correct identifications were produced which correlated to explosive materials that had been previously transported within the vehicle.
Evaluators were very pleased with the sensitivity and detection capability of the RoadRunner. One evaluator would have preferred an indication of source strength but valued the RoadRunner’s detection abilities overall.

Explosives Library — The explosives library on the RoadRunner could not be manipulated from the instrument. The Secure Digital (SD) card had to be removed from the detector and inserted into a computer to access the library. New libraries can be easily created, edited, and saved on the computer. The manufacturer representative stated that the next version of the detector will allow library access on the device. The evaluators were pleased overall with the contents of the library and believed it had all the explosives they were interested in detecting, but evaluators took issue with having to remove the SD card to access and change the library.

Alarm Threshold — The alarm threshold could only be adjusted on a computer after removing the SD card from the instrument. All evaluators except one had a desire to be able to change the threshold on the device. The manufacturer stated that this issue would be addressed in the next version of the device.

Power Options — The power options for this detector included AC power, rechargeable Li-ion batteries, and a car charger. The hot-swappable batteries were considered a positive. The car charger is not included in the standard package and must be purchased separately. The manufacturer recommended starting the detector on AC power, which was not considered practical to some evaluators. A docking station for recharging the battery was included in the standard purchase package and a few evaluators found this to be very useful.

Alarm Configurability — The visual and audible alarms could be turned on and off and the volume of the audible alarm could be adjusted. There was no vibrational alarm. One evaluator was concerned that the alarm turned off without being acknowledged. He was concerned that this could lead to missing an alarm in the noisy conditions they often work in.

Reachback — The evaluators considered this difficult for the RoadRunner. Data had to be transferred to a computer via a thumb drive or Ethernet cable. Then the manufacturer had to be contacted. The manufacturer representative indicated they were available nearly 24/7 via e-mail. Windows 7 or higher was required for transferring data to a laptop.

Data Logging Capability — 128-gigabyte, or 13,000 data files, was considered more than adequate by the evaluators for data storage. The device prompts when the disk is almost full but will overwrite old files. Users were pleased with the file types that were available, including spectrum files (proprietary to Bruker), .pdf and .xml files; however, they wished they could review data on the device.

4.3.2 USABILITY

The RoadRunner received a usability score of 2.5. Evaluator feedback relating to evaluation criteria in this category is summarized below.

User Interface — There was a difference of opinion on the quality of the user interface with some evaluators finding the menus intuitive and user-friendly and others finding them cumbersome and difficult to follow based on the number of menus that had to be toggled through. Buttons could be difficult to press with bare hands and gloves. When changing settings, the instrument had to be restarted for those changes to be saved. This would be
unacceptable for field use due to potential delays of operations. Two evaluators mentioned that they found the sample injection process easy and noted the added convenience that either side of the swab could be used for sampling.

Start-Up Time — Evaluators indicated that the 25- to 30-minute start-up time was too long. One evaluator noted that even when pulling off the charger, the instrument needed approximately 30 minutes until it was ready to analyze samples, which is too long in their opinion, as they would prefer a start-up time with a range of five to 10 minutes. To ensure accurate results, the manufacturer also recommended keeping the instrument running overnight when not in use as the sieve must be changed if the instrument is off for any length of time, which some evaluators found inconvenient.

Ergonomics — The ergonomics of the detector were not favored by most evaluators. Complaints included: detector was large and bulky, no carrying strap, difficult to handle with one hand, and could not be carried “briefcase style.” All the evaluators believed it was top-heavy and could easily topple over, risking breakage. All evaluators stated that the screen on the RoadRunner could not be read properly under bright or cloudy conditions, even when using the different brightness settings. This made using the detector difficult outdoors. There was a large, blank area on screen that served no useful purpose that could be used to accommodate larger font sizes; most evaluators wanted larger font sizes for all menus.

Data Transfer — Data can be exported to a personal computer via ethernet, a USB cable, or to a USB thumb drive. Evaluators prefer wireless transfer such as WiFi or Bluetooth.

Battery Life/Indicator — The runtime of approximately 3.5 hours on a fully charged battery and a charge time of three hours was considered adequate, but the evaluators would have preferred a runtime of eight hours, a typical shift length. The remaining battery life indicator was easily seen.

Ease of Use — There was some concern over the amount of time needed between sample analyses. At least one blank swab must be run after each sample analysis. It could take two to three minutes to clean and run the blank swabs before the detector was ready again. The instrument displays a progress line when in self-cleaning mode, which the evaluators found to be a useful; however, they would prefer if it was in a more easily viewed color.

4.3.3 DEPLOYABILITY

The RoadRunner received a deployability score of 3.4. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Verification — The RoadRunner has an internal calibrant and runs a calibration every second. This internal calibrant must be changed every two years. A verification pen containing TNT and cocaine must be run at the start of every shift where they would make an X on the sampling area of the swab with the pen, which evaluators found straightforward and similar to a sample run. The continuous self-calibration included a progress indicator, which the evaluators
identified as a useful feature for ensuring accuracy throughout sampling. One evaluator did not think favorably of using a verification pen and believed there was no way to control the amount dispensed and there was concern the pen would dry out.

Ease of Battery Replacement — The RoadRunner has hot-swappable batteries, which the evaluators said would be very useful in the field. The process for changing the batteries was straightforward. The carrying case was a standard Pelican case; one of the evaluators thought it was bulky and could be improved with the addition of wheels.

Covertness — The visual and audible alarms on the RoadRunner could be turned on and off and the volume on the audible could be adjusted, which made covert operations easier. The evaluators would have liked the addition of a vibrational alarm, so the instrument could be used covertly and minimize bystander concern. The status light on the front of the detector, indicating the unit was ready to analyze could not be turned off; one of the evaluators believed this would negatively affect covert operations.

**4.3.4 MAINTAINABILITY**

The RoadRunner received a maintainability score of 2.8. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Durability — Most evaluators were slightly worried about the durability of the RoadRunner. Two evaluators found it fragile as it could topple over due to it being very top-heavy. All the evaluators would value a drop test certification for this unit.

Consumables — Sample collection swabs, verification sample pen, disposable nitrile gloves, dust filter, and molecular sieve were needed to run the RoadRunner. The molecular sieve has a life of 720 working hours, and an internal counter keeps track of the filter runtime. The swabs have a 1-year expiration date and can be reused up to 15 times, if not contaminated. The lid should be placed tightly on the can of swabs to ensure they do not get contaminated. Some evaluators noted that the $1-per-swab price and 1-year expiration date increased the consumables price. One evaluator commented that the swabs were expensive, not durable, and had a short shelf life. Another evaluator expressed concern regarding the number of consumables needed as well as purchasing schedules and inventory management.

Decontaminability — Evaluators had different opinions about the decontaminability of the RoadRunner. Two evaluators thought the clear-down time was reasonable and similar to other detectors they worked with. One evaluator who frequently ran mass screenings felt the clear-down time was too long. Another evaluator overloaded the HETD with a very large sample and found the 7-minute clear-down time acceptable, considering the level of contamination. Maintenance of the detector was considered fairly difficult for the Roadrunner. The molecular sieve must be changed after 720 working hours, which a few of the evaluators believed would be difficult for first responders to perform in the field since a funnel and Allen key were required. The evaluators were concerned that the key could be easily lost. The sieve cartridge containing the filling material had to be carefully filled for the detector to operate properly, which concerned the evaluators. Two evaluators mentioned that they were concerned that changing the molecular sieve required a funnel. No bake-out was required to clean this detector.
Training — One-day operator training is offered for a maximum of six trainees. Two-day maintenance training is offered for a maximum of three trainees. WebEx training is offered for explosives library creation and modification.

There is a very useful QuickStart training available online. Generally, the training offerings met the evaluators’ needs. A basic 1-year limited warranty is offered for the RoadRunner, which was acceptable to the responders.

4.3.5 DETECTION PERFORMANCE OBSERVATIONS FROM LABORATORY TESTING

Occasionally, the Optical Sensor would not recognize samples inserted into the sample trap; thus, leading to sample loss as the HETD sample inlet is heated and would ultimately volatilize the explosive sample under assessment without an analysis being performed.

After prolonged testing, residue built up in the desorber and “blank samples” began alarming. This was easily rectified by changing the sieve. Canned air was also used to blow out the system, which resolved the unwarranted false alarms.

If a large explosive mass was introduced into the system, an overload would occur and the HETD analysis would be automatically canceled causing the system to enter into a “cleaning” cycle that would last approximately 10 minutes.

4.4 SMITHS DETECTION SABRE™ 5000

The Sabre 5000 received an overall assessment score of 2.4. It is a handheld, battery-operated detector, which uses IMS technology with a sealed 15-mCi Nickel-63 (Ni-63) source for ionization. The Ni-63 source has an exemption from the Nuclear Regulatory Commission. It can be run in swipe sampling mode, where it typically detects explosives and narcotics, and vapor sampling mode, where it typically detects chemical warfare agents (CWAs) and toxic industrial chemicals (TICs).

The operator can choose one of four operating modes: explosives only, narcotics only, CWAs/TICs, and Auto-Switching Vapor (ASV)-Explosives. The ASV-Explosives mode provides detection in both negative and positive mode for an increased range of explosives detection from a single sample; the vapor sampling mode was not evaluated during this assessment. Per manufacturer’s claims, it can operate at elevations up to 2,000 meters (6,560 feet). The dimensions of the detector are 14.4 x 4.5 inches, and it weighs seven pounds with the battery. The detector has visual and audible alarms. Its start-up time from a cold start is 15 minutes, and a typical detection takes 20 seconds. A fully charged battery will provide four hours of operating time. The battery can be recharged in four hours and must be charged using AC, not a car charger. The explosives detected include RDX, PETN, TNT, Semtex, TATP, NG, NI, Peroxides (H₂O₂), and others. The instrument provides the explosive identification and strength.

A USB port is available to download alarm files for further analysis, program the instrument, and print reports.

The following sections summarize the assessment results for each SAVER category.
4.4.1 CAPABILITY

The Sabre 5000 received a capability score of 2.7. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Evaluators found that the Sabre 5000 detected explosives present on the test substrates, test articles, and in the vehicle. There were inconsistent results when the same substrate with the same explosive was tested repeatedly, but the detector was sensitive to a variety of explosives.

Explosives Library — The Sabre 5000 library had many of the explosives the evaluators were interested in. Evaluators were pleased that the library could only be modified by an administrator with a password. The alarm thresholds could also only be changed by an administrator with a password. Most evaluators believed that responders using these instruments in the field need this level of control for the instrument’s sensitivity.

Alarm Configurability — The visual and audible alarms were considered acceptable by the evaluators, but they prefer the addition of a vibrational alarm.

Power Options — The detector used a rechargeable Li-ion battery with a 4-hour recharging time, which was considered acceptable. The battery could only be recharged with AC power. Evaluators preferred a docking station and the ability to use a car charger for charging the battery.

Reachback — The process for reachback was considered too involved and complex, citing the need for a laptop. The manufacturer’s estimated time of one week for an answer was considered too long as the evaluators preferred responses within 24 hours.

Data Logging — The ability to store 300 files was not considered sufficient data storage. The evaluators found that data was overwritten without warning, which would hinder their ability to use the files as evidence at a later date, if required.

4.4.2 USABILITY

The Sabre 5000 received a usability score of 2.3. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Start-Up Time — Even though the start-up time of 15 minutes was shorter than some of the other detectors, evaluators would have liked a quicker start up.

User Interface — The button layout on the Sabre 5000 was considered acceptable by most evaluators, but it was cumbersome and not intuitive to use when navigating through the menus, which requires a lot of scrolling. Two evaluators found it difficult to control the screen while wearing gloves. The screen was readable in both low and bright light.
Ergonomics — The detector was heavy and difficult to operate with one hand without careful placement on a surface. Evaluators would have preferred an instrument fitted with hooks and a strap to accommodate one-handed use. One evaluator described the handle as being too far from the buttons. A few evaluators noted that the sampling swab was difficult to insert when it was crinkled.

Data Transfer — Data was transferred to a computer via USB connection. Evaluators preferred a wireless data transfer over the current method.

Battery Life/Indicator — An operating time of four hours on a fully charged battery was adequate, but evaluators would prefer eight hours for field deployment. The battery life indicator was clearly visible.

4.4.3 DEPLOYABILITY

The Sabre 5000 received a deployability score of 2.5. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Verification — A verification sample must be run at the start of a shift, when the operating mode (explosives, narcotics or CWA/TICs) or sampling method (particle or vapor) changes and whenever assurance that the detector is working properly is needed. Two blank samples must be run successfully before and after verification. The verification pen contains both TNT and PETN. Ensuring the Sabre 5000 was ready to analyze was not always straightforward for the evaluators. The status indicators were not always easy to interpret. The status bar sometimes showed red in alarm mode and ready to analyze, and other times showed green and not ready to analyze. One evaluator noted the impact of a positive hit on the detector, highlighting a lengthy 7-minute clearing process after a hot sample, which was deemed to be too long, while another believed that it was acceptable based on their personal experience.

Ease of Battery Replacement — Most evaluators found the battery easy to replace, but it is not hot-swappable, and the unit had to be shutdown to replace the battery. One evaluator found the battery difficult to take out and another said that the full warm-up time of 15 minutes was too long. The Sabre 5000 representative noted that the battery should not be removed while the unit is powered as this can damage the instrument.

Covertness — The evaluators believed that there should be one button to mute and unmute the audible alarm rather than going through a series of steps to silence the alarm. They would have valued the addition of a vibrational alarm to make covert operations easier.

4.4.4 MAINTAINABILITY

The Sabre 5000 received a maintainability score of 1.9. Evaluator feedback relating to evaluation criteria in this category is summarized below.

Durability — The evaluators would prefer the detector to have a drop test rating. The desorbing chamber in one unit would not close during the assessment, leading evaluators to worry that first responders would break the detector during normal operations. One evaluator was concerned that the battery would come off if the detector was dropped. Overall, evaluators perceived the detector to be fragile.
Consumables — This includes the air purification cartridge (that must be changed every two weeks), the membrane (that is replaced annually), sampling swabs, gloves, and the verification pen. Evaluators believed that too many consumables were needed and purchasing the air purification cartridges every two weeks would be expensive.

Decontaminability — The manufacturer recommended that a bake-out be performed to vaporize contaminants in the IMS tube at least every week or when the tube becomes contaminated. The bake-out requires a minimum of two hours but can be run for up to eight hours. The unit must be plugged into AC power during the bake-out. Evaluators believed the Sabre 5000 required a great deal of maintenance based on the recommended number of bake-outs and cartridge changes.

Training — Training was not included with purchase price. Evaluators would prefer to see some type of video training and felt that specific maintenance training was needed. A 1-year warranty was offered. Based on the level of maintenance and the perceived fragility of the detector, the evaluators would prefer an extended warranty.

4.4.5 DETECTION PERFORMANCE OBSERVATIONS FROM LABORATORY TESTING

Analyzing explosives at high mass loadings caused the calibrant to take more than three minutes for the HETD become ready for the analysis of additional samples.

During periods of high humidity, the system required a longer period of time to reach a “ready” state before a new sample could be analyzed.

5.0 SUMMARY

HETDs are used by first responders to screen for trace levels of explosives and narcotics so that possible threats can be identified. The assessed HETDs did not all perform as expected, with some unable to identify explosives that were present above the stated sensitivity levels of the detectors. The ability of the detectors to meet vendor-specified sensitivity levels was not one of the evaluation criteria chosen by the focus group and therefore does not influence the results of the SAVER scoring tool, which concentrates on human factors. Detection sensitivity for the various detectors was observed by the evaluators since the assessment involved spiking substrates with explosives in order to experience the operational aspects of the instruments while analyzing real samples and they were informed of the laboratory testing results after the operational assessment. Analysis sensitivity during the operational assessment was consistent with the results obtained during the laboratory testing conducted separately by TSL. The detector with the highest rating during the operational assessment did not detect many of the explosives that responders were interested in. However, first responders were not enthusiastic about detectors that had fairly good detection performance if they were not ergonomic, had long startup times, or required a great deal of maintenance.

Some key advantages and disadvantages identified by the evaluators are summarized in Table 5-1. There were significant differences in evaluation criteria ratings for detection capability, battery life, user interface, start-up time, and ergonomics among the assessed HETDs. Evaluators expressed a preference for HETDs that meet manufacturer’s specifications for detection sensitivity, have an 8-hour run time on fully charged batteries, a relatively short start-up time (less than 10 minutes), hot-swappable batteries, and wireless data transfer.
Evaluators wanted battery runtimes to be improved at temperatures below 70°Fahrenheit, where they knew from experience that runtimes were often far below stated specifications. They preferred detectors that were lightweight, could be operated with one hand, could be operated covertly, and did not require too many consumables or a lengthy clear-down period after analyzing a hot sample.

Responder agencies that are planning to purchase handheld HETDs should carefully research each product’s overall capabilities and limitations in relation to its operational needs.

### Table 5-1 Product Advantages and Disadvantages

<table>
<thead>
<tr>
<th>Product</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLIR Detection Inc. Fido® X3</td>
<td>• 8-hour battery life&lt;br&gt;• 3- to 5-minute start-up time&lt;br&gt;• Light, well-balanced with good ergonomics&lt;br&gt;• Quick battery change-out&lt;br&gt;• Spectrum files can be transferred via WiFi&lt;br&gt;• Only detector with vibrational alarm</td>
<td>• Poor explosive detection sensitivity&lt;br&gt;• Classifies threats into classes, not individual explosives&lt;br&gt;• No ability to access or modify the explosives library&lt;br&gt;• Batteries not hot-swappable</td>
</tr>
<tr>
<td>Rapiscan Systems MobileTrace®</td>
<td>• Good detection performance during operational assessment, although it was not evaluated during laboratory testing&lt;br&gt;• Adjustable explosives library&lt;br&gt;• Hot-swappable batteries</td>
<td>• 25-minute start-up time&lt;br&gt;• Screen is difficult to read in bright sunlight&lt;br&gt;• Detector is heavy and bulky, but usable with strap&lt;br&gt;• Required many consumables</td>
</tr>
<tr>
<td>Bruker Detection Corporation RoadRunner</td>
<td>• Could detect a range of explosives&lt;br&gt;• Hot-swappable batteries</td>
<td>• Detector is awkward to carry and use; no carrying strap&lt;br&gt;• Screen is difficult to read in bright sunlight&lt;br&gt;• 25-minute start-up time</td>
</tr>
<tr>
<td>Smiths Detection Sabre™ 5000</td>
<td>• Could detect commonly encountered explosives&lt;br&gt;• Can be operated in various modes where it can detect explosives, narcotics, CWAs and TICs&lt;br&gt;• Explosives library could be easily accessed&lt;br&gt;• Screen is readable in bright light</td>
<td>• Bulky and difficult to use with one hand&lt;br&gt;• Batteries are not hot-swappable&lt;br&gt;• At times difficult to tell if detector is ready to perform analysis due to conflicting status indicators&lt;br&gt;• Great deal of required maintenance</td>
</tr>
</tbody>
</table>
Appendix A. Assessment Scoring Formulas

The overall assessment score for each product was calculated using the product’s average criterion ratings and category scores. An average rating for each criterion was calculated by summing the evaluators’ ratings and dividing the sum by the number of responses. Category scores for each product were calculated by multiplying the average criterion rating by the weight assigned to the criterion by the focus group, then taking the sum of the resulting value for all criteria and dividing by the sum of the weights for each criterion in the category as seen in the formula and example below:

**Category Score Formula**

\[
\frac{\sum (\text{Average Criterion Rating} \times \text{Criterion Weight})}{\sum (\text{Criterion Weights})} = \text{Category Score}
\]

**Category Score Example**

\[
\frac{(4.3 \times 4) + (5 \times 4) + (4 \times 3) + (4.5 \times 3) + (4.5 \times 3)}{4 + 4 + 3 + 3 + 3} = 4.5
\]

To determine the overall assessment score for each product, each category score was multiplied by the percentage assigned to the category by the focus group. The resulting weighted category scores were summed to determine an overall assessment score as seen in the formula and example below.

**Overall Assessment Score Formula**

\[
\sum (\text{Category Score} \times \text{Category Percentage}) = \text{Overall Assessment Score}
\]

**Overall Assessment Score Example**

\[
(4.0 \times 33\%) + (4.2 \times 27\%) + (4.2 \times 20\%) + (3.8 \times 13\%) + (4.5 \times 7\%) = 4.1
\]

\[\text{ii} \text{ Examples are for illustration purposes only. Formulas vary depending on the number of criteria and categories assessed and the criteria and category weights.}\]
Appendix B. Evaluation Criteria Definitions

The 25 evaluation criteria identified by the HETD focus group are defined below, grouped by the SAVER assessment categories to which they were assigned by the focus group.

CAPABILITY

Six capability criteria were identified and defined by the focus group.

- **Explosives Library** refers to the spectra that are included in the product’s software to which the unknown explosive spectra will be compared. Participants indicated that the trustworthiness of the source of the data in the library, all the “red flag indicators” (-ates, -ides, etc.,) being present and the extensiveness or specificity of the library were all important.

- **Alarm Threshold** refers to the ability of the user to change the sensitivity of the alarm in response to specific conditions. The local environment, humidity, and the level of interferences play a role in explosive trace detection. If there is a very high level of contamination (e.g., near an industrial area) the ability to raise an alarm threshold can greatly reduce the number of false positives recorded.

- **Power Options** refers to the types of batteries that can be used (e.g., standard alkaline, rechargeable, etc.), how many batteries are needed and if the unit can be operated with alternating current from the wall or from a car battery, thus allowing warm up of the detector on the way to the scene.

- **Alarm Configurability** refers to the types of alarms available (e.g., visual, audible, vibrational, etc.) and the ability to turn them on or off and adjust their intensity.

- **Reachback** refers to the ability to send spectra and other sample information to a manufacturer or third party for technical or scientific support.

- **Data Logging Capability** refers to the ability to store relevant spectra on the device and the ability to quickly and easily offload data to an external device. The amount of data that can be stored and what happens when this limit is reached are important. Participants preferred that data not be overwritten.

USABILITY

Seven usability criteria were identified and defined by the focus group.

- **User Interface** refers to the type and layout of buttons used to control the detector. Participants noted that buttons had to be usable with gloves, respirators, and other personal protective equipment (PPE); they mentioned that a stylus would be very useful.

- **Start-Up Time** refers to the time needed after powering on or exiting from sleep mode to be able to run an analysis.

- **Ergonomics** refers to the way the detector feels when it is carried, its ability to be carried and operated with one hand, and screen clarity when viewed while wearing PPE.

- **Data Transfer** refers to the ability to retrieve data from the detector and send it to a command center through Wi-Fi or Bluetooth. The ability to send data as a word document or pdf was considered useful by responders. A docking station that could download and store data remotely and reset device memory was considered an attractive option.

- **Battery Life/Indicator** refers to the length of time the detector operates without the batteries needing to be replaced or recharged. Participants wanted to know times for both actively
running analyses and being in standby mode. Having an easy-to-read indication of remaining battery life was judged to be a useful feature.

- **Ease of Use** refers to the level of difficulty involved in navigating through various menus, interpreting results, calibrating the detector, operating controls with gloves and other PPE, and screen readability in bright sunlight.

- **Ability to Modify Library** refers to being able to add or remove explosives’ spectra from the threat library to meet specific needs. Administrator and user levels of control for modifications were considered a useful feature.

**DEPLOYABILITY**

Six deployability criteria were identified and defined by the focus group.

- **Verification** refers to the process by which the detector indicates it is working properly and ready to do analyses. This can be done through verification samples, self-calibration, and health checks. Results should be easily read by the user.

- **Included Accessories** refers to the completeness of the product when the base model is purchased. Participants would prefer all required accessories to be included and functional.

- **Ease of Battery Replacement** refers to the level of difficulty of changing batteries in the field and whether it is possible when wearing gloves or other PPE.

- **Storage Case Quality** refers to the sturdiness of the carrying case for the detector. Rubber corner guards were considered a useful feature.

- **Optional Accessories** refers to components that are not included with the base model such as swabs, wands, vapor barrier cards, traps, verification samples, computer interface, vapor concentration kits, etc.

- **Covertmess** refers to the ability to silence or lower audible alarms, dim visual alarms, or switch to vibrational alarms so as not to distress the public and/or to allow for covert operations.

**MAINTAINABILITY**

Six maintainability criteria were identified and defined by the focus group.

- **Durability** refers to the ability to remain in good condition over a long period of time and to withstand drops and daily wear and tear. Rubberized corners on the detector and as few external components as possible were noted as desirable features.

- **Consumables** refers to items needed for everyday use, including desiccants, dopants, verification samples, and sieve packs. The costs associated with these items were considered important.

- **Decontaminability** refers to how difficult the detector is to clean, particularly after analyzing a very dirty sample. Participants noted that some detectors took up to 30 minutes to decontaminate, greatly reducing analysis throughput.

- **Level-1 Maintenance** refers to the decontamination the user can perform without having to send the detector back to the manufacturer. Participants want to be able to communicate with the manufacturer and get instructions on decontamination procedures.

- **Training** refers to the length of required training, whether the training is on-site, online, or through a DVD and if a manual is included.

- **Warranty** refers to the amount of time in which the manufacturer promises to repair or replace equipment that is not functioning properly, and the terms of such agreement.
Appendix C. HETD System Performance

Detailed data related to the explosives detection performance testing conducted by the Transportation Security Laboratory is available upon request. Please contact NUSTL@hq.dhs.gov to request this data.

A summary of the overall results as well as the test methods are described below.

<table>
<thead>
<tr>
<th>Systems</th>
<th>Overall Correct Alarms Detection Performance</th>
<th>Background Substance False Alarms</th>
<th>Blank Substrate False Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLIR Fido X3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rapiscan Detectra HX</td>
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<td>Bruker RoadRunner</td>
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<td>Smiths Detection Sabre 5000</td>
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**Correct Alarms Detection Performance Assessment**

For each trace explosive sample, explosives were deposited onto Teflon™ strips and allowed to dry. The dried explosive was then transferred via manual application from the Teflon™ strip to a test substrate representative of operational surfaces. The dried analyte was then harvested from the substrate by swiping the vendor swab across the surface of the substrate to collect the trace explosive particles. The sampling medium was then inserted into the system for analysis. ANFO (a mixture of ammonium nitrate and fuel oil), C4 (composition-4, a common variety of plastic explosive similar to Semtex), HMTD, PETN, TNT, Winchester (a form of NG), and TATP were assessed at low, medium, and high trace testing levels to challenge the units with a range of masses. Deposited quantities ranged from 50 to 1000 ng, which is within the detectable range specified by the manufacturer. There is presently no performance standard for the testing of HETDs.

**False Positive Testing**

- **Background Substances:** False Positive assessment of the HETD against five background substances identified by the focus group as relevant to the first responder mission was performed. The background substances assessed were as follows: Urban Dust, Artificial Sebum, Kerosene, Dirt, and an Oil & Grease mixture. Samples were deposited onto Teflon™ strips, allowed to dry, and were then collected from the Teflon™ strips using the appropriate HETD swab and analyzed. Any significant impact the background substances may have on system performance (i.e. false alarm, prolonged sample clear down time, peak shifting, etc.) was documented.

- **Blank Substrate Assessment:** HETD performance was assessed against 10 blank substrates that were identified by the focus group as relevant to the first responder mission; they were zippers, stainless steel, wood, vinyl, Black Vinyl, Acrylonitrile Butadiene Styrene (ABS) plastic, High-density Polyethylene (HDPE), Vinyl Coated Polyester, Anodized Aluminum, and Polypropylene.
Each substrate was swabbed using the appropriate corresponding HETD swab and analyzed. Any significant impact the blank substrates had on the HETD system performance (i.e. false alarm, prolonged sample clear down time, peak shifting, etc.) was documented.

Quality Control

Quality Control (QC) protocols were in place throughout the detection assessment to assure the explosive mass loadings used were consistent across all HETDs assessed. QC was performed using a combination of techniques, which included Gas and Liquid Chromatography quantitative analysis.

- **Positive Control Samples:** Positive control samples were analyzed throughout testing before and after each explosive sample set. Positive control samples were prepared according to Original Equipment Manufacturer recommendations to assure the system was still performing as expected throughout the assessment.

- **Negative Control Samples:** Negative control samples were analyzed before and after each sample set immediately following the positive control sample. This assured there was no interference or false alarms as a result of test tools, solvents, or supplies used throughout this assessment.
Appendix D. Rapiscan Systems Detectra™ HX

The DETECTRA HX is a handheld explosives detector that can be operated in swipe and vapor sampling modes. It uses ion mobility spectrometry technology with an ionization source with a U.S. Nuclear Regulatory Commission exempt status. The manufacturer claims it can detect picogram-nanogram quantities of nitrates, peroxides, plastic explosives, and their associated taggants. The dimensions of the detector are 11.6 x 5.6 x 10.9 inches, and it weighs 3.9 pounds with the battery. Start-up time is five to seven minutes and analysis time is about 12 seconds. It uses a Li-ion battery, which requires 2.5 hours to charge and will last about four to six hours when fully charged. There are audible and visual alarms. The detector’s operating temperature range is -4° to 131°Fahrenheit and has an operating relative humidity of 1 to 100 percent. This detector has been retired and information in this appendix is provided for informational purposes only. Key specifications are outlined below.

During the operational testing, the DETECTRA HX was available to the emergency responders for use. The DETECTRA HX remained in verify mode for long periods of time, during which it could not perform analyses. It had a very low detection rate when sampling substrates and objects that had been spiked with explosives. Its explosives library could not be accessed by users and alarm settings could not be changed without rebooting the system. However, the unit was considered ergonomic, well-balanced, and easy to handle, with a screen that was readable in sunlight. Advantages and disadvantages of the DETECTRA HX are shown in the table below.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>• Well balanced, easy to handle</td>
<td>• Low explosives detection rate</td>
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<tr>
<td>• Screen was readable in sunlight</td>
<td>• Difficult to access and manipulate explosives</td>
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<tr>
<td>• Short start-up time</td>
<td>library</td>
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Detection performance observations from laboratory testing included:

- Higher mass loadings caused system to go into verification mode displaying “system verifying” message.
- Limited amount of onboard storage for data files caused the stoppage of testing in order to offload date files.