Field Portable Gas Chromatograph/ Mass Spectrometer (GC/MS)

Focus Group Report

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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 and local 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. In support of this tasking, NUSTL will, in conjunction with Pacific Northwest National Laboratory (PNNL), conduct an assessment of commercially available field portable gas chromatograph/mass spectrometer (GC/MS) instruments to provide emergency responders with information on currently available technologies. These instruments fall under AEL reference number 07CD-01-DPGC, titled *Mass Spectrometer, Chemical, Portable*. As part of the project, assessment recommendations were gathered from a focus group and are documented in this report.

For more information on NUSTL's SAVER Program or to view additional reports on field portable GCMS or other technologies, visit www.dhs.gov/science-and-technology/SAVER.

U.S. Department of Homeland Security

SAVER

System Assessment and Validation for Emergency Responders

POINT OF CONTACT

National Urban Security Technology Laboratory (NUSTL)
U.S. Department of Homeland Security
Science and Technology Directorate
201 Varick Street
New York, NY 10014

E-mail: NUSTL@hq.dhs.gov
Website: www.dhs.gov/science-and-technology/SAVER

EXECUTIVE SUMMARY

Field portable gas chromatograph/mass spectrometers (GC/MS) are used by first responders during field operations to chemically analyze substances suspected to be narcotics, toxic industrial chemicals, or chemical warfare agents. Through the System Assessment and Validation for Emergency Responders (SAVER) Program, the National Urban Security Technology Laboratory (NUSTL) will, in collaboration with the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL), conduct an operational assessment of field portable GC/MS instruments. Assessment results will be published in a SAVER assessment report to provide emergency responder organizations with information helpful in identifying the field portable GC/MS instrument best suited to their needs.

As part of the assessment planning process, NUSTL and PNNL conducted a focus group on field portable GC/MS instruments at the City of Seattle Joint Training Facility in Seattle, Washington, on February 26, 2019. Eight emergency responders experienced in the use of field portable chemical detection instruments participated in this focus group. The focus group identified product evaluation criteria, assigned evaluation criteria to SAVER assessment categories, indicated weightings used to determine the numerical product scores that will come out of the assessment, and provided other recommendations that will be used in planning the assessment. This focus group report documents the recommendations provided by the focus group and the process used to gather these recommendations.

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1.0 INTRODUCTION

Field portable gas chromatograph/mass spectrometers (GC/MS) are used by emergency responders during field operations to chemically analyze substances suspected to be narcotics, toxic industrial chemicals, or chemical warfare agents. On February 26, 2019, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a focus group of field portable GC/MS at the City of Seattle Joint Training Facility in Seattle, Washington. The purpose of the focus group was to gather recommendations from emergency responders that will be used to plan an operational assessment of field portable GC/MS instruments. The focus group and assessment are a collaborative effort between The National Urban Security Transportation Laboratory (NUSTL) and the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL).

1.1 Focus Group Demographics

Eight emergency responders with experience using GC/MS or other chemical detection instruments were recruited to participate in the SAVER focus group and the subsequent SAVER assessment. Table 1-1 below provides demographic information about the focus group.

Table 1-1 Focus Group Participant Demographics

Practitioner	Years of Experience	State
Firefighter/HAZMAT	5	WA
Firefighter/HAZMAT	8	FL
National Guard Weapons of Mass Destruction/Civil Support Team	10	WA
Firefighter/HAZMAT	11	NY
Law Enforcement	12	AZ
Law Enforcement/HAZMAT	16	DC
Firefighter/HAZMAT	20+	IN
Firefighter/HAZMAT	25	WA

2.0 FOCUS GROUP METHODOLOGY

The focus group began with overview presentations on the SAVER Program, the SAVER focus group process, and GC/MS technology. These presentations were followed by a series of discussion sessions aimed at gathering information that will be used to plan the upcoming SAVER field portable GC/MS assessment.

In the first discussion session, the focus group recommended and defined criteria by which the field portable GC/MS instruments should be evaluated during the assessment. The focus group then assigned each evaluation criterion to one of the five SAVER categories: affordability, capability, deployability, maintainability, and usability, which are defined as follows:

- **Affordability** criteria relate 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** criteria relate to product features or functions needed to perform one or more responder relevant tasks
- **Deployability** criteria relate to the preparation of using the product, including transport, setup, training and operational/deployment restrictions
- **Maintainability** criteria relate to the routine maintenance and minor repairs performed by responders, as well as included warranty terms, duration and coverage
- **Usability** criteria relate to ergonomics and the relative ease of use when performing one or more responder relevant tasks.

Next, the focus group indicated the relative importance of each evaluation criterion by assigning weights to them using a numerical scale ranging from 1 to 5. The definitions in Table 2-1 were provided as guidance in assigning weights.

Table 2-1 Evaluation Criteria Weighting Scale

Weight	Definition
5	This evaluation criterion is of utmost importance. I would never purchase a product that does not meet my expectations of this criterion or have this feature.
4	This evaluation criterion is very important. Meeting my expectations of this criterion or having this feature would strongly influence my decision to purchase this product
3	This evaluation criterion is important. Meeting my expectations of this criterion or having this feature would strongly influence my decision to purchase this product.
2	The evaluation criterion is somewhat important. Meeting my expectations of this criterion or having this feature would slightly influence my decision to purchase this product.
1	The evaluation criterion is of minor importance. Other things being equal, meeting my expectations of this criterion of having this feature may influence my decision to purchase this product.

After weighting the evaluation criteria, the focus group indicated the relative importance the five SAVER categories using a percent weighting scale. In assigning category weights, the focus group considered that the more highly a SAVER category was rated, the more strongly the evaluation criteria in that category would influence the overall product scores that will come out of the assessment.

While focus group discussion sessions proceeded in the sequence described, the deliberation process allowed evaluators to reconsider and revise earlier recommendations. Thus, some evaluation criteria were redefined, combined with other evaluation criteria or moved to different SAVER categories as a result of later discussions.

During the discussion sessions, the focus group provided other recommendations relevant to planning the assessment. They linked evaluation criteria to specific product features or capabilities that could be assessed either by hands-on operation of the GC/MS instruments during the assessment or by reviewing manufacturer-provided product specifications.

A general recommendation the focus group provided pertained to the question of whether to assess products on an evaluation criterion if all products were effectively identical with regard to the instrument features and capabilities the evaluation criterion assesses. The focus group held that such evaluation criterion should be assessed so that the Field Portable GC/MS Assessment Report might serve as a vehicle for communicating to manufacturers whether the current COTS GC/MS instruments meet emergency responder needs with regard to these features and capabilities.

Figure 2-1 Focus Group Overview Presentation

2.1 Evaluation Criteria Recommendations

Table 3-1 lists the evaluation criteria identified by the focus group and the SAVER categories to which they were assigned. Also indicated are the weights assigned to each evaluation criterion and to the SAVER categories. The evaluation criteria definitions provided by the focus group are presented in Sections 3.1.1 to 3.1.5. These sections also report evaluator comments and recommendations on how to assess the evaluation criteria and factors that correspond to higher numerical ratings for an evaluation criterion.

Table 3-2 Evaluation Criteria Recommendations

SAVER CATEGORIES				
Deployability Overall Weight 40%	**Usability** Overall Weight 35%	**Capability** Overall Weight 10%	**Maintainability** Overall Weight 10%	**Affordability** Overall Weight 5%
Evaluation Criteria				
Hot Swappable Batteries Weight: 5	**Data File Formats** Weight: 4	**Data Analysis** Weight: 4	**Technical Support** Weight: 5	**Cost of Consumables** Weight: 3
Hot Swappable Carrier Gas Weight: 5	**Operation with PPE** Weight:4	**Data Export Modes** Weight: 4	**Field Serviceability** Weight: 4	**Maintenance Costs** Weight: 3
Battery Characteristics Weight: 5	**Sample Introduction Options** Weight: 4	**Column Temperature Range** Weight: 3	**Software/Library Updates** Weight: 4	**Cost of Instrument** Weight: 2
Start-Up Time Weight: 5	**Simplicity of Operation** Weight: 4	**AMU Range** Weight: 2	**Tuning Requirements** Weight: 4	
Operating Temperature Range Weight: 4	**Training Materials** Weight: 4	**Detection Threshold** Weight: 2		
Storage Conditions Weight: 4	**Library Modification** Weight: 3			
Time between Runs Weight: 4	**Configurable User Interface** Weight: 3			
AC Power Weight: 3	**Display Screen Characteristics** Weight: 3			
Decontaminability Weight: 3	**Report Content** Weight: 3			
Portability Weight: 3	**Status Indicators** Weight: 3			
Sample Preparation Time Weight: 3	**User Manual Quality** Weight: 3			
Water and Dust Resistance Weight: 3				

2.1.1 DEPLOYABILITY

The focus group provided the following definitions of the deployability evaluation criteria:

Hot-Swappable Batteries refers to whether batteries can be replaced without shutting down the instrument, and how easily this can be done in the field.

Hot-Swappable Carrier Gas refers to whether the carrier gas supply can be replaced without completely shutting down the instrument, and how easily this can be done in the field.

Battery Characteristics refers to the battery features relevant to field operations, such as battery run time, charge time, the number of batteries needed for continuous operation; also battery type (i.e., nickel metal hydride or lithium ion).

Start Up Time refers to the time to first field sample analysis from a cold start-up; a cold start-up is defined as more than 12 hours since the instrument was last on.

Operating Temperature Range refers to the acceptable environmental temperature range over which the instrument can be operated routinely in the field.

Storage Conditions refers to the temperature and humidity ranges for proper storage, this may include standby electrical power recommendations.

Time between Runs refers to the total time required for the instrument to be ready for the next sample, not including any sample preparation needs.

Alternating Current (AC) Power refers to the ability of the instrument to operate on AC power sources.

Decontaminability refers to how easily, quickly, and effectively an instrument can be decontaminated, based on factors such as the instrument's Ingress Protection (IP) rating, the design of its external surfaces and ports, or other considerations.

Portability refers to the factors relating to carrying or transporting the instrument (e.g., instrument size and weight, suitability of handles or carrying straps).

Sample Preparation Time refers to how much time is required to prepare a sample prior to introduction into the instrument. Evaluators anticipated that this will vary among instruments due to sample introduction restrictions and requirements. Sample processing steps may be required for some instruments to introduce a sample in the proper form and/or to achieve the proper signal-to-noise (e.g., sample dilution to mitigate detector saturation). This criterion includes whether the instrument allows for operation in a "real-time" continuous monitoring survey mode and if so, the suitability of operation in this mode.

Water and Dust Resistance refers to suitability of the instrument for field deployment with regard to field exposure to water and dust, as indicated by IP, Mil-Spec, or other relevant protective ratings.

2.1.2 USABILITY

The focus group provided the following definitions of the usability evaluation criteria:

Data File Formats refers to the suitability of file formats in which acquired data can be saved for further analysis external to the instrument. Focus group participants expressed a preference for non-proprietary data file formats.

Operation with Personal Protective Equipment (PPE) refers to how effectively the instrument can be operated when wearing PPE (e.g., ease of activating buttons, touch screen, etc.).

Sample Introduction Options refers to the availability, suitability, and ease of use of sample introduction methods or attachments for the variety of sample types that responders commonly encounter and analyze.

Simplicity of Operation refers to the ease of use of instrument operating software. Responders indicated a preference for the smallest possible number of software steps to perform instrument functions.

Training Materials refers to the availability and quality of training materials. Responders considered the availability of informative online training videos to be a positive factor.

Library Modification refers to whether it is possible for users to modify and/or add to libraries and how easily this can be done. Responders suggested as a positive factor the ability/willingness of the manufacturer to update libraries for analytes of interest to a particular organization.

Configurable User Interface refers to whether appropriate control settings can be set for users of different abilities (e.g., basic and advanced user interfaces).

Display Screen Characteristics refers to factors related to ability to read displayed data (e.g., screen visibility in bright/dark conditions, font size, contrast, whether displayed information is clearly presented).

Report Content refers to the usefulness of instrument-generated reports for responder needs.

Status Indicators refers to the existence and suitability of status indicators (e.g., battery life, carrier gas level, calibration gas level, or number of analyses possible until replacement is needed).

User Manual Quality refers to the clarity and completeness of the information provided in the instrument's user manual.

2.1.3 CAPABILITY

The focus group provided the following definitions of the capability evaluation criteria:

Data Analysis refers to whether data analyses are informative. The Focus Group indicated, for example, when a specific compound cannot be confidently identified, it would be useful for specific functional groups that can be identified with confidence to be indicated. Conversely, noting that a peak(s) is "unknown" was not considered helpful or useful.

Data Export Modes refers to how measurement data can be exported— from the hardware standpoint (e.g., WiFi, Bluetooth, SD card, memory stick, etc.)—to send to commercial vendor support, or use in other commercial post-analysis software packages.

Column Temperature Range refers to the temperature range (lower and upper) that the field portable GC/MS system can generate for the separation column; evaluators stated that a higher upper range is a positive factor because it is helpful in purging (clearing out) columns.

Atomic Mass Unit (AMU) Range is the measurable ion mass range of the mass spectrometer, a high upper value and wider range is a positive factor as it potentially allows for identification of a wider range of analytes of interest.

Detection Threshold refers to the software threshold that affects and/or decides whether a particular peak is detected and used in compound identification by instrument software. The focus group members indicated that whether and how easily users can change threshold settings were factors to consider in rating this evaluation criterion.

2.1.4 Maintainability

The focus group provided the following definitions of the capability evaluation criteria:

Technical Support refers to the ability of the instrument manufacturer to respond quickly to technical support requests from responders in the field. Evaluators stated that the schedule of availability of the manufacturer's technical support personnel and the ability of technical support personnel to remotely operate the instrument to diagnose problems, were positive features.

Field Serviceability refers to the range of minor instrument repairs and parts replacements that responder personnel can perform with simple tools, and the ease with which these repairs can be performed.

Software/Library Updates refers to the availability of library updates from manufacturer, manufacturer notification of library updates, and whether users are able to delay implementation of updates.

Tuning Requirements refers to the ease and required frequency of tuning the instrument.

2.1.5 Affordability

The focus group provided the following definitions of the affordability evaluation criteria:

Cost of Consumables refers to the cost of consumables needed to operate the instrument, figured as an estimated cost per sample analysis.

Maintenance Costs refers to the costs associated in keeping the instrument in operating condition.

Cost of Instrument refers to the cost to purchase the instrument.

2.2 Determination of Evaluation Criteria Ratings

The focus group provided recommendations on whether the evaluation criteria should be assessed operationally or according to vendor-provided specifications. In an operational assessment, evaluators assess criteria based on their hands-on experience using the product.

In a specification assessment, evaluators assess criteria based on product information provided by the vendor. In some cases, evaluation criteria may be assessed both operationally and according to vendor-provided specifications. Table 3-2 shows how each evaluation criterion should be evaluated based on the feedback provided by the Focus Group.

Table 3-3 Evaluation Criteria Rating Recommendations

Category	Criteria	Operational	Specification
Affordability	Cost of Consumables		✓
	Maintenance Costs		✓
	Cost of Instrument		✓
Capability	Data Analysis	✓	
	Data Export Modes	✓	✓
	Column Temperature Range		✓
	AMU Range		✓
	Detection Threshold	✓	✓
Deployability	Hot Swappable Batteries	✓	✓
	Hot Swappable Carrier Gas	✓	✓
	Battery Characteristics		✓
	Start-Up Time	✓	
	Operating Temperature Range		✓
	Storage Conditions		✓
	Time between Runs	✓	
	AC Power		✓
	Decontaminability	✓	✓
	Portability	✓	
	Sample Preparation Time	✓	
	Water and Dust Resistance		✓
Maintainability	Technical Support		✓
	Field Serviceability	✓	
	Software/Library Updates		✓
	Tuning Requirements	✓	✓
Usability	Data File Formats		✓
	Operation with PPE	✓	
	Sample Introduction Options	✓	✓
	Simplicity of Operation	✓	
	Training Materials	✓	
	User Library Modification	✓	
	Configurable User Interface	✓	
	Display Screen Characteristics	✓	
	Report Content	✓	
	Status Indicators	✓	
	User Manual Quality	✓	

2.3 Product Selection Criteria Recommendations

The number of products available on the commercial market sometimes exceeds the number of products that can be evaluated in a SAVER assessment. In such cases, SAVER focus groups are asked to recommend criteria for selecting products to assess. In the case of field portable GC/MS instruments, only four products are currently available on the commercial market, and so there was no need to obtain product selection criteria recommendations from the focus group. The three field portable GC/MS instruments listed in Table 3-3 have been selected for inclusion in the assessment. The fourth commercially available instrument is a variant of one of the other three instruments produced by a different manufacturer under a licensing agreement. Due to the similarity of this fourth instrument to one of the others, the SAVER Project Manager determined that there was no need to include it in the assessment. During the overview presentations, the focus group was briefed on the features and capabilities of these three instruments and the reasons why they were chosen for inclusion in the assessment.

Table 3-4 Products to be Assessed

Vendor	Product	Product Image
FLIR Detection, Incorporated	Griffin G510	
Inficon AG	HAPSITE ER	
PerkinElmer, Incorporated	Torion T-9	

2.4 Assessment Scenario Recommendations

Due to the high cost of field portable GC/MS instruments (each has a list price in the $100,000 range), instruments will be loaned from their manufacturers rather than purchased for use in the assessment. Hands-on assessment scenarios will mostly occur while operating the instruments indoors at a table to minimize the risk of damaging the instruments by dropping them or exposing them to rain. The assessment plan will be circulated to focus group members for review as it is being developed to incorporate their ideas about design of assessment activities reflecting actual usage of field portable GC/MS and other chemical detection instruments.

3.0 FUTURE ACTIONS

The next step in planning the field portable GC/MS assessment, which will take place in July 2019, will be to develop an assessment plan detailing how the three field portable GC/MS instruments will be assessed. Focus group recommendations will be followed whenever possible in developing the assessment plan. After the field portable GC/MS assessment is held, results will be published in a SAVER assessment report that will be accessible on the SAVER website, www.dhs.gov/science-and-technology/SAVER.

4.0 ACKNOWLEDGMENTS

NUSTL and PNNL thank the focus group participants for contributing their valuable time and expertise to the focus group. Their insights and recommendations will guide the planning and execution of the assessment and will influence future SAVER projects. Appreciation is also extended to the home jurisdictions of the participants for allowing them to participate in the focus group. We would also like to thank the Seattle Fire Department and the Seattle Joint Training Facility for hosting the focus group.