Handheld Raman Spectrometers

Focus Group Report

July 2020

Homeland Security
Science and Technology

NUSTL®
NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY

Approved for Public Release

SAVER-T-FGR-9

The *Handheld Raman Spectrometers Focus Group Report* was prepared by the National Urban Security Technology Laboratory for the System Assessment and Validation for Emergency Responders (SAVER) Program, U.S. Department of Homeland Security, Science and Technology Directorate.

The views and opinions of authors expressed herein do not necessarily reflect those of the U.S. government.

Reference herein to any specific commercial products, processes or services by trade name, trademark, manufacturer or otherwise does not necessarily constitute or imply its endorsement, recommendation or favoring by the U.S. government.

The information and statements contained herein shall not be used for the purposes of advertising, nor to imply the endorsement or recommendation of the U.S. government.

With respect to documentation contained herein, neither the U.S. government nor any of its employees make any warranty, express or implied, including but not limited to the warranties of merchantability and fitness for a particular purpose. Further, neither the U.S. government nor any of its employees assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed; nor do they represent that its use would not infringe privately owned rights.

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, 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 conduct an assessment of handheld Raman spectrometers to provide emergency responders with reference information on currently available products. Handheld Raman spectrometers fall under AEL reference numbers 07CD-01-DPRS (Detector, Raman Spectroscopy, Point), 07ED-01-LASR (Detector, Explosive, Laser-Based), and 07ED-04-LASR (Detector, Explosive, Laser-Based, Standoff). As part of this project, recommendations were gathered from a focus group and are highlighted in this report.

For more information on NUSTL's SAVER Program or to view additional reports on Raman spectrometers 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

Authors:

John Kada, Project Manager, NUSTL

Joseph Jankovic, Test Engineer, NUSTL

Richard Ozanich, Pacific Northwest National Laboratory

EXECUTIVE SUMMARY

Handheld Raman spectrometers are used by first responders during field operations to identify solids and liquids that are suspected to contain toxic industrial chemicals, explosives, illicit drugs, or other hazardous substances. They fall under Authorized Equipment List (AEL) reference numbers 07CD-01-DPRS - Detector, Raman Spectroscopy, Point, 07ED-01-LASR - Detector, Explosive, Laser-Based, and 07ED-04-LASR - Detector, Explosive, Laser-Based, Standoff.

Through its System Assessment and Validation for Emergency Responders (SAVER) Program, the National Urban Security Technology Laboratory (NUSTL)—in collaboration with the Pacific Northwest National Laboratory (PNNL)—will conduct a comparative assessment of handheld Raman spectrometers to provide emergency responders with information that will assist with making operational and procurement decisions. As a part of the assessment process, NUSTL convened a focus group in February 2020, with the primary objectives of obtaining recommendations on evaluation criteria, products to assess, and assessment activities. These recommendations were gathered from a focus group consisting of nine emergency responders with seven or more years of experience from jurisdictions throughout the United States. Their recommendations are documented in this report.

The focus group identified 20 evaluation criteria by which handheld Raman spectrometers should be assessed. They grouped the evaluation criteria into the SAVER categories of Capability, Usability, Deployability, and Maintainability. They assigned weights indicating the importance of each evaluation criterion and assessment category; these weights will be used to calculate the numerical product scores that come out of the assessment. The highest possible numerical weight, a '5', was given to seven evaluation criteria; the highest assessment category weight, 40%, was given to the Capability assessment category. The focus group provided recommendations on factors to consider in rating the products on each evaluation criterion and on how to assess each evaluation criterion, i.e., through hands-on operational use, by reviewing manufacturer-verified product specifications, by reviewing PNNL lab testing results, or through some combination of these three assessment techniques.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Handheld Raman spectrometers are used by first responders during field operations to identify solids and liquids that are suspected to contain toxic industrial chemicals, narcotics, or other hazardous substances. They fall under Authorized Equipment List (AEL) reference numbers 07CD-01-DPRS - Detector, Raman Spectroscopy, Point, 07ED-01-LASR - Detector, Explosive, Laser-Based, and 07ED-04-LASR - Detector, Explosive, Laser-Based, Standoff.

On February 27, 2020, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted a focus group on handheld Raman spectrometers at the City of Seattle Joint Training Facility in Seattle, Washington. The purpose of the focus group was to gather recommendations from knowledgeable first responders, primarily from hazardous materials (HAZMAT) teams, that will be used to plan a SAVER assessment of handheld Raman spectrometers. The focus group and assessment are a collaborative effort between NUSTL and the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL).

1.1 Focus Group Demographics

Nine first responders with at least seven years of experience using handheld Raman spectrometers were recruited to participate in the focus group. Table 1-1 provides demographic information about the focus group participants.

Table 1-1 Focus Group Participant Demographics

Responder Discipline	State	Years of Experience
Firefighter/HAZMAT	WA	20-25
Firefighter/HAZMAT	FL	20-25
Firefighter/HAZMAT	D.C.	15-20
Firefighter/HAZMAT	NY	15-20
Firefighter/HAZMAT	NV	10-15
Firefighter/HAZMAT	CA	10-15
Firefighter/HAZMAT	CA	10-15
Firefighter/HAZMAT	MD	5-10
Law Enforcement/HAZMAT	NJ	5-10

2.0 FOCUS GROUP METHODOLOGY

The focus group opened with an overview of NUSTL, PNNL, the SAVER Program, and focus group goals and objectives. This was followed by a general overview presentation on handheld Raman spectrometers. A series of focus group discussion sessions were then held to obtain recommendations from the first responder participants on the following subjects related to planning and executing the handheld Raman spectrometer assessment:

1) Evaluation Criteria Recommendations – Identification of operationally relevant instrument features and capabilities that should be evaluated during the assessment
2) Evaluation Criteria Categorization – Assignment of evaluation criteria to SAVER assessment categories for product reporting purposes
3) Evaluation Criteria and SAVER Assessment Category Weights – Assignment of weights to each identified evaluation criterion and to the SAVER assessment categories. These weights will be used to calculate the numerical scores that will appear in the SAVER Raman Spectrometers Assessment Report.
4) Product Selection Recommendations – Specific instruments to include in the assessment and specific features that all instruments to be assessed should have.
5) Assessment Activities and PNNL Laboratory Testing – Recommendations on how to assess the instruments on the identified evaluation criteria and on laboratory testing PNNL will conduct to provide data used to assess product evaluation criteria.

Figure 2-1 highlights the process followed to gather these recommendations.

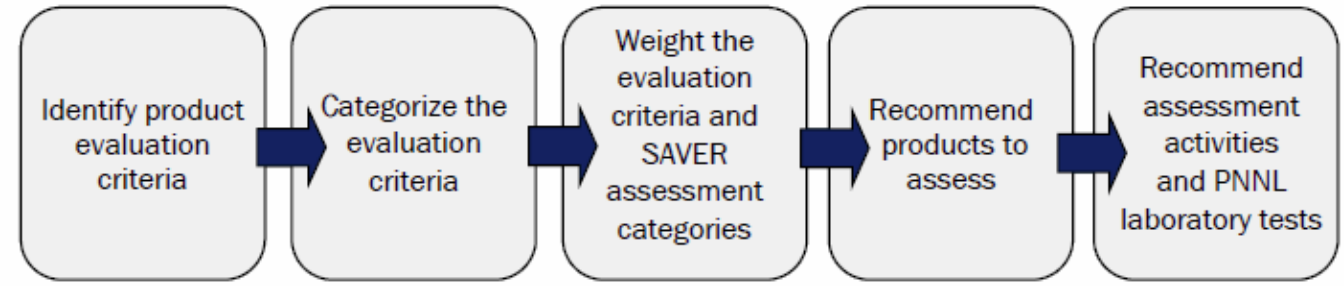

Figure 2-1 Focus Group Process

Focus group participants first identified applications in which handheld Raman spectrometers are commonly used. Next, the focus group participants identified and defined evaluation criteria, which were then grouped and prioritized into the SAVER categories: affordability, capability, deployability, maintainability, and usability. The focus group decided not to group criteria in the affordability category because affordability greatly varies based on an emergency department's budget. The SAVER categories are defined as:

- **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 preparing to use 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.

Once the evaluation criteria were organized within the SAVER categories, focus group participants assigned a weight for each criterion's level of importance on a 1 to 5 scale, where 5 is of utmost importance and 1 is of minor importance. Table 2-1 highlights the evaluation criteria weighting scale.

Table 2-1 Evaluation Criteria Weighting Scale

Weight	Definition
5	This evaluation criterion is ***of utmost importance***: *"I **would never** consider purchasing a product that does not meet my expectations of this criterion or does not have this feature."*
4	This evaluation criterion is ***very important***: *"I **would be hesitant** to purchase a product that does not meet my expectations of this criterion or does not have this feature."*
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	This 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	This evaluation criterion is ***of minor importance***: *"Other things being equal, meeting my expectations of this criterion or having this feature **may influence** my decision to purchase this product."*

After the evaluation criteria were assigned a weight, the focus group participants recommended whether the criteria should be assessed operationally in hands-on activities, by reviewing vendor-provided specifications, and/or by reviewing results of laboratory testing conducted at PNNL prior to the assessment. Next, considering the number evaluation criteria in each category and their assigned weights, the focus group participants ranked the SAVER categories with a percentage weight to represent its level of importance.

After assigning each SAVER category an overall weight percentage, focus group participants identified product selection criteria and identified products that should be considered for the assessment. Finally, focus group participants reviewed the applications identified at the beginning of the focus group and recommended operational assessment activities as well as laboratory tests for PNNL to perform prior to the assessment.

3.0 EVALUATION CRITERIA RECOMMENDATIONS

The 20 evaluation criteria identified by the focus group are listed in Table 3-1, organized by the assessment category to which the focus group assigned them. No evaluation criteria were assigned to the affordability category. Table 3-1 also shows the weights the focus group assigned to the evaluation criteria and to the assessment categories. Evaluation criteria are discussed in Sections 3.1. to 3.5.

Table 3-1 Evaluation Criteria

SAVER CATEGORIES				
Capability	**Usability**	**Deployability**	**Maintainability**	**Affordability**
Overall Weight 40%	Overall Weight 30%	Overall Weight 20%	Overall Weight 10%	Overall Weight 0%
Evaluation Criteria				
Library Weight: 5	**Data Analysis** Weight: 5	**Durability** Weight: 5	**Calibration Requirements** Weight: 4	
Measurement Capabilities Weight: 5	**Ease of Use** Weight: 5	**Decontamination** Weight: 4	**Consumables** Weight: 3	
Sample Identification through Containers Weight: 5	**Functionality with Personal Protective Equipment (PPE)** Weight: 5	**Power** Weight: 3	**Warranty** Weight: 3	
Multicomponent Measurement Weight: 4	**Screen Visibility** Weight: 4			
Reachback Weight: 4	**Accessories** Weight: 2			
Sample Classification Weight: 3	**Administrative Controls** Weight: 2			
Data Export Weight: 3	**Sample Labelling** Weight: 1			

3.1 CAPABILITY

Seven evaluation criteria identified by the focus group were assigned to the capability category. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the instruments on these criteria during the assessment.

Library refers to manufacturer-provided or user-created spectrum libraries.

Factors to consider: Inclusion of references to Chemical Abstracts Service numbers, ability to customize spectral libraries to include spectra of significant sample types users have encountered and to tag spectrum files with informative metadata, i.e., a descriptive text linking a user-collected spectrum to an event.

Measurement Capabilities refers to sample analysis capabilities.

Factors to consider: Laser interrogation features (e.g., raster or broad beam scanning; the ability to see where the laser focal point is aimed), the availability and effectiveness of surface enhanced Raman spectroscopy (SERS) options, standoff measurement capability, the ability to delay the start of analysis, fluorescence compensation capabilities; the minimum measurable sample size, and whether a sample vial holder is provided.

Sample Identification through Containers refers to the ability to analyze samples in container types commonly encountered during field operations.

Factors to consider: Sample identification in various container types that the focus group reported encountering frequently, including: clear and colored glass, opaque and semi-opaque containers, plastic bags, gel caps, wax-paper envelopes, and regular paper envelopes. Relevant instrument features mentioned by the focus group were laser wavelength, laser focal point adjustability, and the ability to see/aim the laser focal point.

Multicomponent Measurement refers to the ability to identify the chemical composition of samples containing a mixture of two or three major components.

Factors to consider: Spectrum analysis software features related to multicomponent sample analysis, such as spectral subtraction.

Reachback refers to technical support provided by the instrument manufacturer to assist responders in correctly identifying analytically challenging samples.

Factors to consider: The technical quality of the analysis results provided, the turnaround time for analysis of submitted data, schedule of reachback availability (e.g., provided on a 24/7/365 basis versus normal business hours), and the cost of reachback service options.

Sample Classification refers to whether analysis results provide supplementary information that is useful in interpreting and acting on analysis results.

Factors to consider: Examples of useful supplemental information cited by the focus group were indication of the chemical compound class identified (e.g., hydrocarbon or protein), whether identified compounds are hazardous (e.g., explosive), and whether the sample is highly fluorescent.

Data Export refers to options provided for exporting acquired data from the instrument, and the suitability of instrument-generated reports for use by the responder organization (e.g., by incident command).

Factors to consider: Cable and wireless data export options, ability for acquired data to be monitored and analyzed in real-time from a remote location. Additional factors cited were: data security and encryption options, the range of data file types that can be created, and the thoroughness and clarity of instrument-generated analysis reports.

3.2 USABILITY

Seven evaluation criteria identified by the focus group were assigned to the usability category. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the instruments on these criteria during the assessment.

Data Analysis refers to features of the spectrum analysis software, both onboard the instrument and manufacturer-provided software running on an external laptop computer.

Factors to consider: The ability to view sample spectra overlaid on reference library spectra to judge the degree of match. The focus group indicated that being able to effectively compare sample spectra to library spectra using just the instrument's user interface rather than transferring the spectra to a laptop is often desirable.

Ease of Use refers to the general ease of operating the instrument.

Factors to consider: Whether the user interface is intuitive to navigate, whether the instrument operating software guides users through sample analysis steps, whether user manuals or quick start guides are helpful and can be viewed on the instrument's display screen. The focus group recommended that instrument start-up and sample analysis times be determined as part of this evaluation criterion.

Functionality with Personal Protective Equipment (PPE) refers to how effectively the instrument can be operated while wearing PPE.

Factors to consider: Ease and effectiveness of instrument operation while wearing typical protective gear. Typical hand protection would be heavy rubber HAZMAT gloves or structural firefighting gloves with nitrile gloves worn underneath; typical facial protection is a Level A hood.

Screen Visibility refers to the readability of the instrument display screen and related controls.

Factors to consider: Display screen readability in bright daylight or in darkness, whether manually operated buttons are backlit, and whether users can adjust display screen font sizes.

Accessories refers to the usefulness of accessories evaluated at the assessment.

Factors to consider: The instrument carrying case, sample interrogation accessories, sample vial holders, and data cables provided with the instrument.

Administrative Controls refers to the ability to limit access to certain instrument features based on user experience level.

Factors to consider: Availability of advanced and basic user level modes, and which instrument control settings and library features are inaccessible in basic user mode.

Sample Labelling refers to the ability to assign descriptive file names to acquired data files.

Factors to consider: Ability for acquired spectrum files to be saved with names and supplementary comments that aid in later finding them and understanding the nature of the analyzed sample.

3.3 Deployability

Three evaluation criteria identified by the focus group were assigned to the deployability category. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the instruments on these criteria during the assessment.

Durability refers to how well the instrument is designed to withstand damage during use, storage, and decontamination.

Factors to consider: Instrument compliance to standards such as U.S. military drop and vibration standards and Ingress Protection (IP) ratings for water and dust resistance. Also, suitability of instrument operating and storage temperature ranges for field conditions, and the protection provided by the instrument storage case.

Decontamination refers to how easily and effectively the instrument can be decontaminated.

Factors to consider: IP rating, presence of hard-to-clean crevices on external surfaces, and whether special tools are needed to clean the instrument.

Power refers to the suitability of internal and external power sources.

Factors to consider: Instrument operating time on battery power both when idle and in active use, whether batteries are 'hot swappable' (i.e., they can be replaced without turning the instrument off), availability of batteries in stores versus special order, and ease of battery change-out in the field. Also, external 12-volt direct current or 120-volt alternating current power options.

3.4 Maintainability

Three evaluation criteria identified by the focus group were assigned to the maintainability category. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the instruments on these criteria during the assessment.

Calibration Requirements refers to long- and short-term requirements for instrument calibration.

Factors to consider: Ease and speed of field calibration, and the manufacturer-recommended factory calibration schedule.

Consumables refers to replaceable components needed for ongoing instrument operation.

Factors to consider: The cost, availability and suitability of necessary consumables such as sampling kits, sample vials, and calibration check samples.

Warranty refers to the terms of the instrument warranty offered by the manufacturer.

Factors to consider: The availability of loaner instruments during repair periods, the turnaround time for repairs, and the cost of the warranty.

4.0 ASSESSMENT RECOMMENDATIONS

After identifying, defining, categorizing, and weighting the evaluation criteria, the focus group provided recommendations on assessment activities and on the selection of instruments to include in the assessment.

4.1 Evaluation Criteria Recommendations

During the handheld Raman spectrometer assessment, instruments will be evaluated in three ways: by hands-on operational use in mission-relevant tasks, by reviewing manufacturer-provided product specifications, and by reviewing laboratory testing data provided by PNNL. Table 4-1 below summarizes focus group recommendations on which method(s) each evaluation criterion should be assessed.

Table 4-1 Evaluation Criteria Assessment Recommendations

Category	Evaluation Criterion	Operational	Specifications	Lab Testing
Capability	Library	✓	✓	
	Measurement Capabilities	✓	✓	✓
	Sample Identification through Containers	✓		✓
	Multicomponent Measurements	✓		✓
	Reachback		✓	✓
	Sample Classification	✓		
	Data Export	✓	✓	
Usability	Data Analysis	✓		
	Ease of Use	✓		
	Functionality with Personal Protective Equipment (PPE)	✓		
	Screen Visibility	✓		
	Accessories	✓	✓	
	Administrative Controls	✓	✓	
	Sample Labelling	✓		
Deployability	Durability	✓	✓	
	Decontamination	✓	✓	
	Power	✓	✓	
Maintainability	Calibration Requirements	✓	✓	
	Consumables	✓	✓	
	Warranty		✓	

4.2 Recommendations on Assessment Activities

The focus group provided suggestions for hands-on operational assessment activities to be performed by the evaluators during the assessment and for pre-assessment laboratory testing to be performed by PNNL, which would provide evaluators with additional relevant information about instrument features and capabilities. A variety of possible sample types were identified that represent materials commonly encountered by first responder HAZMAT teams. These include solids, liquids, single-component samples, and multicomponent samples, illicit drugs, and suspicious powders that could potentially be a biothreat agent. A summary of potential sample types to be used during the assessment or tested by PNNL prior to the assessment are listed below.

Common Hazardous Materials

- Paint thinner
    - There are a variety of chemicals and mixtures used as paint thinners including mineral spirits (mostly long chain hydrocarbons (C10 or greater), hexane, and other organic solvents), turpentine, acetone, naphtha, toluene, methyl ethyl ketone (MEK), dimethylformamide (DMF), glycol ethers, xylene, etc.
- Isopropyl alcohol (IPA)
- Antifreeze (typically ethylene glycol or propylene glycol)
- Hydrocarbon-based materials (gasoline, brake oil, other oil)
- Drain cleaner (strong bases [sodium hydroxide, potassium hydroxide] or strong acids such as sulfuric acid)
- Ammonium nitrate (commonly found in fertilizers, also used as an explosive or to make explosives)
- Pesticides/bug spray
- Potassium chlorate and sugar mixture (can also be used as part of a sensitivity study as indicated below)

Chemical Compounds Related to Illicit Drugs

- Acetaminophen
- Dipyrone
- Diphenhydramine
- Noscapine
- Caffeine
- Lactose
- Mannitol
- Inositol
- Polyethylene glycol 3350
- Microcrystalline cellulose

- Aspirin tablets (crushed and as whole tablets)
- Quinine, mannitol, and caffeine mixture (can also be used as part of a sensitivity study as indicated below)

Commonly Encountered Innocuous Powders

- Organic, biological containing powders
    - Brewer's yeast powder
    - Dipel dust
- Organic, protein-containing powders
    - Milk powder
    - Infant formula
    - White flour
- Organic powders with no protein content
    - Coffee creamer (non-dairy)
    - Instant pectin
    - Acetaminophen
    - Powdered sugar
    - Corn starch polyethylene glycol 3350 (for example, MiraLAX, Glycolax)
- Inorganic powders
    - Toothpaste powder with fluoride
    - Baking powder (aluminum free)
    - Calcium carbonate (antacid)
    - Baking soda
    - Epsom salt
    - Magnesium carbonate (gym chalk)
    - Borax
    - Talc
    - Kaolin clay
    - Popcorn salt

In addition, the focus group recommended that PNNL test different concentrations (e.g., 5%, 10%, 20%, etc.) of certain samples to better understand the sensitivity of the various Raman spectrometers and potential spectral interferences. These include:

- Floor cleaner/water (or solvent) mixtures
- Naphtha/water mixtures
- Hydrogen peroxide/water mixtures
- Quinine, mannitol, caffeine mixtures
- Potassium chlorate and sugar mixtures

In addition to the sample types, the focus group identified several activities that are reflective of scenarios encountered, and how Raman spectrometers are used, during field operations. Participants recommended incorporating these activities into the test plan.

4.2.1 Sample analysis through container walls

The focus group recommended that operational assessment scenarios provide evaluators with opportunities to analyze samples of known chemical composition in sample container types that are frequently encountered in the field. Frequently encountered container types are: colored and uncolored glass jars, plastic labware, plastic zipper bags, wax-paper and regular paper envelopes, and gel caps. Several of these container types are encountered with either clear, opaque, or semi-opaque walls and with a variety of wall thicknesses.

The focus group recommended that PNNL provide lab testing data for review at the assessment if it would not be practical to assess the full range of sample container types during the assessment.

4.2.2 Instrument operation with PPE

The focus group recommended that assessment scenarios provide evaluators with opportunities to operate the instruments while wearing typical PPE, such as HAZMAT gloves or structural firefighting gloves worn over an inner nitrile glove layer, and a Level A hood; it would not be necessary to assess instrument operation while wearing a full-body HAZMAT outfit.

4.2.3 Data analysis software

The focus group recommended that operational assessment activities include using onboard spectrum analysis software and/or spectrum analysis software running on an external laptop computer to assess ease of use and effectiveness of spectrum analysis software capabilities.

4.2.4 Data export

The focus group suggested that operational assessment activities include exporting sample spectra to a laptop computer. The focus group indicated that wireless export data from the instrument is preferable because data could be transferred prior to decontaminating the instrument. The focus group indicated that the ability to remotely monitor instrument analyses in real time from a second location would be a useful option during field operations as it would allow one responder to be in the hot zone collecting data while a second responder outside the hot zone analyzed the data on a laptop computer.

4.2.5 Decontamination

The focus group suggested that a practical method to operationally assess an instrument's ability to be decontaminated would be to coat instrument's surfaces with shaving cream and then determine how easily and effectively the shaving cream can be removed (reflective of a wipe-down decontamination process).

4.2.6 Reachback

Recognizing that time constraints would make it impractical to directly assess reachback support for each instrument, the focus group recommended that PNNL's lab testing effort should include gathering relevant data, which would be reported at the assessment. The suggested approach was to send a set of Raman spectra obtained from samples of known composition to each instrument's reachback support team. The PNNL summary report would indicate the true chemical composition of the sample, the instrument-generated analysis result, and the chemical composition reported by reachback. It would also report the turnaround time for reachback analysis results. The focus group also recommended that the cost and terms of reachback support be provided for evaluator assessment.

4.2.7 Battery run time

The focus group suggested that useful information with regard to battery run time would include battery run time when idle and when actively scanning samples, and how battery run times vary with ambient temperature. The focus group recognized that this information was unlikely to be available from instrument manufacturers and cannot be operationally assessed during the assessment. They recommended that PNNL perform lab testing work to obtain this information, if feasible to do so.

4.3 Product Selection Recommendations

The focus group recommended the 12 handheld Raman spectrometer instruments listed in Table 4-2 for inclusion in the assessment. Their recommendations were based on products used by the focus group participants or their peers, their familiarity with a product, interest in comparing products having different features and laser excitation wavelengths, manufacturer interest in participation, and manufacturer-recommended models for HAZMAT response, where a manufacturer produced more than one instrument model.

Table 4-2 Product Assessment Recommendations

Instrument Manufacturer	Model
Pendar	X10
Rigaku	CQL
Smiths Detection	ACE-ID
Thermo Scientific	First Defender RMX
Agilent	Resolve
B&W	TacticID 1064
Bruker	Bravo
Chemring	PGR-1064
Metrohm	Mira DS
Anton Paar	Cora 100
Field Forensics	Handy Ram II
Thermo Scientific	Gemini

5.0 FUTURE ACTIONS

The focus group recommendations will be used to guide the development of the Handheld Raman Spectrometers Assessment Plan and the selection of products to evaluate in the assessment. Once the assessment is complete, the results will be available on www.dhs.gov/science-and-technology/SAVER.

6.0 SUMMARY

A focus group of nine first responders experienced in using handheld Raman spectrometers identified 20 evaluation criteria on which Raman spectrometers should be evaluated. They assigned each evaluation criteria to one of four SAVER categories—capability, usability, deployability, and maintainability—assigned a numerical weight to each evaluation criteria on a 1 to 5 numeric scale and assigned weights to each SAVER assessment category on a percentage scale summing to 100 percent. These weights will be used to calculate the overall product scores and assessment category scores that will come out of the assessment.

The highest possible numerical weight, a '5', was given to seven evaluation criteria:

- Library
- Measurement Capabilities
- Sample Identification through Containers
- Data Analysis
- Ease of Use
- Functionality with Personal Protective Equipment (PPE)
- Durability

The capability category was assigned the highest percentage weight, 40%, followed in order of relative weight by usability, deployability, and maintainability.

The focus group provided recommendations on assessment activities carried out through a mix of hands-on instrument use during the assessment, review of pre-assessment laboratory testing to be conducted at PNNL, and review of manufacturer-verified product specifications.

The focus group recommendations documented here will be used to develop an assessment plan that will be developed jointly by NUSTL and PNNL.

7.0 ACKNOWLEDGEMENTS

The National Urban Security Technology Laboratory thanks the focus group participants for their valuable time and expertise. Their insights and recommendations will guide the planning and execution of the handheld Raman spectrometers assessment. Appreciation is also extended to the home jurisdictions of the participants for allowing them to participate in the focus group.