Physiological Monitoring Systems

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 conduct an assessment on physiological monitoring systems to provide emergency responders with reference information on currently available products. Physiological monitoring systems fall under AEL reference number 01ZA-01-PPMS (Personnel Physiological Monitoring System). 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 physiological monitoring systems 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

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EXECUTIVE SUMMARY

A physiological monitoring system, as addressed in this report, is a product worn by first responders that collects and relays real-time physiological data to remote command displays during incident responses. The system is used to monitor the health status of staff, especially during strenuous activity or potentially hazardous conditions, to help determine when they are experiencing life signs that pose a risk to their health and/or safety. Physiological monitoring systems fall under the Authorized Equipment List reference number 01ZA-01-PPMS, entitled "Personnel Physiological Monitoring System."

Through its System Assessment and Validation for Emergency Responders (SAVER) program, the National Urban Security Technology Laboratory (NUSTL) will conduct a comparative assessment of physiological monitoring systems to provide emergency responders with information that will assist with making operational and procurement decisions.

As a part of the assessment planning process, in October 2020 NUSTL convened a virtual focus group composed of first responders with the primary objective of soliciting their recommendations on evaluation criteria, product selection criteria, products to assess, and possible scenarios for the assessment of physiological monitoring systems. Recommendations were gathered from a focus group consisting of nine emergency responders from various jurisdictions and are highlighted in this report.

Twenty-five evaluation criteria were identified, defined, categorized and prioritized during the focus group. Four of these criteria were determined to be "information only" and will not be assessed. SAVER has five standard categories into which the remaining 21 criteria have been binned: capability, usability, deployability, maintainability, and affordability. The five SAVER categories were each assigned a percentage to reflect their contribution to the overall weight based on level of importance. The focus group also provided recommendations for NUSTL staff's consideration regarding assessment methods: six different assessment activities, five potential venues, and suggested features for product selection.

The DHS Science and Technology Directorate's Operational Experimentation (OpEx) program supported NUSTL in the planning and facilitation of this focus group and will further support the planning of the SAVER assessment of physiological monitoring systems.

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1.0 INTRODUCTION

Physiological monitoring systems may be used by emergency response organizations to measure and track key physiological indicators of emergency responders and to infer a responder's health status. They may prevent injuries to responders during incident responses and/or help identify their need for a responder's rehabilitation prior to reentering an incident scene, as well as protect their health during routine duty shifts and training. Physiological monitoring systems fall under the Authorized Equipment List reference number 01ZA-01-PPMS, entitled "Personnel Physiological Monitoring System."

Between October 19, 2020 and October 26, 2020, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a virtual focus group on physiological monitoring systems using the Microsoft Teams video communications platform. The purpose of the focus group was to gather knowledgeable first responders who could offer recommendations to be used in planning a SAVER assessment of physiological monitoring systems. The focus group and assessment are a collaborative effort between NUSTL and the DHS S&T Operational Experimentation (OpEx) program. The scope of this project does not include monitoring of any patients.

1.1 FOCUS GROUP PARTICIPANTS PROFESSIONAL EXPERIENCE

Nine emergency responders representing fire and emergency medical services (EMS), each with at least ten years of experience, participated in the focus group. Table 1-1 provides additional professional information about the focus group participants. Of the nine participants, three emergency responders had at least one year of experience using physiological monitoring systems to track emergency responder vitals in a training or operational environment.

Table 1-1 Focus Group Participant Professional Backgrounds

Responder Discipline	State or Country	Years of Experience
Firefighter/EMS	GA	10-15
Firefighter/EMS	OH	15-20
EMS	WA	15-20
Firefighter	AL	20-25
EMS	Canada	20-25
Firefighter	CA	25-30
Firefighter/EMS	MD	25-30
Firefighter	VA	25-30
Firefighter/EMS	IL	35-40

2.0 FOCUS GROUP METHODOLOGY

While the SAVER program traditionally hosts in-person focus groups, this focus group was held virtually to comply with travel restrictions precipitated by the COVID-19 pandemic. To adjust for a virtual environment, the team from S&T held focus group activities in a number of sessions from October 19–26, 2020. Those proceeded as follows:

- October 19: Introduction session
- October 20-22: Individual interview sessions with first responder participants
- October 23: Planning team internal session (without first responders)
- October 26: Group discussion session

Each portion of the focus group was facilitated in Microsoft Teams. Figure 2-1 highlights the information gathering process followed over the course of the focus group sessions.

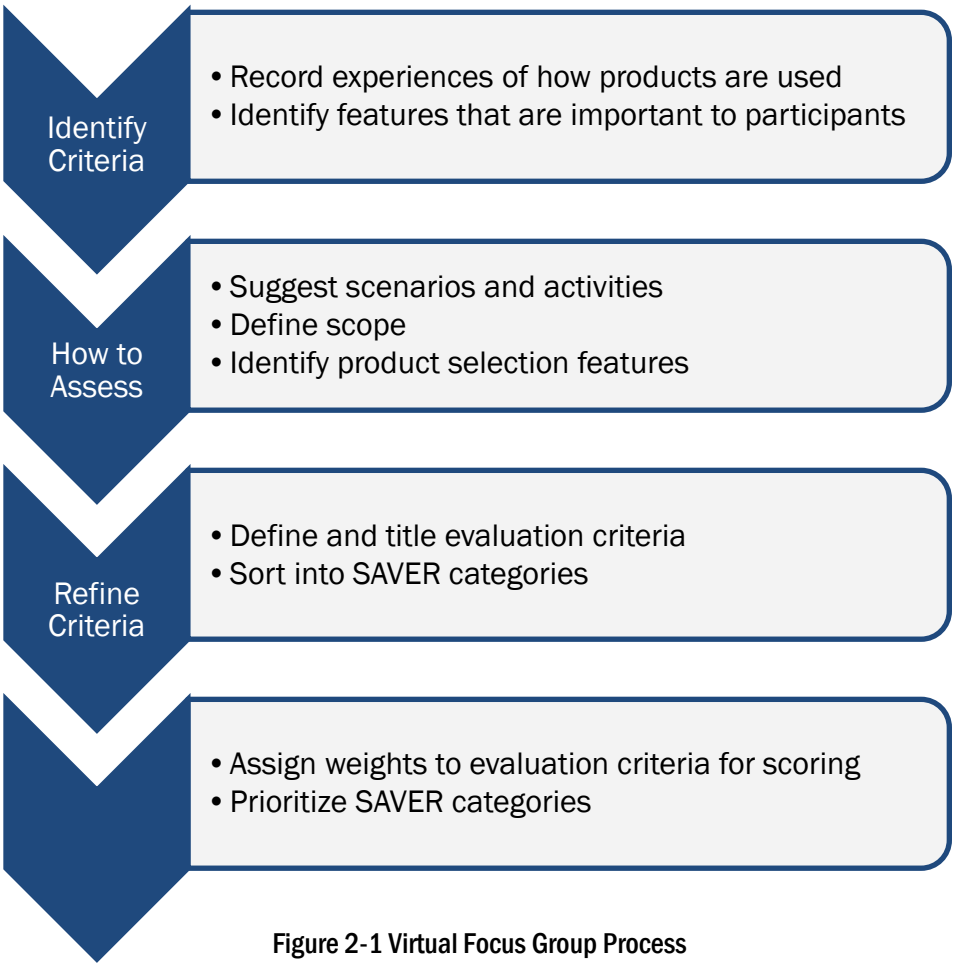

Figure 2-1 Virtual Focus Group Process

The introduction session on October 19 included overviews of NUSTL, the SAVER Program, a high-level description of physiological monitoring systems and their features, and an initial discussion among the participants on their technology solution needs. This session was also used to finalize the schedule for individual interviews.

Individual interviews, conducted with each participant between October 20 and 22, covered identifying evaluation criteria and how to assess them (the first two stages noted in Figure 2-1). The project team first gathered information from the interviewees on physiological monitoring system use cases and the specific products currently used by the participants' agencies. Individual interviews then focused on gathering participants' recommendations in four areas relevant to planning an assessment of physiological monitoring systems:

1) Evaluation criteria: General criteria important to consider when making acquisition or operational decisions
2) Assessment scenarios and venues: Operational scenarios in which the products should be assessed to evaluate their performance and venues that provide an optimal environment for those assessment activities
3) Products: Products and vendors relevant to the emergency responder community that should be candidates for inclusion in the comparative assessment
4) Product selection criteria: Criteria identifying specifications, attributes, or characteristics that a product should possess in order to be considered for the assessment

On October 23, after all interviews were completed, the project team met in a session without the first responder participants in order to refine the recommended criteria (a stage described in Figure 2-1). The team compiled information from each interview to name all evaluation criteria proposed by participants and to determine additional criteria that had not explicitly been mentioned during the interviews. Using this information, the project team drafted a clear, concise definition for each criterion and then sorted each criterion into one of the SAVER categories: affordability, capability, deployability, maintainability, and usability. The SAVER categories definitions are:

1) Affordability**:** relates to the total cost of ownership over the life of the product; includes purchase price, training costs, warranty costs, recurring costs, and maintenance costs
2) Capability: relates to product features or functions needed to perform one or more responder-relevant tasks
3) Deployability: relates to the preparation for using the product, including transport, setup, training, and operational/deployment restrictions
4) Maintainability: relates to routine maintenance and minor repairs performed by responders, as well as included warranty terms, duration, and coverage
5) Usability: relates to ergonomics and the relative ease of use when performing one or more responder-relevant tasks

On October 26, the focus group reconvened to review and prioritize the evaluation criteria the project team had identified based on the individual interviews. This session addressed refining and prioritizing the criteria (the third and fourth stages illustrated in Figure 2-1). After the project team reviewed the definitions of the criteria, focus group participants assigned a weight for each criterion's level of importance on a scale from one to five, where one is of minor importance and five is of utmost importance in making a procurement decision. Table 2-1 details the evaluation criteria weighting scale used in this process. Each participant provided input during this step and the group came to a consensus regarding the assigned weights.

Table 2-1 Evaluation Criteria Weighting Scale

Weight	Label	Definition
5	Utmost importance	*Greatest influence* on my decision; **would not purchase any product that did not meet my expectations** for this criterion.
4	Very important	Meeting **expectations for this feature would *strongly influence* my decision** to purchase this product.
3	Important	**Meeting expectations would *influence* my decision** to purchase this product.
2	Somewhat important	**Meeting expectations would have a *small influence* on my decision** to purchase this product.
1	Minor importance	**Meeting expectations** or having this feature ***may influence* my decision** to purchase this product.

After assigning each evaluation criteria a weight for relative importance, the focus group participants considered how the evaluation criteria fell into the SAVER categories and then ranked those five categories in order of importance. Based on the first responders' rankings, the project team assigned a percentage representing the level of importance to the SAVER categories.

The project team closed out the group discussion session with a review of the suggested assessment scenarios and assessment venues as well as product recommendations and product selection criteria that were gathered during the individual interviews.

3.0 EVALUATION CRITERIA RECOMMENDATIONS

The 25 evaluation criteria identified by the focus group are listed in Table 3-1, where they are also organized by the SAVER assessment category into which the project team and focus group participants assigned them. Table 3-1 also shows the weights the focus group participants assigned to the evaluation criteria and to the assessment categories. The criteria in each category are listed below from highest to lowest weight (importance ranking) as assigned by the focus group; where two or more criteria have an identical weight they are arranged alphabetically. Evaluation criteria assigned to the affordability category are for informational purposes only and will not be evaluated in the assessment activity.

Thirteen of the evaluation criteria were given the highest possible weight of five:

- health status alerting
- physiological measures
- remote sensor platform
- accuracy
- battery life
- comfortable fit
- command interface
- ease of donning and activation
- scalability
- software compatibility
- third party software integration
- cleaning/decontamination
- durability

Seven of the evaluation criteria were given the second highest possible weight, a four:

- data privacy
- data sharing
- compatibility with Personal Protective Equipment (PPE)
- wearer interface
- battery type
- customer support
- in-house maintenance

Only one of the evaluation criteria was given the midpoint value weight of three: profiles or baselines. Four of the criteria, those considered for information only, were not given a score (location services, additional and recurring costs, contract listing, and list price). The evaluation criteria are discussed in more detail in Sections 3.1. through 3.5.

The SAVER categories to which the group gave the most weight were capability and usability, each one assigned 35% of the total weight (100%). Deployability and maintainability were each assigned 15%. Of the four criteria that were not assigned a weight, three constitute the affordability category; accordingly, the SAVER affordability category was also not given a weight. Those four factors will not be part of the assessment's evaluation.

Table 3-1 Evaluation Criteria

SAVER ASSESSMENT CATEGORIES				
Capability	**Usability**	**Deployability**	**Maintainability**	**Affordability**
Overall Weight 35%	Overall Weight 35%	Overall Weight 15%	Overall Weight 15%	Information Only
Evaluation Criteria				
Health Status Alerting Weight: 5	**Accuracy** Weight: 5	**Scalability** Weight: 5	**Cleaning/ Decontamination** Weight: 5	**Additional and Recurring Costs** Information Only
Physiological Measures Weight: 5	**Battery Life** Weight: 5	**Software Compatibility** Weight: 5	**Durability** Weight: 5	**Contract Listing** Information Only
Remote Sensor Platform Weight: 5	**Comfortable Fit** Weight: 5	**Third Party Software Integration** Weight: 5	**Battery Type** Weight: 4	**List Price** Information Only
Data Privacy Weight: 4	**Command Interface** Weight: 5		**Customer Support** Weight: 4	
Data Sharing Weight: 4	**Ease of Donning and Activation** Weight: 5		**In-House Maintenance** Weight: 4	
Profiles or Baselines Weight: 3	**Compatibility with PPE** Weight: 4			
Location Services Information Only	**Wearer Interface** Weight: 4			

3.1 CAPABILITIES

The project team assigned seven of the evaluation criteria identified by the focus group to the capability category. One evaluation criterion in this category, location services, is included for informational purposes only since it is a feature not directly related to physiological monitoring. This criterion will not be evaluated in a follow-on assessment activity. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the instruments on these criteria during the assessment.-Listed by their weight score from highest to lowest, the seven criteria are:

Health status alerting refers to the user interface providing alerts to remote command staff when physiological measures of the wearer exceed or fall below agency-defined threshold values (also known as out-of-tolerance (OOT) conditions).

Factors to consider: presentation of alert (e.g., stoplight status identifying personnel with green, yellow, or red (critical) health status); ability to configure out-of-tolerance threshold values to meet agency standards or thresholds generated by artificial intelligence (AI); alerts may be in the form of text messages.

Physiological measures refers to what sensor measurements are reported by the system.

Factors to consider: provides, at minimum, a pulse rate (i.e. heart rate) and body temperature reading (core temperature preferred over skin temperature); other measures may include electrocardiogram (ECG), (1-, 2-, 5- or 12-lead) with lead II included, blood pressure, blood oxygen saturation, blood carbon monoxide saturation, hydration levels, sleep feedback, respiration rate, motion detection, position, and environmental or ambient temperature.

Remote sensor platform refers to the ability of sensors to transmit data to a remote platform, rather than to a device on the wearer's body (such as a smartphone).

Factors to consider: coverage range is sufficient for operational use; additional sensor platforms can be added to increase coverage range.

Data privacy refers to the need for system compliance with agency data privacy standards.

Factors to consider: usernames are customizable to allow identification of wearer while protecting personally identifiable information (PII) and personal health information (PHI); data transmissions are encrypted.

Data sharing refers to the ability to transmit data to other agencies (e.g., hospitals, EMS, paramedic), if desired.

Factors to consider: data is savable for future analysis; includes language translation services and standardized terms.

Profiles or baselines refers to creation of profiles or baselines for different wearers to adjust (and save their individual) thresholds for out-of-tolerance alerts.

Factors to consider: whether this feature is included or not.

Location services* refers to the ability of the system to provide the location of the wearer in a critical incident.

Factors to consider: provides location in outdoor, indoor, or underground environments; provides three-dimensional location.

*This criterion is for informational purposes only since it is a feature outside the scope of physiological monitoring. It will not be used as an evaluation criterion in the follow-on assessment.

3.2 USABILITY

Seven evaluation criteria identified by the focus group were assigned to the capability category. The focus group defined each evaluation criterion and suggested factors for the project team to consider in evaluating these criteria during the assessment. Listed by their weight score from highest to lowest, the seven criteria are:

Accuracy refers to the ability to produce reliable measurements of physiological signs.

Factors to consider: minimal false alerts and missed alerts for out-of-tolerance values.

Battery life refers to the ability for the battery to last throughout a critical response or duty shift (depending on the agency's preferred use case).

Factors to consider: minimum battery life of six hours for critical incident response; minimum battery life of 24 hours for continual monitoring; system has active mode and power saver mode to preserve battery life (e.g., in power saver mode, the system provides limited measurement of vitals, limited alert processing, or longer period of update intervals).

Comfortable fit refers to availability of sensors in different sizes or adjustable for comfortable fit.

Factors to consider: sweat and body hair do not impact fit or effectiveness; comfortable material; comfortable for sleeping if sleep activity is monitored; as low-profile and non-intrusive as possible; breathable for garment-based sensors; extreme sizes (XXXS, XXXL, etc.) are available.

Command interface refers to the ease of use or intuitiveness of the display and controls for command staff.

Factors to consider: default display includes "stoplight status" of wearers' vital signs; more detailed data (such as measurement values) for specific wearers is available upon query; interface can display data trends in addition to instantaneous measurements; display is configurable to command staff preferences; minimal training is necessary.

Ease of donning and activation refers to need to put on sensors quickly and easily initiate monitoring.

Factors to consider: minimal training necessary; sensor can be donned without the need to remove PPE or clothing.

Compatibility with PPE refers to the ability of sensor to be optimally worn without interfering with other pieces of personal protective equipment.

Factors to consider: integrated within PPE (e.g., garments, self-contained breathing apparatuses); integrated into a base garment, if used for continual monitoring; as low profile and non-intrusive as possible; easily adjustable while wearing PPE (e.g., standard turnout, Level A); compliant with agency standards for PPE.

Wearer interface refers to the ability for wearers to receive out-of-tolerance alerts but receive minimal real-time updates on physiological measurements (to prevent distractions) during a critical incident response.

Factors to consider: alerts can be visual (heads-up display (HUD)), audible, or vibrating; alerts should be intense enough to be sensed by the wearer during a critical incident response; wearers can review their own physiological data retroactively; ability to lock parameter adjustments in mobile apps.

3.3 DEPLOYABILITY

Three evaluation criteria identified by the focus group fit into the deployability category. The focus group defined each evaluation criterion and suggested factors for the project team's consideration when evaluating the systems on these criteria during the assessment.

Scalability refers to the ability to add additional wearers to the software platform when additional responders arrive on the incident scene after monitoring has already started.

Factors to consider: maximum or minimum number of responders needed per response type.

Software compatibility refers to the system's ability to be accessed on various platforms (e.g., tablet, mobile phone, computer and to run on a variety of desktop and mobile operating systems (e.g., Mac OS, Linux, Windows, iOS, Android) that may be used by incident command.

Factors to consider: ability to monitor from multiple platforms and operating systems at the same time, for the same incident.

Third party software integration refers the ability to readily share and use data collected from system sensors with third-party software (e.g., incident management or situational awareness platforms).

Factors to consider: easy integration between software; easy integration to multiple software.

3.4 MAINTAINABILITY

Five evaluation criteria identified by the focus group were assigned to the maintainability category by the project team. The focus group defined each evaluation criterion and suggested factors to consider in evaluating the systems on these criteria during the assessment. Listed in order of their weight values, they are:

Cleaning/decontamination refers to the ability to withstand cleaning and decontamination after being worn by one or more users or in the event of being exposed to contaminants during an incident.

Factors to consider: minimal cracks and crevices; sensor(s) can be laundered if integrated into a garment; withstands cleaning with medical grade disinfectants; allows decontamination from bodily fluids (e.g., sweat, blood); holds up through decontamination after each use; decontamination of individual components separately may not be accomplished.

Durability refers to the ability to withstand wear, environmental conditions, and damage.

Factors to consider: target anticipated shelf life of 2-3 years for the device's physiological monitoring sensor; waterproof or water resistant (at least ingress protection (IP) 67 or equivalent); shock and impact proofing and/or resistance (as per MIL-STD-810G or other agency specific standards); can withstand heavy wind and rain if directly exposed; can operate in high and low temperature environments; minimal corrosion to metal components (e.g., wires, battery leads); long battery lifetime expectancy (if an internal battery is used in a rechargeable device); no glass.

Battery type refers to system power source options.

Factors to consider: compact, rechargeable battery packs; spare batteries available for purchase; easily changed battery; easily charged to full battery charge; standard, non-proprietary batteries (e.g., AA, AAA).

Customer support refers to the technical support or customer service being available to the purchasing agency.

Factors to consider: the available support is either acceptable or not.

In-house maintenance refers to regular recalibration and repairs that can be completed "in-house" by the purchasing agency.

Factors to consider: situational calibration is rarely needed.

3.5 AFFORDABILITY

Three criteria identified by the focus group were matched to the affordability category. The focus group defined each criterion and determined that affordability criteria are for informational purposes only.

Additional and reoccurring costs refers to any costs associated with the use of the system or its services, not including the list price.

Factors to consider: maintenance costs (including contract fees); integration costs; consumables (e.g., ECG pads); software subscription fees (e.g., multiple user accounts); unique or extreme sizing costs (e.g., XXXS, XXXL).

Contract listing refers to any contracting vehicles where the vendor or associated contract is listed.

Factors to consider: system is listed on GSA schedule or existing contract with vendor; system meets agency procurement requirements.

List price refers to the unit price or the manufacturer's suggested retail price (MSRP). Factors to consider: list price does not include bulk discounts.

4.0 ASSESSMENT RECOMMENDATIONS

After identifying, defining, categorizing, and weighting the evaluation criteria, the focus group provided recommendations on assessment activities and on selecting which systems to include in the assessment.

4.1 EVALUATION CRITERIA RECOMMENDATIONS

During the physiological monitoring systems assessment, products will be evaluated in two ways: by hands-on operational use in mission-relevant tasks and by reviewing manufacturer-provided product specifications. Data for the information-only criteria will be obtained through vendor outreach (websites, specification sheets and direct contact) and included in the report as available but will not be used to assess the products. Table 4-1 below summarizes the focus group's recommendations on which method(s) each evaluation criterion should be assessed.

Table 4-1 Evaluation Criteria Assessment Recommendations

Category	Evaluation Criterion	Operational	Specifications	Information
Capability	Health status alerting	✓	✓	
	Physiological measures		✓	
	Remote sensor platform		✓	
	Data privacy		✓	
	Data sharing		✓	
	Profiles or baselines	✓	✓	
	Location services			✓
Usability	Accuracy	✓		
	Battery life		✓	
	Comfortable fit	✓	✓	
	Command interface	✓	✓	
	Ease of donning and activation	✓		
	Compatibility with PPE	✓	✓	
	Wearer interface	✓	✓	

Category	Evaluation Criterion	Operational	Specifications	Information
Deployability	Scalability	✓	✓	
	Software compatibility		✓	
	Third-party software integration		✓	
Maintainability	Cleaning/decontamination		✓	
	Durability	✓	✓	
	Battery type	✓	✓	
	Customer support		✓	
	In-house maintenance		✓	
Affordability	Additional and reoccurring costs			✓
	Contract listing			✓
	List price			✓

4.2 RECOMMENDATIONS ON ASSESSMENT ACTIVITIES

The focus group provided suggestions and recommendations for hands-on operational assessment activities to be performed by first responder participants during the assessment. The focus group identified several activities that reflect frequently encountered occupational scenarios and how physiological monitoring systems can be used during the activities. Participants recommended incorporating these activities into the test plan.

NUSTL will consider all the information provided during the focus group to identify the most suitable assessment activities.

4.2.1 SYSTEM OPERATION IN MULTIPLE ENVIRONMENTS

The focus group recommended that the operational assessment provide participants with opportunities to analyze the system in use in multiple environments, including:

- Live fire burn buildings
- High-rise buildings
- Underground
- Urban
- Suburban

- Wildland
- Multiple types of construction (e.g., Type 1, wood frame, concrete, steel)

Examples of evaluation criteria that could be assessed in these environments include health status alerting, remote sensor platform, accuracy, command interface, wearer interface, and scalability.

NUSTL will identify a venue, or multiple venues, with features to best assess the criteria in multiple environments.

4.2.2 DONNING AND DOFFING SENSOR WITH UNIFORMS AND PPE

The focus group recommended that operational assessment scenarios provide participants with opportunities to don and doff the sensors with various types of PPE, including but not limited to:

- Bunker gear
- Standard turnout gear
- Self-contained breathing apparatus (SCBA)
- Level A HAZMAT gear

In addition to donning and doffing the physiological monitoring system while wearing various uniforms or PPE, participants recommended completing different physical training activities wearing different uniforms or PPE. To better understand usability and capability criteria, participants would like to wear the sensor with an assortment of gear while completing assigned tasks and activities. For example, a response incident does not always require use of an SCBA; similarly, strenuous training activities may be completed in bunker gear rather than full turnout gear. The recommended physical training activities appear below in 4.2.3. “Physical Training Exercises.”

Examples of evaluation criteria that could be assessed during this activity include comfortable fit, ease of donning and activation, compatibility with PPE, and durability.

4.2.3 PHYSICAL TRAINING EXERCISES

The focus group suggested that operational assessment activities should include a variety of physical training exercises that reflect or simulate activities regularly completed by emergency responders. Focus group participants suggested that these activities should encompass the largest portion of the assessment.

Suggested activities include climbing a stair, dragging a hose, carrying equipment, raising and extending a ladder, making a forcible entry, breaching and pulling a ceiling, and conducting some form of heavy weight activity (e.g., wielding a sledgehammer) as well as walking, running and crawling—activities similar to those required to complete the Candidate Physical Ability Test (CPAT). These activities should be completed wearing different PPE and uniforms, as referenced in 4.2.2. “Donning and Doffing Sensor with Uniforms and PPE.”

Examples of evaluation criteria that could be assessed during this activity include health status alerting, profiles or baselines, accuracy, comfortable fit, ease of donning and activation, compatibility with PPE, wearer interface, and durability,

4.2.4 DURABILITY ACTIVITIES

The focus group suggested that the operational assessment include assessing the systems' durability, including the systems' use in water or rain, shock resistance while using heavy materials, use in extreme temperatures (e.g., in a burn building or in high heat/humid environments) and the system's ability to withstand decontamination or cleaning procedures.

Examples of evaluation criteria that could be assessed during this activity include accuracy, comfortable fit, compatibility with PPE, and durability.

4.2.5 24-HOUR SYSTEM USE

The focus group suggested that an operational assessment should involve 24-hour monitoring of a system and participant, in order to evaluate the different systems' capability to monitor – when applicable – sleep, sleep to active status, and active training or simulated operational activities as referenced in 4.2.3. "Physical Training Exercises."

Examples of evaluation criteria that could be assessed through this activity include physiological measures, health status alerting, and comfortable fit.

4.2.6 COMMAND INTERFACE/HEALTH STATUS ALERTING

The focus group recommended that operational assessment activities include evaluating the command interface and health status alerting for out-of-tolerance threshold values. Participants would like to evaluate setting baseline and individual values with the software platform. Participants would also like to see systems' configurable notifications and alerts for out-of-tolerance threshold values. Evaluating the command interface and health status alerting should encompass a large portion of the assessment evaluation activities and can be conducted simultaneously with 4.2.3. "Physical Training Exercises."

Examples of evaluation criteria that could be assessed in this activity include command interface, health status alerting, profiles or baselines, and scalability.

4.3 VENUE RECOMMENDATIONS

The focus group also provided recommendations on potential assessment venues. The participants noted that many fire department training facilities would meet most, if not all, the facility requirements documented in the focus group's recommended assessment scenarios. However, the following facilities were suggested by name as possibly meeting all assessment scenario requirements:

- Arlington County, VA Training Academy
- Barrow County, GA Training Academy

- Frederick County, MD Public Safety Training Facility
- Illinois Fire Service Institute

One participant mentioned that various firefighter training centers in southern California could be considered as well.

NUSTL will consider all the information provided during the focus group to identify a venue most suitable for the assessment.

4.4 PRODUCT SELECTION RECOMMENDATIONS

NUSTL asked the focus group participants to provide recommendations of physiological monitoring systems for inclusion in the assessment. Members of the group mentioned only one product for possible inclusion by name: FireHUD Inc.'s BioTrac. The participants had knowledge or experience with very few products on the market, so rather than name other specific products for assessment, they considered features that would be desirable for the assessed products to offer.

For factors to consider, the participants thought that the products selected for the assessment should be inclusive of multiple form factors (for example, rings, wrist or arm bands, chest bands, patches, and sensors integrated into clothing) rather than focus on one form factor. Focus group participants reiterated that the evaluation criteria they had identified for the assessment should also be used to guide product selection.

NUSTL will consider all the information provided during the focus group to identify products that would be most suitable for the assessment.

5.0 FUTURE ACTIONS

The focus group's recommendations will be used to guide the development of the "Physiological Monitoring System Assessment Plan" and the selection of products to evaluate in the assessment. Once the assessment is complete, the results will be available on the DHS website in the SAVER Document Library.

6.0 SUMMARY

A focus group of nine first responders with experience using physiological monitoring systems identified twenty-five evaluation criteria on which physiological monitoring systems should be evaluated. The project team developed evaluation criterion definitions and assigned each criterion to one of the five SAVER categories —capability, usability, deployability, maintainability, and affordability; the participants reviewed and finalized these. The focus group participants then assigned a numerical weight to each evaluation criteria, ranking the importance of that criterion on a one to five scale. Each SAVER assessment category was then given a weight using a percentage scale that summed to 100 percent. These weighting and ranking values will be used to calculate the overall product scores and assessment category scores that will be determined through the assessment.

After identifying, defining, categorizing, and prioritizing the evaluation criteria, then ranking the relative importance of the five SAVER categories, the focus group provided recommendations to be considered for assessment methods. They recommended six hands-on activities, four possible venues, and desirable features to consider in product selection.

All information gathered during the focus group will be used to develop test plans for a SAVER assessment led by NUSTL.

7.0 ACKNOWLEDGEMENTS

NUSTL offers its thanks to the focus group participants for their valuable time and expertise. Their insights and recommendations will guide the planning and execution of the physiological monitoring systems assessment as well as future SAVER projects. Appreciation is also extended to the home jurisdictions of the participants for allowing them to participate in the focus group. NUSTL also acknowledges the support provided by S&T's OpEx program in planning and facilitating the focus group.