In-Suit Communications Equipment

Focus Group Report

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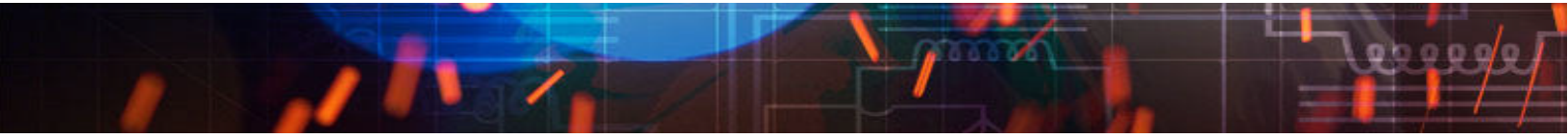

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FOREWORD

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) National Urban Security Technology Laboratory (NUSTL) of DHS, SAVER 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 mission includes:

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

SAVER 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.

NUSTL manages SAVER and is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, coordinating with other organizations and ensuring flexibility and responsiveness to first responder requirements.

NUSTL provides expertise and analysis on a wide range of key subject areas, including chemical, biological, radiological, nuclear, and explosive weapons detection; emergency response and recovery; and related equipment, instrumentation, and technologies. To support this tasking, NUSTL, in collaboration with the U.S. Department of Energy (DOE) Pacific Northwest National Laboratory (PNNL), will conduct a comparative assessment of in-suit communications (ISC) equipment to provide emergency responders with reference information on currently available technologies. ISC equipment falls under AEL reference number 06CP-03-PRAC titled, "Portable Radio Accessories." As a part of this 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 ISC equipment 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

In-suit communication (ISC) equipment are radio accessories that enable emergency responders to effectively communicate when wearing encapsulated or partially encapsulated personal protective equipment and a self-contained breathing apparatus, air-purifying respirator or powered air-purifying respirator. ISC equipment enables communication in high noise or high background audio environments. ISC equipment falls under the Authorized Equipment List reference number 06CP-03-PRAC titled "Portable Radio Accessories."

Through its System Assessment and Validation for Emergency Responders (SAVER) Program, the National Urban Security Technology Laboratory (NUSTL) will conduct a comparative assessment of ISC equipment 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 March 2019 with the primary objectives of recommending evaluation criteria, product selection criteria, products and possible scenarios for the assessment of ISC equipment. These recommendations were gathered from a focus group consisting of eight emergency responders from various jurisdictions and are documented in this report.

The U.S. Department of Energy (DOE) Pacific Northwest National Laboratory (PNNL) supported planning and facilitation of the focus group and will further support the SAVER assessment of in-suit communications equipment.

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1.0 INTRODUCTION

In-suit communications (ISC) equipment are radio accessories that enable emergency responders to effectively communicate when wearing encapsulated or partially encapsulated personal protective equipment (PPE) and a self-contained breathing apparatus (SCBA), air-purifying respirator or powered air-purifying respirator. These accessories are extensions of responders' existing portable two-way radios and include microphones, headsets, earpieces and activation accessories such as push-to-talk or hands-free voice-operated exchange. ISC equipment enables communication in high noise or high background audio environments. In March 2019, the National Urban Security Technology Laboratory's (NUSTL's) System Assessment and Validation for Emergency Responders (SAVER) Program conducted a focus group on ISC equipment. The purpose was to obtain information on ISC equipment that will be useful to make operational and procurement decisions, including recommendations on evaluation criteria, product selection criteria, product types and potential scenarios for a future operational assessment of ISC equipment. The U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) supported the planning and facilitation of the focus group and will support the future operational assessment.

1.1 Participant Information

Eight emergency responders from various jurisdictions with at least 10 years of experience using ISC equipment were selected to participate in the focus group. All participants were firefighters with hazardous materials (HAZMAT) experience.

Table 1-1 Focus Group Participant Demographics

Practitioner	Discipline	Years of Experience	State
A	Firefighter	36	Illinois
	HAZMAT	22	
	Health/Safety	1	
B	Firefighter	35	Florida
	HAZMAT	32	
	Health/Safety	20	
C	Firefighter	30	Maryland
	HAZMAT	26	
	Rescue Services	15	
	Bomb Technician	10	
D	Firefighter	30	Washington
	HAZMAT	24	
E	Firefighter	24	Washington
	HAZMAT	22	
F	Firefighter	23	New York
	HAZMAT	17	
	Emergency Room Nurse	16	
G	Firefighter	15	Maryland
	HAZMAT	15	
H	Firefighter	13	Colorado
	HAZMAT	11	

2.0 FOCUS GROUP METHODOLOGY

The focus group opened with overviews of NUSTL, PNNL and the SAVER Program, a high level description of various types of in-suit communications equipment and the focus group's goals and objectives of determining evaluation criteria and other recommendations to guide the development of an assessment plan. Once the background material was reviewed, a facilitator led focus group discussions that resulted in recommendations in five areas relevant to ISC equipment:

1. Evaluation criteria–Criteria that products will be evaluated against during the assessment. The results of the assessment are important to consider when making acquisition or operational decisions.
2. Assessment scenarios–Operational scenarios in which the products should be assessed to evaluate their performance.
3. Product selection criteria–General criteria that identify specifications, attributes, or characteristics a product should possess to be considered for inclusion in the assessment.
4. Products preferences–Products and vendors that are relevant to and preferred by the emergency responder community and should be candidates for inclusion in the comparative assessment.
5. Laboratory testing–Laboratory performance tests and research to be conducted by PNNL to better understand parameters of some evaluation criteria identified by first responders.

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

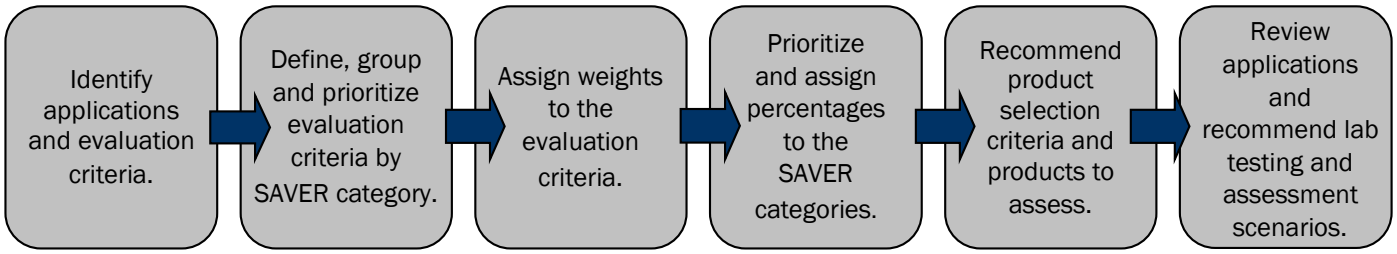

Figure 2-1 Focus Group Process

Focus group participants first identified applications in which ISC equipment are commonly used. Next, participants identified and defined evaluation criteria that were then grouped and prioritized in the five SAVER categories: affordability, capability, deployability, maintainability and usability. 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 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.

Once the evaluation criteria were prioritized 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 or according to vendor-provided specifications. Next, considering the evaluation criteria in each category, the focus group participants ranked the SAVER categories in order of importance. Based on the ranking, a percentage was assigned to each category to represent its level of importance.

After rating the SAVER categories, focus group participants identified product selection criteria. The focus group also identified products that should be considered for the assessment and products that were not compatible with certain types of PPE. Lastly, the focus group participants reviewed the applications identified at the beginning of the focus group session and recommended laboratory testing and operational scenarios for the assessment.

The laboratory testing of ISC equipment, to be conducted by PNNL, will serve to gain a better understanding of the products and their features to potentially aid in the selection of products for the assessment. Insights from PNNL laboratory testing will be used to guide the development of an assessment plan. The specific recommendations for laboratory testing and operational scenarios are captured in Section 4.3.

3.0 FOCUS GROUP RECOMMENDATIONS

3.1 Evaluation Criteria

The focus group identified 27 evaluation criteria and concluded that usability was the most important SAVER category for ISC equipment, followed by capability, deployability, maintainability and affordability, respectively. Table 3-1 summarizes the category weights, the evaluation criteria and the evaluation criteria weights.

Table 3-1 Evaluation Criteria

SAVER CATEGORIES				
Usability	**Capability**	**Deployability**	**Maintainability**	**Affordability**
Overall Weight 40%	Overall Weight 35%	Overall Weight 10%	Overall Weight 10%	Overall Weight 5%
Evaluation Criteria				
Ability to Remain in Proper Position Weight: 5	Clarity of System Weight: 5	Ease of Donning/Doffing Weight: 4	Parts Availability Weight: 4	Warranty/Tech Support Weight: 3
Adjustable Fit/Comfort Weight: 4	Durability Weight:4	Assembly/ Deployment Tools Accessibility Weight: 3	Maintenance Tools Accessibility Weight: 3	Accessory Option Costs Weight: 2
Effect on Mobility Weight: 4	Team Centered Full Duplex Weight: 4	Setup Time Weight: 3	Cleaning/ Sanitation Weight: 3	Replacement Part Costs Weight: 2
Overall Ease of Operation Weight: 4	Effect on Non-Radio Communications Weight: 3	Special Storage Needs Weight: 1	Component Replaceability Weight: 3	System Cost Weight: 2
Location Flexibility and Size of PTT Button Weight: 3	Interoperability with Different Facemasks Weight: 2		Ease of Replacing/ Recharging Power Supply Weight: 3	Power Supply/ Source Costs Weight: 1
Specialized Training Required Weight: 2	Volume Controls Weight: 1		Tech Training for Personnel Weight: 2	

3.1.1 USABILITY

Six usability criteria were identified and defined by the focus group:

- **Ability to Remain in Proper Position** refers to the ability of the product to remain properly mounted and positioned while in use without having to be readjusted.
- **Adjustable Fit/Comfort** refers to built-in size adjustment mechanisms and the overall comfort of wearing the product while in use.
- **Effect on Mobility** refers to whether or not system components, such as cables, restrict movement while in use or require careful stowage to prevent restriction of movement.
- **Overall Ease of Operation** refers to how intuitive the product is to use.
- **Location Flexibility and Size of PTT Button** refers to whether the push-to-talk (PTT) button can be mounted in an easily accessible position on the wearer's body, whether the PTT button can be adjusted as necessary and whether the size of the button makes it easy to use.
- **Specialized Training Required** refers to any training that would be required before the product could be used in the field. A product that requires a specialized technician or extensive training to use would receive a lower score for this criterion.

3.1.2 CAPABILITY

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

- **Clarity of System** refers to the audio and vocal clarity of transmitted and received communications in environments of varying noise levels and noise types (e.g., fire alarms, hissing, etc.).
- **Durability** refers to the overall durability of the product. This includes ruggedness, strain relief on cables and connectors, capability to withstand repeated usages and moisture resistance.
- **Team Centered Full Duplex** is a feature that allows field responders to talk to each other via radio simultaneously without using an activation mechanism (PTT or VOX). When this feature is activated, an activation mechanism may still be necessary to communicate with an incident commander (IC). This evaluation criterion refers to whether or not a product has this feature and, if so, how effective it is.
- **Effect on Non-Radio Communications** refers to any effects the product or the ISC equipment has on the ability of responders to hear verbal face-to-face communications (as opposed to radio transmissions) while wearing the product.
- **Interoperability with Different Facemasks** refers to whether or not the product can be integrated or used with different facemask models.
- **Volume Controls** refers to whether or not a product has volume control features and, if so, how effective they are, what their range of adjustment is and how easy they are to use.

3.1.3 DEPLOYABILITY

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

- **Ease of Donning/Doffing** refers to how easy or difficult it is for responders to don or doff PPE (e.g., suit, facemask) without affecting the ISC equipment placement on the body in preparation for field use. Factors that may influence the score of this criterion include whether or not assistance is required, the time and sequence to don and doff and the ability to make comfort and fit adjustments to PPE while wearing ISC equipment.
- **Assembly/Deployment Tools Accessibility** refers to the availability of these tools. A product that requires no tools or that requires standard readily accessible tools (e.g., a flathead screwdriver) is preferable to a product that requires a specialized tool unique to the product manufacturer.
- **Setup Time** refers to how quickly the product is ready for field use. This includes the time it takes to change the size or fit of the product.
- **Special Storage Needs** refers to any specific cases that might be needed for transport and storage when not in use. Other storage requirements may include temperature and humidity range, battery removal and wire and cable storage.

3.1.4 MAINTAINABILITY

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

- **Parts Availability** refers to which parts are replaceable and how readily available replacement parts are.
- **Maintenance Tools Accessibility** refers to the level of availability of these tools. A product that requires no tools or requires standard readily accessible tools (e.g., a flathead screwdriver) is preferable to a product that requires a specialized tool unique to the product manufacturer.
- **Cleaning/Sanitation** refers to how easy or difficult it is to clean or sanitize the product after field use, cleaning solutions required, cleaning precautions and multi-user considerations. Factors that may influence this criterion include the shape and material of the product.
- **Component Replaceability** refers to whether or not individual system components (as opposed to the entire system) can be replaced.
- **Ease of Replacing/Recharging Power Supply** refers to how easy it is to replace or recharge the batteries of the product. Field replaceability may influence this criterion.
- **Tech Training for Personnel** refers to the necessity and availability of training on how to maintain the product and whether or not a specialized technician is required for maintenance. A product that requires specialized training for maintenance would receive a lower score for this criterion.

3.1.5 AFFORDABILITY

Five affordability criteria were identified and defined by the focus group.

- **Warranty/Tech Support** refers to warranty and service contract costs, the length of the warranty, warranty options and any technical support available.
- **Accessory Option Costs** refers to the cost of accessories and consumables (e.g., replaceable earpieces) that can be used with the product.
- **Replacement Part Costs** refers to the cost of replacement parts.
- **System Cost** refers to the list price of the product. Any purchasing discounts will not be taken into account when evaluating this criterion.
- **Power Supply/Source Costs** refers to the cost of the power supply, including over the counter batteries and proprietary batteries.

3.2 OTHER PRODUCT CONSIDERATIONS

In addition to the 27 evaluation criteria that will be used during the assessment, the focus group identified seven other features that should be considered when purchasing new ISC equipment. These features, which will not be evaluated during the assessment, are listed below.

- **Battery Life** refers to the duration of a full battery charge.
- **Battery Life Indicator** refers to any mechanisms or displays that inform the wearer of the remaining battery life of the product while in use.
- **Bluetooth** refers to whether or not the product can be paired with a radio over a Bluetooth connection.
- **Intrinsic Safety** refers to the ability to use the product in potentially explosive environments.
- **Over-the-Counter Battery or Battery Options** refers to the power source options that are available for the product. A product that has multiple options, such as over the counter batteries (AA, AAA, etc.) and not just proprietary batteries developed by the manufacturer, would be considered a more desirable product.
- **Voice Activation (VOX) Sensitivity/Capability** refers to whether or not a product has a voice activation feature (as opposed to using a PTT activation mechanism) and if so, the ability to adjust the sensitivity to accommodate use in certain operational environments (e.g., high noise).
- **Voice Amplification** refers to the presence of external speakers that amplify transmitted voice communications without requiring the use of a radio.

4.0 ASSESSMENT RECOMMENDATIONS

After identifying, defining, and weighting evaluation criteria, focus group participants offered recommendations to help guide the development of an assessment plan. The assessment will include several ISC products and will consist of various operational scenarios designed to facilitate evaluation of the criteria defined by the focus group. Each ISC product included in the assessment will receive a score that emergency response agencies can use to help guide purchasing and acquisition decisions.

4.1 Product Selection Recommendations for the Assessment

The focus group identified eight product selection considerations that may be used to guide whether a product is considered for use in the ISC equipment assessment. Table 4-1 summarizes the product selection criteria in priority order.

Table 4-1 Product Selection Considerations

Product Selection Consideration	Description
Compatible With Fully Encapsulated PPE	The ISC equipment must be able to fit inside fully encapsulated PPE and not interfere with SCBA facemask.
Intrinsic Safety for HAZMAT Operations	The ISC equipment must have an intrinsic safety applicable to HAZMAT operations, including ingress protection (IP) ratings and the ability to use the product in potentially explosive environments. Many focus group participants noted that HAZMAT teams often receive “hand me down” communications equipment from general firefighting teams.
Variety of Product Categories	Two to three products in each of the following categories should be assessed: facemask-mounted ISC systems, throat-worn ISC systems, bone conduction ISC systems and in-ear ISC systems.
Universal Fit	Products that have a universal or adjustable fit are preferable over products that require a specially molded earpiece. This consideration only applies to products that will be included in the assessment.
Team Centered Full Duplex	This is a potentially useful feature, but some products do not have this option. This is described in Section 3.1.2.
Bluetooth	Products may have the ability to connect to radios via Bluetooth, although most focus group participants had more confidence in using wired connections. This is described in Section 3.2.
Multiple Battery Options	The product may be powered by multiple sources, including the radio. This is described in Section 3.2.
Voice Amplifier	The product may have an external facemask mounted speaker. This is described in Section 3.2.
VOX Capability	The product may have a voice activation feature. This is described in Section 3.2.

In addition to these product selection considerations, the focus group recommended seven products from manufacturers 3M (Scott), Savox Communications, CeoTronics, MSA and CavCom.

4.2 Evaluation Criteria Recommendations for the Assessment

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 criteria may be assessed both operationally and according to vendor-provided specifications. Table 4-2 shows the focus group's assessment recommendations for the evaluation criteria.

Table 4-2 Evaluation Criteria Assessment Recommendations

Category	Criteria	Operational	Specification
Usability	Ability to Remain in Proper Position	✓	
	Adjustable Fit/Comfort	✓	✓
	Effect on Mobility	✓	
	Overall Ease of Operation	✓	
	Location Flexibility and Size of PTT Button	✓	✓
	Specialized Training Required		✓
Capability	Clarity of System	✓	✓
	Durability	✓	✓
	Team Centered Full Duplex	✓	✓
	Effect on Non-Radio Communications	✓	
	Interoperability with Different Facemasks	✓	✓
	Volume Controls	✓	✓
Deployability	Ease of Donning/Doffing	✓	
	Assembly/Deployment Tools Accessibility		✓
	Setup Time	✓	
	Special Storage Needs		✓
Maintainability	Parts Availability		✓
	Maintenance Tools Accessibility		✓
	Cleaning/Sanitation	✓	✓
	Component Replaceability		✓
	Ease of Replacing/Recharging Power Supply	✓	
	Tech Training For Personnel		✓
Affordability	Warranty/Tech Support		✓
	Cost of Accessory Options		✓
	Cost of Replacement Parts		✓
	System Cost		✓
	Power Supply/Source Costs		✓

4.3 Operational Scenario Recommendations for the Assessment

4.3.1 Building Entry

During this scenario, two responders in full PPE will enter a simulated HAZMAT incident scene, and a third responder will act as an IC. The two responders in full PPE will use ISC equipment to communicate with each other and the IC. While in the building, responders will be required to either carry various objects throughout the scene or read placards/labels placed throughout the building. This scenario will allow participants to evaluate criteria such as Overall Ease of Operation and Team Centered Full Duplex.

4.3.2 Physical Activity

While wearing ISC equipment, responders will perform physical activities, such as climbing up and down a flight of stairs. This scenario will allow participants to evaluate criteria such as Ability to Remain in Proper Position and Adjustable Fit/Comfort.

4.3.3 Noise Levels

In this scenario, responders will communicate with each other in an environment with very little background noise, an environment with loud noises and an environment with a medium noise level. This will allow participants to evaluate criteria such as Clarity of System and Effect on Non-Radio Communications.

4.3.4 Laboratory Testing

In addition to the three assessment scenarios described above, PNNL will also conduct laboratory testing on the equipment included in the assessment. The testing will serve to develop a better understanding of product features and to potentially aid in the selection of products to be included in the assessment. Results from this testing will be used to guide assessment planning and execution. Any technical literature on the products provided by vendors or manufacturers will be consulted to plan laboratory testing.

One suggested goal of the laboratory testing is to identify which products include a team centered, full duplex feature and to develop a better awareness of how this feature can be used to support HAZMAT operations.

Another recommendation for laboratory testing was to analyze signal amplifiers that may be used in the transmission or reception of the products, and to conduct objective speech intelligibility measurements (which corresponds to the evaluation criterion “Clarity of System”). This will be done to create standardized measurements and to avoid discrepancies in units that may be used across different technology vendors.

Additional scenarios will be developed with emergency responder input to ensure key criteria identified in Table 4-2 are evaluated during the assessment.

4.4 Venue Information

Following the conclusion of the focus group, NUSTL and PNNL participated in a site visit of the Seattle Joint Training Facility, which will serve as the venue for the assessment. Buildings and facilities toured included the following:

- **The Classroom Training Building** consists of multiple classrooms. This building will be used for presentations by technology developers and for score reviews following the assessment. This building also includes an outdoor staircase to small basement storage rooms.
- **The Apparatus Building** is used as an equipment staging building. This building also has a classroom that can be used for presentations.
- **The Burn Building** simulates a two-story home in which recruits are trained on building entry procedures. This building could be used for building entry assessment scenarios.
- **The High Rise Building** is similar to the Burn Building but simulates a multi-story building.
- **The Pavilion** is an open structure that can be used as a staging area or a rest area during the assessment.
- **Tunnels** are used to simulate a subterranean environment for training purposes.

5.0 FUTURE ACTIONS

The focus group recommendations will be used to guide the development of an ISC equipment laboratory test plan, collection of additional product specification and use information, an ISC equipment assessment plan and the selection of products to evaluate in the assessment. Once the laboratory test and assessment are complete, the results will be available in the SAVER Website.

6.0 CONCLUSION

The focus group, which consisted of eight emergency responders with at least 10 years in firefighting and HAZMAT disciplines, identified 27 evaluation criteria for ISC equipment that will be used when scoring products during the assessment. The heaviest weighted SAVER categories were usability (weight of 40 percent) and capability (weight of 35 percent). The five heaviest weighted evaluation criteria were:

- Ability to Remain in Proper Position
- Clarity of System
- Adjustable Fit/Comfort
- Overall Ease of Operation
- Effect on Mobility.

These five criteria will contribute to 44 percent of a product's score. In addition to the 27 evaluation criteria, seven product considerations were also identified, which should be used to guide purchasing decisions.

After identifying, defining and prioritizing the evaluation criteria, the focus group provided recommendations for product selection and test cases to be included during the assessment.

All information gathered during the focus group and site visit will be used to develop test plans for laboratory testing led by PNNL and a SAVER assessment led by NUSTL.

7.0 ACKNOWLEDGEMENTS

NUSTL thanks the focus group participants for their valuable time and expertise. Their insights and recommendations will guide the planning and execution of the 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 PNNL in planning and facilitating the focus group. We would also like to thank the Seattle Fire Department and the City of Seattle Joint Training Facility for hosting the focus group.