In-Suit Communications Equipment

Assessment 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 DHS Science and Technology Directorate (S&T), 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 S&T's 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. For this SAVER project, NUSTL, with the support of the U.S. Department of Energy (DOE) Pacific Northwest National Laboratory (PNNL), conducted a comparative assessment of In-Suit Communications (ISC) equipment to provide emergency responders with reference information on currently available technologies. ISC equipment falls under the AEL reference number 06CP-03-PRAC, titled Portable Radio Accessories.

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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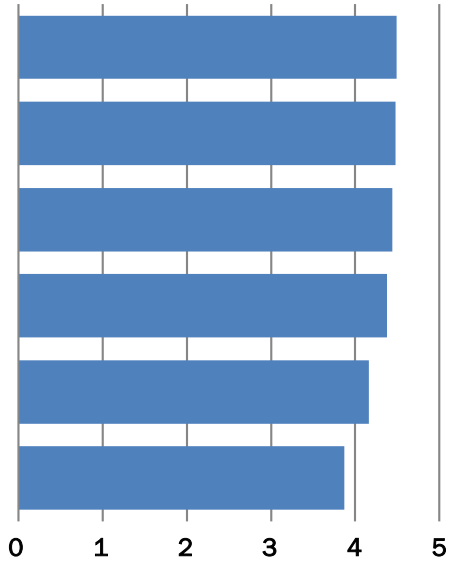
EXECUTIVE SUMMARY

In August 2019, the U.S. Department of Homeland Security Science and Technology Directorate National Urban Security Technology Laboratory's System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally-oriented assessment of In-Suit Communications (ISC) equipment with the support of the U.S. Department of Energy's Pacific Northwest National Laboratory.

Six ISC products were assessed by six emergency responders. The criteria and scenarios used in this assessment were derived from the recommendations of a focus group of emergency responders with experience using ISC equipment. The focus group identified 27 evaluation criteria across five SAVER categories; however, the assessment only addressed 21 evaluation criteria in four SAVER categories: capability, deployability, maintainability and usability. The criterion team centered full duplex (under the capability category) was not assessed as only one product (the Dräger FPS-COM 7000) was equipped with this feature. Additionally, none of the five evaluation criteria under the affordability category were assessed, as the scores for these products would largely depend on the budgets of the evaluators' agencies. The overall results of the assessment are highlighted in the following table.

Product	Overall Score	Overall	Usability	Capability	Deployability	Maintainability
CeoTronics CT-SkullMike		**4.49**	4.46	4.53	4.57	4.36
TEA Headsets IC Pro		**4.48**	4.41	4.57	4.66	4.23
CavCom Talk Through Your Ears		**4.44**	4.31	4.55	4.55	4.38
CeoTronics CT-ClipCom EarMike		**4.38**	4.41	4.31	4.57	4.27
Dräger FPS-COM 7000		**4.16**	4.47	3.94	3.95	4.00
CeoTronics CT-ThroatMike		**3.87**	3.91	3.84	4.23	3.44



Key: 1 (least favorable) to 5 (most favorable)

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1.0 INTRODUCTION

In-Suit Communications (ISC) equipment allows emergency responders to more easily use push-to-talk (PTT) tactical radios under fully encapsulated personal protective equipment (PPE). ISC equipment can be used with a self-contained breathing apparatus (SCBA), air-purifying respirator (APR) or powered APR.

In August 2019, the System Assessment and Validation for Emergency Responders (SAVER) Program conducted an operationally-oriented assessment of ISC equipment for hazardous material (HAZMAT) technicians at the City of Seattle Joint Training Facility in Seattle, Washington. The U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) National Urban Security Technology Laboratory (NUSTL) led the assessment and coordinated data collection. The U.S. Department of Energy (DOE) Pacific Northwest National Laboratory (PNNL) provided general exercise support and subject matter expertise during the assessment.

The purpose of this assessment was to obtain information on ISC equipment that will be useful in making operational and procurement decisions. The activities associated with this assessment were based on recommendations from a focus group of emergency responders with experience using ISC equipment that was conducted in March 2019.

1.1 Evaluator Information

Six evaluators assessed the ISC products following assessment procedures developed by NUSTL. Evaluators were selected for the assessment based on their respective responder discipline, geographic location and professional experience, as well as their operational experience using ISC equipment. Table 1-1 lists evaluator information.

Table 1-1 Evaluator Demographics

Evaluator	Years	State
Firefighter Hazardous Materials (HAZMAT) Emergency Medical Services (EMS)	>35 20 to 25 <5	IL
Firefighter/HAZMAT EMS	30 to 35 15 to 20	FL FL
Firefighter/HAZMAT	20 to 25	WA
Firefighter HAZMAT/Emergency Room Nurse	20 to 25 15 to 20	NY NY
Military HAZMAT/EMS	10 to 15	OR
Firefighter/HAZMAT	1 to 5	WA

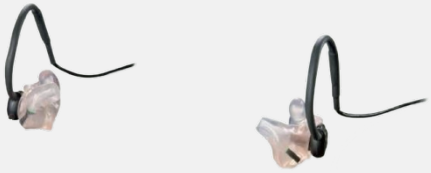
1.2 Assessment Products

Six ISC products were selected and acquired for the assessment based on market research and the focus group's recommendations. Final selection by NUSTL was based on how well each product met the product selection criteria identified by the focus group:

- **Compatible with fully encapsulated PPE.** The ISC equipment must be able to fit inside fully encapsulated PPE and not interfere with SCBA masks. Although ISC equipment can be compatible with APRs and powered APRs, only SCBAs were used in the assessment.
- **Applicable to HAZMAT operations.** The ISC equipment must have an intrinsic safety applicable to HAZMAT operations, including ingress protection 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.** Focus group participants suggested evaluating two or three products in each of the following categories: facemask-mounted systems, throat-worn systems, bone conduction systems and in-ear systems.
- **Universal fit.** Products that require an earpiece molded specifically to the user will not be included in the assessment. Products with a universal or adjustable fit are preferred.
- **Team centered full duplex.** Products with this feature are preferred over those without the feature; however, ISC products without a team centered full duplex feature were not excluded from the assessment. This feature is further described in Appendix A of this report.
- **Multiple battery options available.** Products may be powered by multiple sources. This includes over-the-counter batteries (AA, AAA, etc.) or proprietary power sources.

The products selected for assessment met all product selection criteria. Table 1-2 presents the products that were assessed.

Table 1-2 Assessed Products

Vendor	Product	Category	Product Image
CavCom	Talk Through Your Ears	In-Ear	
CeoTronics	CT-ClipCom EarMike	In-Ear	
CeoTronics	CT-SkullMike	Bone Conduction	
CeoTronics	CT-ThroatMike Comfort	Throat-Worn	
Dräger	FPS-COM 7000	Facemask-Mounted	
TEA Headsets	IC Pro	In-Ear	

2.0 EVALUATION CRITERIA

The SAVER Program assesses products based on criteria in five established categories:

- **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.

The focus group of emergency responders met in March 2019 and identified 27 evaluation criteria within five SAVER categories noted above. The Focus Group participants assigned a weight for each criterion's level of importance on a scale of 1 to 5, with 1 being somewhat important and 5 being of utmost importance. The SAVER categories were assigned a percentage to represent each category's importance relative to the other categories.

During the assessment, products were assessed against 21 evaluation criteria. Affordability was not assessed because the scores received are largely dependent on the budgets of the evaluators' agencies. Since affordability (originally weighted at 5 percent) was not assessed, the overall weight of capability was increased from 35 to 40 percent. Additionally, the criterion team centered full duplex was not evaluated as only one product included in the assessment had this feature. Table 2-1 presents the evaluation criteria and their associated weights as well as the percentages assigned to the SAVER categories. Refer to Appendix A for evaluation criteria definitions.

Table 2-1 Evaluation Criteria

SAVER CATEGORIES				
Usability	**Capability**	**Deployability**	**Maintainability**	**Affordability**
Overall Weight 40%	Overall Weight 40%	Overall Weight 10%	Overall Weight 10%	Not Assessed
EVALUATION CRITERIA				
Ability to Remain in Proper Position	**Clarity of System**	**Ease of Donning/Doffing**	**Parts Availability**	**Warranty/Tech Support**
Weight: 5	Weight: 5	Weight: 4	Weight: 4	Not Assessed*
Adjustable Fit/Comfort	**Durability**	**Assembly/ Deployment Tools Accessibility**	**Maintenance Tools Accessibility**	**Accessory Option Costs**
Weight: 4	Weight: 4	Weight: 3	Weight: 3	Not Assessed*
Effect on Mobility	**Team Centered Full Duplex**	**Setup Time**	**Cleaning/Sanitation**	**Replacement Part Costs**
Weight: 4	Not Assessed	Weight: 3	Weight: 3	Not Assessed*
Overall Ease of Operation	Effect on Non-Radio Communications	Special Storage Needs	Component Replaceability	System Cost
Weight: 4	Weight: 3	Weight: 1	Weight: 3	Not Assessed*
Location Flexibility and Size of Push to Talk Button	**Interoperability with Different Facemasks**		**Ease of Replacing/ Recharging Power Supply**	**Power Supply/ Source Costs**
Weight: 3	Weight: 2		Weight: 3	Not Assessed*
Specialized Training Required	**Volume Controls**		**Tech Training for Personnel**	
Weight: 2	Weight: 1		Weight: 2	

*Although Affordability criteria were not assessed, cost information was still gathered and provided in Section 4.0.

3.0 ASSESSMENT METHODOLOGY

The products were assessed over two days. On the first day of the assessment, a subject matter expert (SME) from PNNL and assessment facilitators from NUSTL gave a safety briefing and an overview of the assessment process, procedures and schedule to the evaluators. Each product was then assessed in two phases: (1) specification assessment and (2) operational assessment. Throughout the assessment, evaluators worked in pairs. A NUSTL data collector observed each evaluator pair as they completed the assessment activities.

During the Focus Group, evaluators provided recommendations on which criteria should be evaluated with a specification assessment, which should be evaluated with an operational assessment, and which should be both. These recommendations are provided in Table 3-1. This list does not include the Team Centered Full Duplex criterion nor any Affordability criteria as these were not assessed.

Table 3-1 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	✓	
	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		✓

3.1 Phase I – Specification Assessment

During the specification assessment, evaluators discussed product features and operation with vendor representatives. After the vendor presentation, evaluators assessed each product based on vendor-provided information and specifications.

Evaluation criteria addressed in this phase included the following: specialized training required, assembly/deployment tools accessibility, special storage needs, parts availability, maintenance tools accessibility, component replaceability and tech training for personnel.

Figure 3-1 Specification Assessments

Evaluators and NUSTL Staff Participating in the Specification Assessment for the TEA Headsets IC PRO (Left); Evaluators Testing the Dräger FPS-COM 7000 during the Specification Assessment (Right).

3.2 Phase II – Operational Assessment

During the operational assessment, evaluators assessed each product based on their hands-on experience using the product after becoming familiar with its proper use, capabilities and features. The SME and facilitators assisted the evaluators with product familiarization and evaluators had access to the reference material included with each product. The products were assessed in four scenarios: (1) donning equipment, (2) communications in various noise levels, (3) incident scene operations and (4) doffing equipment. Evaluators used the products one at a time and completed the assessment worksheets for each product before assessing the next product.

3.2.1 Donning Equipment

During this scenario, evaluators donned a radio, the ISC product being assessed, a facemask, an SCBA and a chemical resistant HAZMAT suit.

Evaluation criteria addressed in this scenario included the following: adjustable fit/comfort; overall ease of operation; location flexibility and size of PTT button; durability; interoperability with different facemasks; ease of donning/doffing and setup time.

Figure 3-2 Evaluators Donning ISC Equipment

An Evaluator Positioning the CavCom Talk Through Your Ears (Left); an Evaluator with the CavCom Talk Through Your Ears in Position (Center); NUSTL Staff Zipping an Evaluator's Encapsulated Suit after Donning ISC (Right).

3.2.2 Communications in Various Noise Levels

During this scenario, evaluators communicated with each other using the ISC equipment. Three background noise levels were used: quiet, medium and loud. Prior to the assessment, noise levels were measured with a Quest Model 1800 noise meter.

Quiet background noise consisted only of ambient noise, including some "crackling" of the HAZMAT suits. Quiet noise levels were measured at 55-65 dBA (A-weighted decibels). All members of the assessment team, except for the evaluators, were asked to remain silent during this part of the scenario.

Medium noise levels (measured at 80-85 dBA) were produced by playing music on a smartphone and the assessment team having a general conversation at the same time.

Loud noise levels (measured at 90-100 dBA) were produced by activating a six-tone car alarm within the room. The car alarm operated at full output volume during the test.

Evaluators stood at opposite ends of the relatively unobstructed, concrete-block walled room while conducting this operational scenario. Separation distance between evaluators in this scenario was between 30 and 40 feet. Evaluators either read from a script or had a general conversation while using the ISC equipment.

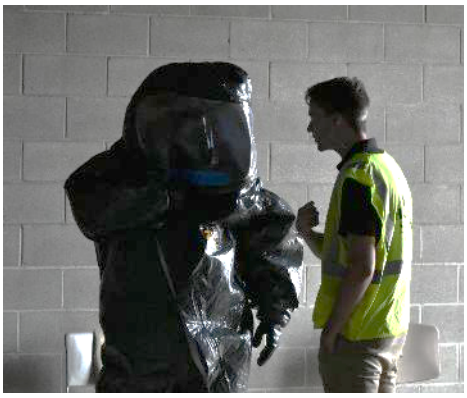


Figure 3-3 Communicating Through Encapsulated Suit

NUSTL Staff Member Attempting to Communicate with an Evaluator Through an Encapsulated Suit During the Communications in Various Noise Levels Scenario

Evaluation criteria addressed in this scenario included the following: overall ease of operation; location flexibility and size of PTT button; clarity of system; effect on non-radio communications and volume controls.

3.2.3 Incident Scene Operations

The incident scene operations scenario entailed evaluators performing a series of tasks while still wearing PPE and the ISC equipment. Tasks included walking through different rooms, climbing stairs, carrying items through a building and reading text from placards to each other. Evaluators performed these tasks while together in the building at the same time. Then one evaluator waited outside of the building while the other evaluator performed the tasks a second time. When possible, evaluators switched positions and the second evaluator waited outside while the first evaluator performed the tasks in the building for a second time.

Evaluation criteria addressed in this scenario included the following: ability to remain in proper position; adjustable fit/comfort; effect on mobility; location flexibility and size of PTT button; overall ease of operation; clarity of system; durability and volume controls.

Figure 3-4 Evaluators Participating in the Operational Assessment
Testing the TEA Headsets IC PRO (Top Left and Bottom Left);
Testing the Dräger FPS-COM 7000 (Top Right and Bottom Right)

3.2.4 Doffing Equipment

During this scenario, evaluators removed their PPE, SCBA, facemask and ISC equipment. Evaluators then reviewed cleaning, sanitation, and power source recharging or replacement procedures with vendor representatives.

Evaluators then filled out a survey on the product with a data collector from the assessment team.

Evaluation criteria addressed in this scenario included the following: overall ease of operation, durability, cleaning/sanitation and ease of replacing/recharging power supply.

Figure 3-5 NUSTL and PNNL Staff Members Assisting Evaluators Doffing Their Encapsulated Suits

3.3 Data Gathering and Analysis

Each NUSTL data collector was issued an assessment workbook that was used to score products with respect to the evaluation criteria listed in Section 2. The workbook contained several statements corresponding to the specific criteria which were evaluated in each assessment scenario. Following each scenario, NUSTL data collectors presented these statements to evaluators, who then provided a score based on the following 1 to 5 scale:

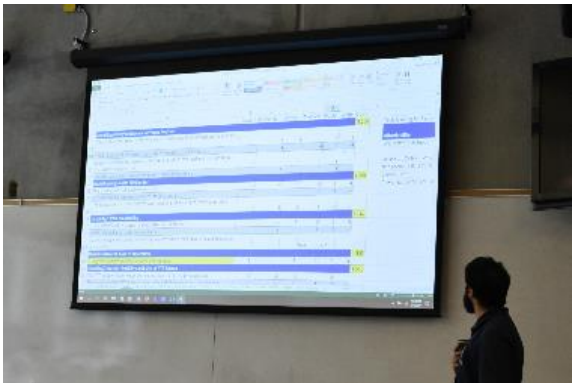


Figure 3-6 NUSTL Test Director Facilitating the Criteria Rating Review Session

1) I strongly disagree with this statement.
2) I disagree with this statement.
3) I somewhat agree with this statement.
4) I agree with this statement.
5) I strongly agree with this statement.

This scale was used to match the language in the assessment workbook. However, these scores correspond to the standard scale that is used for most SAVER Assessments:

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

All scores were then averaged for each evaluation criterion within each scenario. If it was determined that the criterion was not applicable, N/A was selected for a statement.

For example, if an evaluator did not need to readjust the ISC after donning PPE, then the evaluator would respond N/A to a statement about the ease of readjusting the ISC. If the response to a statement was N/A, then the statement was not counted towards the average.

Criteria that were rated multiple times throughout the assessment were assigned final overall ratings by the evaluators. Data collectors on the assessment team captured comments on advantages and disadvantages for the assessed products as well as general comments on the ISC equipment assessment and the assessment process. Once assessment activities were completed, evaluators had an opportunity to review their criteria ratings and comments for all products and make necessary adjustments.

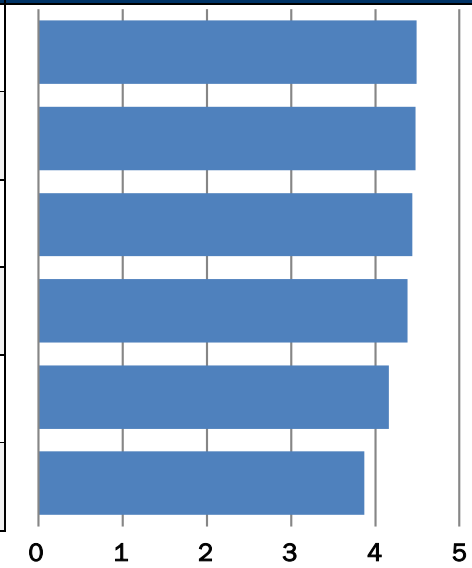
At the conclusion of the assessment activities, an overall assessment score, as well as category scores and criteria scores, were calculated for each product using the formulas referenced in Appendix B. In addition, evaluator comments for each product were reviewed and summarized for this assessment report.

The list of statements corresponding to each evaluation criterion is presented in Appendix C.

4.0 ASSESSMENT RESULTS

The highest score given to one of the assessed products was 4.49, while the lowest score was 3.87. Table 4-1 presents the overall assessment score and category scores for each product. Products are listed in order from highest to lowest overall assessment score throughout this section. Calculation of the overall score uses the raw scores for each category, prior to rounding.

Table 4-1 Assessment Results

Product	Overall Score	Overall	Usability	Capability	Deployability	Maintainability
CeoTronics CT-SkullMike		**4.49**	4.46	4.53	4.57	4.36
TEA Headsets IC Pro		**4.48**	4.41	4.57	4.66	4.23
CavCom Talk Through Your Ears		**4.44**	4.31	4.55	4.55	4.38
CeoTronics CT-ClipCom EarMike		**4.38**	4.41	4.31	4.57	4.27
Dräger FPS-COM 7000		**4.16**	4.47	3.94	3.95	4.00
CeoTronics CT-ThroatMike		**3.87**	3.91	3.84	4.23	3.44

Key: 1 (least favorable) to 5 (most favorable)

Table 4-2 presents the criteria ratings for each product. The ratings are graphically represented by colored and shaded circles. A green, fully shaded circle represents the highest rating. Refer to Appendix A for evaluation criteria definitions. Table 4-3 presents vendor-provided key specifications for the assessed products.

Table 4-2 Criteria Ratings

Key: Lowest Rating → Highest Rating		Products					
Category	Evaluation Criteria	CeoTronics CT-SkullMike	TEA Headsets IC Pro	CavCom Talk Through your Ears	CeoTronics CT-ClipCom EarMike	Dräger FPS-COM 7000	CeoTronics CT-ThroatMike
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	●	◕	●	◕	●	◕
	Effect on Non-Radio Communications	◕	●	◕	●	●	◕
	Interoperability with Different Facemasks	●	●	●	●	○	●
	Volume Control	●	●	●	◕	◕	◑
Deployability	Ease of Donning/Doffing	●	●	●	●	●	◕
	Assembly/Deployability 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	●	◕	●	◕	◕	◕

Table 4-3 Key Specifications

Key Specification	CeoTronics CT-SkullMike	TEA Headsets IC Pro	CavCom Talk Through Your Ears	CeoTronics CT-ClipCom EarMike	Dräger FPS-COM 7000	CeoTronics CT-ThroatMike
MSRP*	$700 - $1,000	$460	$1,225	$900 - $1,200	$2,200	$700 - $900
Warranty Duration*	3 Years	1 Year	1 Year	3 Years	15 Years	3 Years
Category	Bone conduction	In-ear	In-ear	In-ear	Facemask-mounted	Throat-worn
Team Centered Full Duplex	No	No	No	No	Yes	No
Facemask Interoperability	Compatible with multiple facemasks	Compatible with multiple facemasks	Compatible with multiple facemasks	Compatible with multiple facemasks	Requires specific facemask manufactured by Dräger	Compatible with multiple facemasks
Power Source	Powered by radio	Powered by radio	Requires one 9-volt battery	Powered by radio	Requires two AA batteries	Powered by radio

*Values listed for MSRP and warranty duration are the standard purchasing option for one unit.

4.1 CeoTronics CT-SkullMike

The CeoTronics CT-SkullMike (Figure 4-1) received an overall assessment score of 4.49 and has a price range of $700 to $1,000, which includes a skullcap microphone, a 12-pin connection adaptor (required for radios used during the assessment), a PTT connection and a three-year warranty.

The following sections, broken out by SAVER category, summarize the assessment results.

Figure 4-1 CeoTronics CT-SkullMike

4.1.1 Usability

The CeoTronics CT-SkullMike received a usability score of 4.46. The following information is based on evaluator comments:

Ability to Remain in Proper Position: All evaluators agreed or strongly agreed that the CT-SkullMike remained in position. Four of the evaluators noted that the system could be easily adjusted while in the encapsulated suit.

Adjustable Fit/Comfort: All evaluators agreed or strongly agreed that the product was adjustable to their size and that the adjustment mechanism was intuitive and easy to use. While five of the evaluators agreed or strongly agreed that the CT-SkullMike was comfortable, one evaluator only somewhat agreed that it was comfortable, noting that the position was off centered on the top of the head in order to avoid interference with the facemask mesh. One evaluator noted that they did not feel the CT-SkullMike.

Effect on Mobility: All evaluators agreed or strongly agreed that the product did not impact their mobility during the operational scenarios.

Overall Ease of Operation: All evaluators agreed or strongly agreed that using the product to communicate was intuitive.

Location Flexibility and Size of PTT Button: All evaluators agreed or strongly agreed that the PTT button had location flexibility and that the size was appropriate. Additionally, one evaluator noted that the PTT button of this system had a good positive click that confirmed transmission and that it could be pushed without needing to reach inside the encapsulated suit.

Specialized Training Required: CeoTronics provides manuals—both hard copies and a PDF version—and an installation training session for purchasing agencies. While these resources were deemed sufficient, one evaluator preferred training videos, and another preferred training materials to be available on laminated cards.

4.1.2 Capability

The CeoTronics CT-SkullMike received a capability score of 4.53. The following information is based on evaluator comments:

Clarity of System: All evaluators agreed or strongly agreed that the clarity was sufficient in all noise levels and while completing operational tasks.

Durability: All evaluators agreed or strongly agreed that the CT-SkullMike was durable, capable of withstanding repeated use and rugged enough for HAZMAT operations. All evaluators strongly agreed or agreed that moisture resistance was sufficient for HAZMAT operations. One evaluator noted that moisture would have a limited effect on this system.

Effect on Non-Radio Communications: All evaluators agreed or strongly agreed that the equipment did not affect non-radio communications.

Interoperability with Different Facemasks: All evaluators strongly agreed that the CT-SkullMike was interoperable with different face masks.

Volume Controls: All evaluators agreed or strongly agreed that the range of volume was sufficient for HAZMAT operations. The CT-SkullMike does not have a separate volume control, it relies on the connected radio's volume controls.

4.1.3 Deployability

The CeoTronics CT-SkullMike received a deployability score of 4.57. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that donning and doffing PPE while wearing the CT-SkullMike was easy.

Two evaluators somewhat agreed that the system could be easily adjusted while wearing the encapsulated suit as the helmet would need to be taken off to adjust the microphone, which could be somewhat challenging. Additionally, two evaluators noted that the CT-SkullMike would need to be removed if an adjustment to the SCBA mask was needed.

Assembly/Deployment Tools Accessibility: No tools are required for assembly and deployment of the CT-SkullMike.

Setup Time: All evaluators agreed or strongly agreed that set up was intuitive and the amount of time required for set up was acceptable for both HAZMAT and firefighting operations.

Special Storage Needs: No special storage requirements were identified. All evaluators agreed or strongly agreed that wires and cables could be neatly and securely stored by their agencies. One evaluator noted the system was compact and could fit into a box for storage.

4.1.4 Maintainability

The CeoTronics CT-SkullMike received a maintainability score of 4.36. The following information is based on evaluator comments:

Parts Availability: The ear piece, PTT button and skull piece components can all be replaced individually and obtained directly through CeoTronics. There could be a lag time of up to two weeks for parts based on availability. With this consideration, two evaluators somewhat agreed that parts were readily available.

Maintenance Tools Accessibility: No tools are required for maintenance of the CT-SkullMike.

Cleaning/Sanitation: All evaluators agreed or strongly agreed that the product could be easily cleaned and sanitized, noting that it required just soap and water.

Component Replaceability: The ear piece, PTT button and skull piece components can be replaced individually. The evaluators noted the importance of keeping spare components on hand due to the potential lag time in parts availability described in the parts availability section above.

Ease of Replacing/Recharging Power Supply: This system is powered by the radio battery.

Tech Training for Personnel: Other than cleaning, no other maintenance can be performed on the CT-SkullMike by the end user. If there is an issue with the product, it must be returned to CeoTronics.

4.2 TEA Headsets IC Pro

The TEA Headsets IC Pro (Figure 4-2) received an overall assessment score of 4.48 and costs approximately $460. One in-ear microphone headset, one pair of each size of replaceable foam ear tips, one ear hook wire guide, one clothing clip and one PTT button with a radio adapter are included with purchase.

The following sections, broken out by SAVER category, summarize the assessment results.

4.2.1 Usability

The TEA Headsets IC Pro received a usability score of 4.41. The following information is based on evaluator comments:

Ability to Remain in Proper Position: All evaluators agreed or strongly agreed that the headset remained in proper position throughout the assessment. One evaluator had the optional over the ear piece knocked off with the face piece and continued the scenarios without the earpiece. This evaluator stated some teams would use duct tape to keep the earpiece wire in. Another evaluator noted that the ear piece did not do anything for their performance.

Adjustable Fit/Comfort: All evaluators agreed or strongly agreed that the product was adjustable to their size and that the product was comfortable to wear. One evaluator noted that the in-ear piece was held in good position by the expanding foam piece. Another evaluator mentioned that there was no adjustment for size and that it would either fit or not fit.

Figure 4-2 TEA Headsets IC PRO

Effect on Mobility: All evaluators agreed or strongly agreed that the product did not affect their mobility.

Overall Ease of Operation: All evaluators agreed or strongly agreed that the overall ease of operating the product was intuitive. It was noted that it was difficult to know if enough pressure was applied to the PTT button to ensure transmission.

Location Flexibility and Size of PTT Button: Five evaluators agreed or strongly agreed that the product's PTT button had flexibility in its mounting location and was sized appropriately. One evaluator somewhat agreed that the PTT button could be easily activated under PPE. Evaluators noted that there was no distinct indication for a pressed down PTT button to ensure transmission confirmation. They noted that it could use a click to indicate that the button was sufficiently pressed down.

Specialized Training Required: All evaluators agreed or strongly agreed that the level of training, materials and resources were sufficient for their agencies. However, all evaluators agreed or somewhat agreed that training materials and resources were readily accessible. TEA Headsets IC Pro does not have video training resources available and it was noted that materials are limited to operator's manuals.

4.2.2 CAPABILITY

The TEA Headsets IC Pro received a capability score of 4.57. The following information is based on evaluator comments:

Clarity of System: All evaluators agreed or strongly agreed that the audio clarity of the system was sufficient across all noise levels. One evaluator commented that the loud alarm did not affect hearing.

Durability: Four evaluators agreed or strongly agreed that the durability of the system was sufficient for HAZMAT operations while two evaluators somewhat agreed. These two evaluators noted that they did not like the thinness of the earphone wiring sheath and could see it wearing over time.

Effect on Non-Radio Communications: All evaluators agreed or strongly agreed that the equipment did not affect non-radio communications. One team noted they did not have issues communicating even when a Personal Alert Safety System alarm went off inside the PPE.

Interoperability with Different Facemasks: All evaluators agreed or strongly agreed that the headset was interoperable with different facemasks; however, one evaluator noted that their earpiece was knocked off with the facepiece.

Volume Controls: All evaluators strongly agreed that the range of volume was sufficient for HAZMAT operations.

4.2.3 DEPLOYABILITY

The TEA Headsets IC Pro received a deployability score of 4.66. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that donning and doffing PPE while wearing the TEA headset was easy.

Assembly/Deployment Tools Accessibility: No tools were required for assembly and deployment of the device.

Setup Time: All evaluators agreed or agreed strongly that set up of the headset was intuitive and easy and the time it took to set up was appropriate.

Special Storage Needs: All evaluators agreed or strongly agreed that the IC Pro could be stored neatly and securely.

4.2.4 MAINTAINABILITY

The TEA Headsets IC Pro received a maintainability score of 4.23. The following information is based on evaluator comments:

Parts Availability: Four evaluators agreed and two evaluators somewhat agreed that replacement parts are readily available as necessary. The vendor representative noted that replacement parts can be shipped and delivered within a week if they are in stock. If not in stock, it would take approximately four to six weeks for the part to be delivered to the end user.

Maintenance Tools Accessibility: No tools are required for maintenance.

Cleaning/Sanitation: All evaluators agreed or strongly agreed that the product was easy to clean and sanitize.

Component Replaceability: Five evaluators agreed or strongly agreed that a malfunctioning component of the product could be individually replaced. One evaluator somewhat agreed and noted that while specific components could be replaced, it would be inconvenient as there are minimal components.

Ease of Replacing/Recharging Power Supply: This system is powered by the radio battery.

Tech Training for Personnel: All evaluators agreed or strongly agreed that the level of training and training materials to maintain the product were appropriate for their respective agencies. One evaluator disagreed and noted that technical resources were limited. Five evaluators somewhat agreed that user manuals and technical references were readily available.

4.3 CavCom Talk Through Your Ears

The CavCom Talk Through Your Ears (TTYE) (Figure 4-3) received an overall assessment score of 4.44 and costs $1,225. One TTYE ear set, one TTYE control unit, one PTT button, one radio adapter cable and one chest harness and an ear tip variety pack (that includes a CavCom 3-flange vinyl ear tip, a slim comply foam ear tip, a standard comply foam ear tip, and a large comply foam ear tip) are included with purchase.

The following sections, broken out by SAVER category, summarize the assessment results.

Figure 4-3 CavCom Talk Through Your Ears

4.3.1 Usability

The CavCom TTYE received a usability score of 4.31. The following information is based on evaluator comments:

Ability to Remain in Proper Position: Five evaluators agreed or strongly agreed that the product was able to remain in proper position. One evaluator somewhat agreed that the product and specific components were easy to reposition as necessary. Though the evaluator did not have to reposition the device, they noted that it would be challenging to reposition for optimal use.

Adjustable Fit/Comfort: All evaluators agreed or strongly agreed that the CavCom TTYE was adjustable and comfortable to wear. An evaluator liked that it was all in one piece and could be put on first before all other PPE. Another evaluator noted that it was a well thought out package. One evaluator did note that it was discomforting to have noise blocked out and felt slightly isolating.

Effect on Mobility: All evaluators agreed or strongly agreed that the product did not affect mobility. Two evaluators, who were paired with each other during the assessment, noted that cables are stowed in the chest harness and entanglement of wires is much less an issue than in other systems.

Overall Ease of Operation: All evaluators agreed or somewhat agreed that the overall ease of product operation was intuitive.

Location Flexibility and Size of PTT Button: All evaluators agreed or strongly agreed that the PTT button had location flexibility and that the size was appropriate. One evaluator noted that they liked the vest as it encapsulates the product, though they would like more grip on the PTT clip.

Specialized Training Required: Responses varied for the criteria of specialized training required. All evaluators agreed or somewhat agreed that the level of training to use this product is appropriate for their agencies. Two evaluators paired with each other during the assessment noted that the level of training is a little more complicated than other systems and training time will be greater. Another evaluator noted that it might not be as intuitive to use the system. All evaluators agreed or strongly agreed that training materials were sufficient and readily accessible despite the complexity of the system.

4.3.2 CAPABILITY

The CavCom TTYE received a capability score of 4.55. The following information is based on evaluator comments:

Clarity of System: All evaluators strongly agreed that the audio clarity of CavCom's product was sufficient across all background noise levels and while completing a series of tasks. Evaluators noted that it had very good audio quality. One evaluator noted that the hearing protection provided by the earpiece was more than sufficient for HAZMAT operations.

Durability: All evaluators agreed or strongly agreed that the durability of the system was sufficient for HAZMAT operations. Evaluators voiced concerns about the wires getting frayed and that they were a little thin. One evaluator liked that the system was self-contained through the use of the harness. Another evaluator noted that it is the "Cadillac of the systems," and on the higher end.

Effect on Non-Radio Communications: Four evaluators agreed that they were able to hear other people clearly and that the system did not affect their non-radio communications. However, one evaluator somewhat agreed and one disagreed that the system did not affect their non-radio communications. One evaluator noted that they could hear clearly but that noise reduction is by design of the system. Similarly, another evaluator noted that they had difficulty hearing from inside the suit, which they attributed to having both ears blocked. Of all the products tested, one evaluator said that they had the most difficult time hearing their data collector with this system. Another evaluator noted that he could not hear clearly.

Interoperability with Different Facemasks: All evaluators strongly agreed that the CavCom TTYE was interoperable with different facemasks.

Volume Controls: All evaluators strongly agreed that the range of volume was sufficient for HAZMAT operations with the exception of one evaluator who agreed.

4.3.3 DEPLOYABILITY

The CavCom TTYE received a deployability score of 4.55. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that the system was easy to don and doff while wearing PPE. One evaluator somewhat agreed that the product was adjustable under the PPE and mentioned that they would like to see how well the device would stay in the ear.

Assembly/Deployment Tools Accessibility: No tools were required for assembly and deployment of the device.

Setup Time: Four evaluators agreed or strongly agreed that the amount of time required to set up the ISC product was appropriate for HAZMAT operations. Two evaluators somewhat agreed that set up of the TTYE was intuitive and easy. One evaluator noted that due to the complexity of the product, it could take a little longer to set up. Another evaluator noted that although it is a complex system, it is packaged in a way that is still easy to set up.

Special Storage Needs: All evaluators agreed or strongly agreed that the product's storage needs could be accommodated by their respective agencies. One evaluator team noted that it would require more work to put together, organize and store the kit.

4.3.4 MAINTAINABILITY

The CavCom TTYE received a maintainability score of 4.38. The following information is based on evaluator comments:

Parts Availability: All evaluators agreed or strongly agreed that replacement parts are readily available.

Maintenance Tools Accessibility: No tools are required for maintenance.

Cleaning/Sanitation: Evaluators varied in opinions with regard to various aspects of cleaning and sanitation of the product. All evaluators somewhat agreed that the product was easy to clean and maintain and that no precautions were needed to clean and sanitize the product. However, one evaluator noted that they were curious about how well sealed the battery was on the control unit. Four evaluators somewhat agreed, and two evaluators disagreed that the product could be successfully cleaned for multi-person use during the same incident. One evaluator noted that the chest piece would need to be decontaminated, and that there would be lots of cables to wipe clean. Another evaluator noted that it would require at least 20 minutes between users due to washing needs for the harness. One evaluator suggested cleaning with alcohol wipes, while another suggested soap and water.

Component Replaceability: All evaluators agreed or strongly agreed that malfunctioning components could be individually replaced. One evaluator noted that it should be easy to do.

Ease of Replacing/Recharging Power Supply: A 9-volt battery is required to power the CavCom TTYE control unit. All evaluators strongly agreed that the batteries were easy to replace. An evaluator noted that replacing the battery simply involved sliding the door open and no tools are required. All evaluators agreed or strongly agreed that the time to replace batteries was sufficient for HAZMAT operations.

Tech Training for Personnel: All evaluators agreed or strongly agreed that technical training for personnel was appropriate. Four evaluators agreed or strongly agreed and two evaluators somewhat agreed that the product will not require a specific technician to maintain the product. One evaluator stated, "I would not have every guy maintaining this system. I would have one [communications] guy… in charge of maintaining the equipment. A person would need to be real familiar with the system to maintain [it] because there are a lot of moving parts."

4.4 CEOTRONICS CT-CLIPCOM EAR MIKE

The CeoTronics CT-ClipCom EarMike (Figure 4-4) received an overall assessment score of 4.38 and costs $900 to $1,200, depending on the set up of the ear piece, PPT button and adapter type. The purchase price of the unit includes a three-year warranty.

The following sections, broken out by SAVER category, summarize the assessment results.

4.4.1 USABILITY

The CeoTronics CT- ClipCom EarMike received a usability score of 4.41. The following information is based on evaluator comments:

Figure 4-4 CeoTronics CT-ClipCom EarMike

Ability to Remain in Proper Position: All evaluators agreed or strongly agreed that the system remained in position throughout the assessment activities. Two evaluators thought it was very easy to achieve a good fit with the earpiece, with one attributing this to the plastic earpiece attachment. One evaluator noted that the use of plastic, as opposed to foam, could lead to the earpiece popping out due to sweat.

Adjustable Fit/Comfort: Three evaluators agreed or strongly agreed that the product was adjustable to their size, while three evaluators somewhat agreed. One evaluator noted that there was not anything to adjust on the product.

Effect on Mobility: All evaluators agreed or strongly agreed that the product did not affect their mobility.

Overall Ease of Operation: All evaluators agreed or strongly agreed that using the product to communicate was intuitive.

Location Flexibility and Size of PTT Button: All evaluators agreed or strongly agreed that the PTT button could be mounted in a readily accessible location. One evaluator noted that the button was easily adjusted under PPE and was the only PTT at the assessment that included an emergency alert button. One evaluator thought the button was smaller than that of other products assessed, and there was no indication if the PTT is clicked or not. Another evaluator noted that there are wires on both sides of the PTT button and disliked this configuration.

Specialized Training Required: All evaluators agreed or strongly agreed that the level of training required to use the product is appropriate for their agencies. Two evaluators noted that training materials were limited to paper manuals, but they were readily accessible. One evaluator suggested that the company should provide a video or PowerPoint for training purposes.

4.4.2 CAPABILITY

The CeoTronics CT- ClipCom EarMike received a capability score of 4.31. The following information is based on evaluator comments:

Clarity of System: All evaluators agreed or strongly agreed that the clarity of the system was sufficient under low background noise levels and while completing a series of tasks. Five evaluators agreed or strongly agreed, and one evaluator somewhat agreed, that the clarity of the system was sufficient under medium background noise levels. Four evaluators agreed or strongly agreed, one evaluator somewhat agreed and one disagreed, that the clarity of the system was sufficient under loud background noise levels. Two evaluators noted that they needed to cognitively process out the sound from the non-earpiece ear and two other evaluators had to turn up the radio volume under loud background noise levels because the background noise was picked up. It was noted that they could hear their partners, but the words were not necessarily clear in some cases.

Durability: All evaluators agreed or strongly agreed that the overall physical reliability of the system was sufficient for HAZMAT operations. One evaluator mentioned being able to feel reinforcement in the wire between the earpiece and the radio adaptor. Another evaluator mentioned the wire could deteriorate despite the reinforcement.

Effect on Non-Radio Communications: All evaluators agreed or strongly agreed that they were able to hear other people clearly through their PPE and the ISC equipment.

Interoperability with Different Facemasks: All evaluators strongly agreed that the product did not interfere with the facepiece used during the assessment.

Volume Controls: Evaluator opinions on volume controls varied for this product. One evaluator strongly agreed that the range of volume through the ISC equipment was sufficient for HAZMAT operations. Four evaluators agreed while one evaluator somewhat agreed with that statement.

4.4.3 DEPLOYABILITY

The CeoTronics CT- ClipCom EarMike received a deployability score of 4.57. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that donning and doffing PPE was easy while wearing the ISC product, with one noting that the hanging wires did not affect their ability to don PPE in a timely manner.

Assembly/Deployment Tools Accessibility: No tools are required for assembly of the CT-ClipCom EarMike.

Setup Time: All evaluators agreed or strongly agreed that set up was intuitive and easy and the time to set up was appropriate for HAZMAT operations.

Special Storage Needs: All evaluators believed their agencies could neatly and securely store the ISC wires and cables.

4.4.4 MAINTAINABILITY

The CeoTronics CT- ClipCom EarMike received a maintainability score of 4.27. The following information is based on evaluator comments:

Parts Availability: Four evaluators agreed and two evaluators somewhat agreed that replacement parts are readily available as necessary. One evaluator, who has experience with the company, stated that the vendor usually has some parts on hand. Otherwise parts need to be ordered and would be received within two weeks. Another evaluator liked that system was simple and there were no complex parts that would need to be replaced.

Maintenance Tools Accessibility: No tools are required for maintenance.

Cleaning/Sanitation: All evaluators agreed or strongly agreed that the product was easy to clean and sanitize. Two evaluators noted that the product would be easy to clean with alcohol pads and could be used by a different user quickly by swapping out the in-ear attachments.

Component Replaceability: All evaluators agreed or strongly agreed that if the product malfunctions, the malfunctioning component (earpiece, earpiece attachment, PTT button) could be individually replaced.

Ease of Replacing/Recharging Power Supply: Batteries are not required to operate the ISC equipment. The product draws its power from the radio.

Tech Training for Personnel: All evaluators agreed that the level of training required to properly maintain the product was appropriate for their agencies, but a few evaluators had issues with the training resources available. One evaluator stated that there was an in-person training upon purchase as well as available manuals. However, another evaluator thought these training resources were limited and should be improved, noting that a video would be very useful. One evaluator thought the manual provides sufficient information for basic maintenance but does not provide enough detail for more in-depth maintenance and is not suitable for "refresher" training.

4.5 DRÄGER FPS-COM 7000

The Dräger FPS-COM 7000 (Figure 4-5) received an overall assessment score of 4.16 and costs approximately $2,200, which includes the communications facepiece, PTT button and cable, assuming the customer already uses Dräger equipment that is compatible with the ISC system. A 15-year warranty is included in the price of the ISC product. It should be noted the Dräger system was the only fully integrated communications unit tested at the assessment. This means that it must be used with SCBAs, air tanks and a specific facemask all manufactured by Dräger.

Figure 4-5 Dräger FPS-COM 7000

The following sections, broken out by SAVER category, summarize the assessment results and focuses on the use of the PTT radio communications (evaluator feedback concerning hands free Team Talk communication is noted otherwise).

4.5.1 USABILITY

The Dräger FPS-COM 7000 received a usability score of 4.47. The following information is based on evaluator comments:

Ability to Remain in Proper Position: All evaluators strongly agreed that the product remained in proper position throughout the assessment and would have been easy to reposition if necessary. One evaluator noted that the only components that may need to be repositioned are the earpieces, though they did not need to be repositioned during the assessment.

Adjustable Fit/Comfort: All evaluators agreed or strongly agreed that the product was adjustable to their size and was comfortable to wear. Two evaluators made comments pertaining to the earpieces: one was initially concerned with the design of the earpieces but was surprised how clear the audio was, while the other felt the earpieces did not have a lot of range as they could not be extended or shortened to adjust the location. One evaluator noted that the equipment was comfortable to wear although it was heavy.

Effect on Mobility: All evaluators agreed or strongly agreed that the product did not affect their mobility during the assessment activities. Three evaluators were impressed with the system's cabling: one stated the cable had great flexibility and was much more durable than other products and one noted the cable held up when their radio fell inside the suit.

Another evaluator said this was the first product used during the assessment where the potential of cable hinderance did not even cross their mind.

Overall Ease of Operation: Five evaluators agreed and one evaluator somewhat agreed that using the product to communicate was intuitive. Overall, the evaluators believed that there were a lot of features and functions to learn (i.e., channel changing on the face piece) and it would take some time to get familiar with the system, but one evaluator suggested that some of the steps could be streamlined by standard operating procedures and support staff to assist the responder when donning the equipment.

Location Flexibility and Size of PTT Button: Two evaluators somewhat agreed, two agreed and two strongly agreed that that the PTT button could be mounted in a readily accessible location. Note that one evaluator performed the assessment activities with an incident commander (IC) PTT after technical issues with the HAZMAT suit PTT button. That evaluator could not clip the HAZMAT suit PTT button on easily and stated that the Dräger harness limited the possible locations for the PTT (no chest strap). Another evaluator felt the PTT button could be mounted anywhere.

All evaluators, aside from the one that used the IC PTT button, agreed or strongly agreed that the PTT button could be easily activated under encapsulated HAZMAT PPE. One evaluator thought the button was easily adjusted under PPE and stayed in place during the activities. Another evaluator liked that there was a backup PTT button integrated into the facepiece. One evaluator thought the button was very easy to press through the suit, but it did not have a distinguishable click. This evaluator also liked the style of clip used to secure the PTT button.

Specialized Training Required: All evaluators agreed or strongly agreed that the level of training and materials provided would be sufficient for their organizations. Two evaluators somewhat agreed that the equipment would not require a specific technician to maintain. Dräger provides training videos and manuals as well as customizable training posters. One evaluator noted that the technology is more advanced than other products and would require a more training.

4.5.2 Capability

The Dräger FPS-COM 7000 received a capability score of 3.94. The following information is based on evaluator comments:

Clarity of System: Five evaluators agreed or strongly agreed that the clarity of the system was sufficient throughout the assessment activities; however, one evaluator somewhat agreed under low, medium and loud background noise levels. There were mixed experiences during the assessment scenarios. Two evaluators believed the system provided adequate noise cancellation and the audio was clear during the loudest alarms. However, one evaluator experienced garbled and unclear communications when using the PTT button and another thought the volume was too low throughout. Another evaluator lost communications over the radio multiple times during the activities.

Durability: All evaluators agreed or strongly agreed that the ruggedness of the system was sufficient for HAZMAT operations. One evaluator thought the product was rugged but had concerns about the overall physical reliability because of the added complexity of the additional technological components of the system.

In addition, one evaluator had trouble with the communications facepiece attachment and noted the tabs felt like they needed extra force and were not "fire-fighter proof."

Effect on Non-Radio Communications: All evaluators were able to hear other people clearly through their PPE and the ISC equipment.

Interoperability with Different Facemasks: The communications equipment requires a specific Dräger facepiece to operate and was not interoperable with other facemasks.

Volume Controls: Three evaluators agreed, one evaluator strongly agreed and two evaluators somewhat agreed that the range of volume provided by the product was sufficient for HAZMAT operations. When using the PTT button, the volume was controlled by the radio. The difference between Team Talk volume control and PTT volume control caused some confusion for one evaluator who noted that the controls were not intuitive and had to continually ask the vendor for assistance.

4.5.3 Deployability

The Dräger FPS-COM 7000 received a deployability score of 3.95. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that donning and doffing their PPE was easy while wearing the ISC product, with two noting a slightly increased don/doff time due to the additional features, buttons and connections. One evaluator had some challenges donning the communications facepiece (as noted previously), while another thought the set-up time would improve with practice.

Assembly/Deployment Tools Accessibility: A Philips head screwdriver is needed for the earpiece speakers and PTT button on the mask, and a 2-millimeter star screwdriver is needed for the battery compartment. All the evaluators somewhat agreed that the tools required to assemble and deploy the product were readily accessible. One evaluator noted the star screwdriver is not a common tool but is easily purchased.

Setup Time: All evaluators agreed or somewhat agreed that set up of the ISC equipment was intuitive and easy, noting that the set-up time was longer than other systems due to the additional features.

Special Storage Needs: All evaluators agreed or strongly agreed that their agencies could neatly and securely store the systems wires and cables.

4.5.4 Maintainability

The Dräger FPS-COM 7000 received a maintainability score of 4.00. The following information is based on evaluator comments:

Parts Availability: All evaluators agreed or strongly agreed that parts are available as necessary. Evaluators noted that many replacement parts are readily available while other parts are available in replacement part kits for purchase or by over-night shipping.

Maintenance Tools Accessibility: All evaluators somewhat agreed the tools required for maintenance are readily accessible. One evaluator noted that different tools are required for different parts of the product.

For example, a Phillips head screwdriver is needed for the ear puck speakers and the PTT button on the mask, while a 2-millimeter star screwdriver is needed for the battery compartment. Evaluators noted that while the star screwdriver is not a common tool, it is easily purchased.

Cleaning/Sanitation: All evaluators agreed or strongly agreed that the product was easy to clean and sanitize. One evaluator noted the product could be cleaned simply by submerging it in a sanitary solution.

Component Replaceability: All evaluators agreed or strongly agreed that a malfunctioning component of the system could be individually replaced. The three primary components (PTT button, communications attachment and cable) can be replaced. One evaluator noted that Dräger has factory training for optimal equipment use and maintenance of device and replacement parts. Another evaluator confirmed the component replaceability was available based on the disassembly of the replacement parts of the device.

Ease of Replacing/Recharging Power Supply: The product requires batteries to operate. All evaluators somewhat agreed that the batteries were easy to replace in an amount of time sufficient for HAZMAT operations. Five evaluators commented that changing the batteries would be easy if you have the proper tools. One evaluator liked that over-the-counter batteries (two AA batteries) could be used. One evaluator noted they would have to remove their PPE and the ISC product to replace the batteries. This evaluator noted that this could be a problem which would prevent radio communications if the wearer is still on the incident scene and not in a safe location to remove PPE. It should also be noted that the product is supposed to have a low battery warning, but one evaluator stated they did not hear a warning before the batteries died.

Tech Training for Personnel: Two evaluators somewhat agreed that the level of training required to properly maintain the product was appropriate for their organization, while the remaining evaluators agreed or strongly agreed. In addition, three evaluators thought a specific technician would be required to maintain the product. One evaluator noted that the product requires preventative maintenance, such as replacing valves, so issues would not occur in the field (like an issue that occurred with the PTT button during the assessment). Another evaluator stated that their organization's services division would need to handle the maintenance of the equipment. One evaluator did point out that the company has 24-hour tech support available to help troubleshoot any issues.

4.6 CeoTronics CT-ThroatMike

The CeoTronics CT-ThroatMike (Figure 4-6) received an overall assessment score of 3.87 and has a price range of $700 to $900, which includes a throat microphone, a microphone strap, an earpiece, a 12-pin connection adaptor (required for radios used during the assessment), a plunger-style PTT connection and a three-year warranty.

The following sections, broken out by SAVER category, summarize the assessment results.

4.6.1 USABILITY

Figure 4-6 CeoTronics CT-ThroatMike

The CeoTronics CT- ThroatMike received a usability score of 3.91. The following information is based on evaluator comments:

Ability to Remain in Proper Position: Four evaluators somewhat agreed that the CT-ThroatMike remained in proper position during the operational scenarios. One evaluator had to bring his hand into the encapsulated suit to reposition the microphone, another noted that the microphone moved and that if it was any tighter it would impact comfort, and a third evaluator did not think the system was ideal for HAZMAT responders as they anticipated that, because of sweat, the microphone would slip out of place within 30 minutes and need frequent readjustment.

Adjustable Fit/Comfort: All evaluators agreed or strongly agreed that the microphone strap was adjustable to their size but there was a range of scores regarding comfort level. Three evaluators agreed that the system was comfortable, two somewhat agreed noting it was not comfortable around the neck, and one disagreed stating that the ideal positioning of the device for optimal operation may not be conducive to comfort. This is because, for the microphone to successfully transmit, it needs to sit close to the throat, and if the microphone strap is loosened for comfort it would not transmit well.

Effect on Mobility: All evaluators agreed or strongly agreed that overall the entire system did not impact their mobility during the assessment. Three evaluators indicated that the cable lengths could reduce mobility for some users. This was attributed to the system using multiple cables and having a straight cord connection from the radio to PTT button, which limited flexibility and could result in cable strain or the adaptor coming loose.

Overall Ease of Operation: Three evaluators agreed that using the system to communicate was intuitive while three somewhat agreed. The evaluators who somewhat agreed noted that the product was not complicated in theory, yet they ran into issues with the system during the assessment including slippage of the throat microphone. They also stated that if a training session had not occurred prior to use, it would have been even more difficult to operate the system.

Location Flexibility and Size of PTT Button: There was a range of responses on the location flexibility and size of the PTT button. Five evaluators agreed or strongly agreed that the PTT button could be mounted in a location that is readily accessible, while one evaluator somewhat agreed, noting that it was harder to place and had less adjustment of direction.

Another evaluator noted that there was no hook on the end of the clamp, which could lead to the PTT button becoming displaced. Again, five evaluators agreed or strongly agreed that the PPT button could be adjusted after mounting it on their body, while one evaluator somewhat agreed noting that it was difficult to place the PTT and to adjust the direction of the cables coming from both ends of the PTT. Four evaluators agreed that the PTT button could be easily activated within the encapsulated PPE while two somewhat agreed as they could not feel a positive feedback click confirming transmission.

Specialized Training Required: All evaluators agreed or strongly agreed that the level of training to use the product is appropriate.

Two evaluators somewhat agreed that the training materials and resources were sufficient to gain a working knowledge of product operation. They noted that training is crucial to master the placement of the microphone and could take time to learn, and they thought a demonstration video would be useful.

4.6.2 CAPABILITY

The CeoTronics CT- ThroatMike received a capability score of 3.84. The following information is based on evaluator comments:

Clarity of System: There was a range of scores regarding clarity of the CT-ThroatMike. Three evaluators somewhat agreed that the audio quality was sufficient while completing operational tasks. During the noise level scenarios, two evaluators strongly disagreed that the clarity was sufficient while in a high noise environment; one evaluator disagreed, one somewhat agreed and two agreed. Two of the evaluators could not clearly hear the radio transmissions in the high noise environment. Another evaluator indicated that the earpiece did not isolate external noise, which made radio communications difficult to hear.

Durability: Two evaluators strongly agreed and four somewhat agreed that the overall physical reliability of the system was sufficient for HAZMAT operations. This was attributed to the potential of thin cables breaking or coming untethered, sweat within an encapsulated suit possibly resulting in movement of the microphone and the earpiece not fitting snuggly, and therefore, not sealing the ear very well.

Effect on Non-Radio Communications: All evaluators agreed or strongly agreed that they were able to hear other people clearly through their PPE and the ISC equipment.

Interoperability with Different Facemasks: All evaluators strongly agreed that the product does not interfere with the facepiece used during the operational scenarios.

Volume Controls: The CT-ThroatMike does not have a separate volume control, it relies on the connected radio's volume controls. There was a range of scores regarding the range of volume being sufficient for HAZMAT operations; one evaluator strongly disagreed, two disagreed, one somewhat agreed, one agreed and one strongly agreed. Those evaluators who strongly disagreed and disagreed had difficulties hearing each other during the scenario involving communication in various noise levels, with the radio's volume turned up as loud as it would go. The volume issue was further perpetuated by the throat microphones slipping out of place (i.e., flipping over on the throat).

4.6.3 DEPLOYABILITY

The CeoTronics CT- ThroatMike received a deployability score of 4.23. The following information is based on evaluator comments:

Ease of Donning/Doffing: All evaluators agreed or strongly agreed that donning and doffing PPE was easy while wearing the CT-ThroatMike; however, one evaluator noted the CT-ThroatMike made it more difficult to put on the SCBA mask as it got in the way. Another evaluator noted that the order of normal operations of donning SCBA and PPE was affected by the design of the CT-ThroatMike.

Assembly/Deployment Tools Accessibility: No tools are required for assembly and deployment of the CT-ThroatMike.

Setup Time: Four evaluators somewhat agreed that set up was intuitive and easy although it took time to get the proper placement of the microphone. The evaluators did note that with repeated use, they would be able to more quickly place the microphone. One evaluator suggested marking the front of the microphone to ensure that it is not inadvertently put on backward.

Special Storage Needs: Five evaluators agreed or strongly agreed that wires and cables could be neatly and securely stored by their agencies, while one evaluator somewhat agreed noting concern about the durability of the product while being stored.

4.6.4 MAINTAINABILITY

The CeoTronics CT- ThroatMike received a maintainability score of 3.44. The following information is based on evaluator comments:

Parts Availability: Four evaluators disagreed that replacement parts are readily available. The system would need to be returned to the manufacturer for repair and could leave the responders without a system for more than 48 hours. There was a major concern that the rubber on the earpiece is a fail point that cannot be easily replaced.

Maintenance Tools Accessibility: No tools are required for maintenance.

Cleaning/Sanitation: All evaluators somewhat agreed that the product was easy to clean and sanitize. Additionally, the evaluators somewhat agreed or disagreed that the system could be successfully cleaned for multi-person use during the same incident. This was attributed to the material comprising the microphone strap. It would remain wet after being cleaned and could impact comfort and use. One responder suggested issuing individual microphone straps to avoid the issue of wearing wet straps, noting it would be easy to interchange the microphone between straps.

Component Replaceability: Evaluators somewhat agreed, disagreed or strongly disagreed that components could be replaced individually based on the need to return the system to the manufacturer.

Ease of Replacing/Recharging Power Supply: Batteries are not required for operation. The product draws its power from the radio.

Tech Training for Personnel: All evaluators strongly agreed or agreed that the level of training required to properly maintain the product is appropriate for their agencies, but two disagreed that the materials were sufficient to gain a working knowledge of product maintenance. They noted that laminated quick guides would be useful, but ultimately the system would need to be returned to CeoTronics for repair or maintenance.

5.0 SUMMARY

The advantages and disadvantages for the assessed products are highlighted in Table 5-1. Emergency responder agencies that consider purchasing In-Suit Communications equipment should carefully research each product's overall capabilities and limitations in relation to their agency's operational needs.

Table 5-1 Product Advantages and Disadvantages

Vendor/Product		Advantages	Disadvantages
	CeoTronics CT-SkullMike	• Easy to use • Sufficient audio clarity and volume of earpiece • Minimal impact on mobility and non-radio communications • Durable for HAZMAT operations • Interoperable with different facemasks • Easy to set up, assemble, don and doff, clean and sanitize • Powered by radio	• Could be difficult to adjust the position of the ISC equipment or the SCBA while using this product
MSRP: $700 - $1,000	Overall Score: 4.49		
	TEA Headsets IC Pro	• Easy to use • Sufficient audio clarity and volume of earpiece • Minimal impact on mobility and non-radio communications • Interoperable with different facemasks • Easy to set up, assemble, don and doff, clean and sanitize • Powered by radio • Most cost-effective system evaluated	• Thin wires • Earpiece can get knocked off with facemask • No indication that PTT button is fully pressed down • No specific sizes for earpieces
MSRP: $460	Overall Score: 4.48		
	CavCom Talk Through Your Ears	• Easy to use • Sufficient audio clarity and volume of earpiece • Noise reduction design provides hearing protection • Self-contained harness reduces impact on mobility • Interoperable with different facemasks • Easy to set up, assemble, don and doff • Easy to replace battery (9 volt)	• Thin wires • Noise reduction design of system impacts non-radio communications • Harness is difficult to clean and sanitize • Not powered by radio and requires additional batteries
MSRP: $1,225	Overall Score: 4.44		

Vendor/Product		Advantages	Disadvantages
	CeoTronics CT-ClipCom EarMike	• Easy to use • Minimal impact on mobility and non-radio communications • Durable for HAZMAT operations • Interoperable with different facemasks • Easy to set up, assemble, don and doff, clean and sanitize • Powered by radio	• Background noise experienced during usage • No indication that PTT button is fully pressed down
MSRP: $900 - $1,200	Overall Score: 4.38		
	Dräger FPS-COM 7000	• Easy to use • Sufficient audio clarity and volume of earpiece • Includes a team centered full duplex feature • Minimal impact on mobility and non-radio communications • Durable for HAZMAT operations • Easy to set up, don and doff, clean and sanitize • Secondary PTT button integrated into facepiece	• Requires a specific facemask developed by Drager for usage • Maintenance may be difficult as the product requires the usage of Drager SCBA components • Not powered by radio and requires additional batteries • Screwdriver required to replace batteries
MSRP: $2,200	Overall Score: 4.16		
	CeoTronics CT-ThroatMike	• Minimal impact on mobility and non-radio communications • Interoperable with different facemasks • Easy to set up and assemble • Powered by radio	• Difficult to properly position the microphone • Improper microphone placement greatly reduces audio quality • Thin wires • Placement of product interferes with donning SCBA • Difficult to clean and sanitize • No indication that PTT button is fully pressed down
MSRP: $700 - $900	Overall Score: 3.87		

APPENDIX A. EVALUATION CRITERION DEFINITIONS

The focus group identified 27 criteria, which they defined as follows.

USABILITY

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.

CAPABILITY

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 reliability of the product. This includes ruggedness, strain relief on cables and connectors, capability to withstand repeated usage 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 Voice-Activated Exchange). When this feature is activated, an activation mechanism may still be necessary to communicate with an incident commander. 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.

DEPLOYABILITY

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.

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.

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.

MAINTAINABILITY

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.

AFFORDABILITY

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.

APPENDIX B. ASSESSMENT SCORING FORMULAS

The overall score for each product was calculated using the product's averaged criterion ratings and category scores. An average rating for each criterion was calculated by summing the evaluators' ratings and dividing the sum by the number of responses. Category scores for each product were calculated by multiplying the average criterion rating by the weight assigned to the criterion by the focus group, resulting in a weighted criterion score. The sum of the weighted criterion scores was then be divided by the sum of the weights for each criterion in the category as seen in the formula and example below.

Category Score Formula

$$\frac{\sum\left(\textit{Average Criterion Rating} \times \textit{Criterion Weight}\right)}{\sum\left(\textit{Criterion Weights}\right)} = \textit{Category Score}$$

Category Score Example[i]

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

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

Overall Assessment Score Formula

$$\sum\left(\textit{Category Score} \times \textit{Category Percentage}\right) = \textit{Overall Assessment Score}$$

Overall Assessment Score Example

Capability	*Usability*	*Affordability*	*Maintainability*	*Deployability*	
$(4.0 \times 33\%)$	$+ (4.2 \times 27\%)$	$+ (4.2 \times 20\%)$	$+ (3.8 \times 13\%)$	$+ (4.5 \times 7\%)$	$= 4.1$

[i] Examples are for illustration purposes only. Formulas vary depending on the number of criteria and categories assessed and the criteria and category weights.

APPENDIX C. PRODUCT EVALUATION STATEMENTS

This Appendix lists statements corresponding to evaluation criteria. Each statement was answered by evaluators with N/A (for not applicable) or using the following scale:

1) I strongly disagree with this statement.
2) I disagree with this statement.
3) I somewhat agree with this statement.
4) I agree with this statement.
5) I strongly agree with this statement.

Product Evaluation Statements

Category	Criteria	Statement	Notes
Usability	Ability to Remain in Proper Position	The product (entire system) remained in proper position throughout the scenario.	
		The product (entire system) was easy to reposition as necessary.	Conditional on the previous statement.
		Specific components (earpiece, microphone, etc.) remained in proper position throughout the scenario.	
		Specific components were easy to reposition as necessary.	Conditional on the previous statement
	Adjustable Fit/Comfort	The product was adjustable to my size.	
		Size adjustment mechanisms were intuitive and easy to use.	
		The product was comfortable to wear (padding, sharp edges, ear fatigue, etc.).	
	Effect on Mobility	The product (entire system) did not affect my mobility.	
		Cable length did not affect my mobility.	
		Cable stowage (wrapping or spooling) would reduce the impact of cable length on my mobility.	Conditional on the previous statement
	Overall Ease of Operation	Using the product to communicate was intuitive.	
	Location Flexibility and Size of PTT Button	The PTT button can be mounted in a location that is readily accessible.	
		The position of the PTT button can be adjusted after mounting it on my body.	
		The PTT button can be easily activated under encapsulated HAZMAT PPE.	

Category	Criteria	Statement	Notes
Usability, continued	Specialized Training Required	The level of training to use this product is appropriate for my organization.	
		Training materials and resources are sufficient to gain a working knowledge of product operation.	
		The product will not require a specific technician to use during operations.	
		Training materials and resources are readily accessible.	
Capability	Clarity of System	Audio clarity of the system was sufficient under low background noise levels.	
		Audio clarity of the system was sufficient under medium background noise levels.	
		Audio clarity of the system was sufficient under loud background noise levels.	
		Audio quality of system was sufficient while completing a series of tasks.	
	Durability	The ruggedness of the system was sufficient for HAZMAT operations.	
		Strain relief on cables and connectors was sufficient for HAZMAT operations.	
		The product is capable of withstanding repeated usage.	
		Moisture resistance was sufficient for HAZMAT operations.	
		The overall physical reliability of the system was sufficient for HAZMAT operations.	
	Effect on Non-Radio Communications	I was able to hear other people clearly through PPE and ISC equipment.	
	Interoperability with Different Facemasks	The product does not require the use of a specific facepiece.	
		The product does not interfere with the facepiece used during the assessment.	
	Volume Controls	The range of volume was sufficient (compensate for background noise, not too loud, etc.) for HAZMAT operations.	This refers to the volume of the earpiece because the volume of all the systems was controlled by the radio.

Category	Criteria	Statement	Notes
Deployability	Ease of Donning/Doffing	Donning and doffing PPE was easy while wearing the ISC product.	
		PPE was adjustable as necessary while wearing the product.	
		The ISC product was adjustable under the PPE.	
		The ISC was not displaced by donning the PPE.	
		Special assistance was not needed to don PPE while wearing the ISC product.	
		The presence of the ISC product did not significantly affect the time to don PPE.	
		No special steps were necessary to don PPE while wearing the ISC product.	
	Assembly/ Deployment Tools Accessibility	Tools required for assembly and deployment are readily accessible to my organization.	If no tools were required, this criterion was given a 5. If standard, readily available tools were required, this criterion was given a 3. If specialized tools were required, this criterion was given a 1.
	Setup Time	Set up of the ISC equipment and system was intuitive and easy.	
		Set up time of the ISC product was appropriate for HAZMAT operations.	
	Special Storage Needs	Battery removal and storage needs can be accommodated by my organization.	Conditional on the previous statement.
		Wires and cables can be neatly and securely stored by my organization.	

Category	Criteria	Statement	Notes
Maintainability	Parts Availability	Replacement parts are readily available as necessary.	
	Maintenance Tools Accessibility	Tools required for maintenance are readily accessible by my agency.	If no tools were required, this criterion was given a 5. If standard, readily available tools were required, this criterion was given a 3. If specialized tools were required, this criterion was given a 1.
	Cleaning/Sanitation	The product was easy to clean and sanitize.	
		The shape and material of the product did not affect the ease of cleaning and sanitation.	
		No precautions needed to be taken to clean and sanitize the product.	
		The amount of time it took to clean the product was acceptable.	
		The product can be successfully cleaned for multi-person use during the same incident.	
		Cleaning solutions required for cleaning the product are readily accessible.	
	Component Replaceability	If the product malfunctions, the malfunctioning component (as opposed to the whole system) can be individually replaced.	
	Ease of Replacing/ Recharging Power Supply	Batteries are not required for operation.	If batteries were not required and the product was powered by the radio, this entire criterion was given a 4. If batteries were required, this statement would be given a 2 and the remaining statements would be answered as indicated.

Category	Criteria	Statement	Notes
Maintainability, continued	Ease of Replacing/ Recharging Power Supply, continued	The system does not use proprietary batteries.	If the product did not use proprietary batteries, then the statement was given a 4. If the product used proprietary batteries, then the statement was given a 2.
		Batteries (consumable or removable rechargeable) were easy to replace.	Conditional on the previous statements.
		The time it took to replace the battery was sufficient for HAZMAT operations.	Conditional on the previous statements.
		Proprietary batteries (if used) are easily recharged.	Conditional on the previous statements.
	Tech Training for Personnel	The level of training required to properly maintain the product is appropriate for my organization.	
		Training materials and resources are sufficient to gain a working knowledge of product maintenance.	
		The product will not require a specific technician to maintain the product.	
		User manuals and technical references are readily accessible.	