Homeland Security
Science and Technology

Summary

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective operational tests on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

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National Fire Protection Association (NFPA) 1994 Class 2 Terrorism Incident Protective Ensembles

In order to provide emergency responders with information on currently available NFPA 1994 Class 2 Terrorism Incident Protective Ensembles, or Class 2 ensemble capabilities, limitations, and usability, the Center for Domestic Preparedness (CDP) conducted a comparative assessment of four Class 2 ensembles for the SAVER Program in September 2008. Detailed findings of the assessment are provided in the complete Assessment Report on National Fire Protection Association (NFPA) 1994 Class 2 Terrorism Incident Protective Ensembles*, which is available by request at https://www.rkb.us/saver.*

Background

Class 2 ensembles certified as compliant with the *NFPA 1994: Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, 2007 Edition* are designed to protect the wearer's entire body. These ensembles provide limited protection to emergency first responders at terrorism incidents involving known vapor or liquid chemical hazards where the concentrations are at or above immediately dangerous to life and health (IDLH) levels and require the use of self-contained breathing apparatuses (SCBA) approved for chemical, biological, radiological, and nuclear (CBRN) use. These ensembles may also be worn in biological hazardous environments where direct exposure to liquids is expected through contact with contaminated surfaces, where victims are not ambulatory but symptomatic, and where self-evacuating victims are also present.

Assessment

A focus group of 10 emergency response practitioners from various regions of the country met in June 2008 to identify equipment selection criteria, evaluation criteria, and assessment scenarios. The recommended selection criteria included encapsulating and non-encapsulating models, as well as front and rear entry models. Based on focus group recommendations and market survey research, the CDP selected the following four ensembles for assessment:

- Lion Apparel, Inc., Tactix® MT94™
- Lakeland Industries, Inc., Tychem® TK648W
- Kappler®, Inc. Zytron® 500 Z5HTNC2
- Geomet Technologies, LLC Disposable Toxicological Agent Protective System (DTAPS®) 10-260.

Eight emergency response practitioners served as assessment evaluators.

Each Class 2 ensemble was evaluated using a Scott Air-Pak® Fifty™ CBRN SCBA with AV-3000® facepiece, and operational conditions were controlled to make the evaluation of each ensemble as similar as possible.

Evaluators conducted four rotations, and a different ensemble was assigned for each rotation. There were four assessment stations within each rotation: (1) extrication and victim drag, (2) victim cutout, (3) decontamination, and (4) victim evacuation.

Assessment Results

Evaluators rated the Class 2 ensembles based on the evaluation criteria established by the NFPA Class 2 ensemble focus group. Each original criterion was assigned to one of the five SAVER categories, and each SAVER category was assigned a weighting factor to indicate its impact on the total composite score. The SAVER category and composite scores are shown in table 1. Higher scores indicate better performance. To view how each ensemble scored against each of the evaluation criteria assigned to the SAVER Program categories, see table 2 (on page 7).

The following sections provide a brief summary of the evaluator comments and feedback on each Class 2 ensemble. The sections present the ensembles from the highest to lowest composite score. For the purposes of this SAVER Summary, the category scores are normalized and rounded to the nearest whole number. The complete assessment report includes a breakdown of evaluator comments by individual criterion.

Lion

The Lion received the highest overall score, received the highest evaluator scores in the capability and usability categories, and tied for the highest affordability and maintainability scores. Evaluators reported that the ensemble was the most comfortable to wear of the assessed ensembles. Evaluators found the ensemble material sufficiently thick but still flexible enough for good freedom of movement. Despite their initial reservations about the non-encapsulating garment's horizontal zipper and unique rear entry design, evaluators agreed that the Lion was the easiest assessed ensemble to don and doff. Additionally, the garment's facepiece gasket provided a secure seal around the SCBA facepiece while allowing the evaluators' vision to be unhindered by the additional faceshield used in the totally encapsulating garments. The exposed SCBA facepiece allowed a wider range of vision and eliminated the faceshield fogging problems experienced with the encapsulating garments. The non-encapsulating garment also allowed evaluators to

SAVER Program Category Definitions

Affordability: This category groups criteria related to life-cycle costs of a piece of equipment or system.

Capability: This category groups criteria related to the power, capacity, or features available for a piece of equipment or system to perform or assist the responder in performing one or more responder-relevant tasks.

Deployability: This category groups criteria related to the movement, installation, or implementation of a piece of equipment or system by responders at the site of its intended use.

Maintainability: This category groups criteria related to the maintenance and restoration of a piece of equipment or system to operational conditions by responders.

Usability: This category groups criteria related to the quality of the responders' experience with the operational employment of a piece of equipment or system. This includes the relative ease of use, efficiency, and overall satisfaction of the responders with the equipment or system.

Table 1. Class 2 Protective Ensembles Assessment Results[1]

Class 2 Protective Ensembles	Composite Score	Affordability (25% Weighting)	Capability (25% Weighting)	Deployability (10% Weighting)	Maintainability (5% Weighting)	Usability (35% Weighting)
Lion	**73**	66	64	64	76	86
Lakeland	**66**	68	59	72	71	68
Kappler	**65**	60	60	75	70	68
Geomet	**63**	67	56	60	67	67

Note:

[1] Scores contained in the assessment report may be displayed differently. For the purposes of the SAVER Summary, all SAVER category scores are normalized using a 100-point scale and rounded to the nearest whole number.

Pros

- Comfortable
- Excellent mobility
- Wide, clear field of vision
- Excellent glove dexterity and grip
- Storage pockets
- Fire/rescue and tactical versions available
- Detailed user manual
- Minimal garment moisture buildup
- Good bootie to bootie interface
- SCBA accessibility

Cons

- Price
- Unclear instructions for SCBA facepiece gasket
- Unclear doffing instructions
- Unspecified shelf life
- Glove moisture buildup
- SCBA is exposed to contaminants

Lion	Composite Assessment Score: 73

verbally communicate with one another more clearly than the other assessed ensembles. In addition to the exposed SCBA facepiece, the SCBA was also worn on the outside of the garment. While noting the additional risk of contaminating the SCBA harness, evaluators reported that wearing the SCBA outside the garment allowed excellent mobility and unhindered access to the SCBA gauges. They also noted that cylinder exchanges could be made without doffing the garment.

Evaluators also preferred the GORE® CHEMPAK® Ultra Barrier gloves, which are the only gloves certified for use with this ensemble. The glove system was included in the purchase price of the ensemble garment. They reported the glove system provided a snug fit and excellent dexterity for effectively completing gross and fine motor tasks. Evaluators were able to easily grasp objects, pick up items from a flat surface, and write using fine point markers.

The ONGUARD Hazmax® 87012 boot was worn with all of the ensembles during the assessment. Evaluators consistently described the boots as rugged, lightweight, and comfortable. Evaluators reported that the ONGUARD boot worked well with the Lion garment. The garment boot wells were long enough for the height of the boots, and the boots comfortably accommodated the garment's bootie material. The garment also had convenient hook and loop adjustment tabs at the ankles and wrists to provide additional security to the boot and glove interfaces. The ONGUARD boot is the only boot currently certified for use with the ensemble under the 2007 edition of the NFPA 1994 standard.

Evaluators did note some disadvantages for the ensemble. Although they found the manual easy to understand with detailed instructions, it did not include clear instructions and illustrations for properly sealing the gasket around the facepiece. Evaluators also commented that the instructions for safely doffing the garment after decontamination were unclear, and the non-encapsulating garment does not provide protection for the SCBA.

Lakeland

The Lakeland ensemble received the second highest overall score and tied for the highest evaluator score in the affordability category. Some evaluators found the Tychem garment material to be comfortable and pliable while others commented that it was stiff and heavy. They added that the reinforced knees were an advantage. Evaluators noted that the Lakeland garment was spacious and allowed plenty of room for the SCBA. The garment was easy to don and doff with assistance, and evaluators commented that the large zipper pull was easy to grasp and use, even when wearing gloves.

The ONEGlove® Hazmat glove system worn in the assessment is the only glove certified for use with this ensemble, and was included in the purchase price of the garment. Evaluators agreed the ONEGlove Hazmat glove system allowed adequate dexterity for completing the assessment tasks.

Pros

- Ample room for SCBA
- Large, rugged zipper pull
- Reinforced knees for tear resistance
- Certified with any CBRN SCBA certified by NIOSH as compliant with NFPA 1981
- Easy to don and off garment and gloves
- Protects SCBA
- Price

Cons

- Excessive hood/faceshield height
- Distorted vision
- Limited mobility
- Minimal fine glove dexterity
- Limited downward vision
- Booties not comfortably accommodated by boots

Lakeland	Composite Assessment Score: 66

Evaluators were confident that the boot interface remained sealed during the assessment activities. They reported that the garment leg wells were long enough to ensure that no garment bootie material was exposed, and the boot flaps sufficiently covered the boot. The ONGUARD Hazmax 87012 boot is the only boot currently certified for use with the ensemble under the 2007 edition of the NFPA 1994 standard.

There were noted disadvantages with the Lakeland Class 2 ensemble. Evaluators stated they were required to remove their hands from the gloves and pull their arms out of the garment sleeves in order to access the SCBA gauge and to adjust the SCBA harness and straps. The hood and faceshield section of the garment was very large, and evaluators considered its height to be a hindrance. Due to its height, the large faceshield area did not provide the field of vision that the evaluators expected. The dual layer faceshield caused vision to be slightly distorted and made focusing difficult. Faceshield fogging also created visibility problems for the evaluators.

There were also noted disadvantages for the gloves and boots worn with the Lakeland ensemble. Evaluators stated that dexterity while wearing the ONEGlove Hazmat glove system was limited to only gross motor movements and fine motor movements were almost completely lost. The surface of the outer gloves was slick which made it difficult for evaluators to grasp smaller objects. In addition, they pointed out the heavier Lakeland bootie material caused some chaffing and irritation at the heels and toes while wearing the ONGUARD Hazmax 87012 boot.

Kappler

The Kappler ensemble received the third highest overall score, received the highest evaluator score in the deployability category, and tied for the highest maintainability score. Evaluators commented that the fabric was pliable and did not restrict mobility as much as the Lakeland. They also noted the garment became more comfortable the longer it was used. Overall, evaluators noted only slight differences in the comfort and mobility afforded by all of the assessed totally encapsulating garments. However, they noted the Kappler garment allowed the most freedom of movement of the three. Evaluators agreed that both donning and doffing required the help of only one assistant and was accomplished quickly and easily. The zipper pull was large and easy to grasp, even when wearing gloves. Evaluators noted that the faceshield provided a good horizontal field of vision.

	**Pros**	• Detailed instruction manual • Wide field of vision • Easy to doff • Good mobility for a totally encapsulating garment • Detachable storage pocket inside suit • Certified with any CBRN SCBA certified by NIOSH as compliant with NFPA 1981 • Also certified with Tingley HazProof 82230 boots • Available in charcoal gray • Storage/carry case • Protects SCBA • Price
	Cons	• Difficult to don glove system • Excessive inner glove material • Minimal fine glove dexterity • Rapidly fogging faceshield • Difficult to maneuver garment around SCBA when donning
Kappler	**Composite Assessment Score: 65**	

The only glove system currently certified for use with this ensemble is the GUARDIAN™ CP- 25 butyl rubber middle glove with the Ansell Kevlar® K2300 outer glove. The glove system was included with the ensemble garment. Evaluators reported that the glove system was comfortable and that dexterity actually improved when the outer glove was wet.

Evaluators were confident that the boot interface remained sealed during the assessment activities. They reported that the garment leg wells were long enough to ensure that no garment bootie material was exposed, and the boot flaps sufficiently covered the boot. Evaluators agreed that the bootie material was comfortably accommodated by the boots. The Kappler ensemble has been certified with the ONGUARD Hazmax 87012 worn in the assessment, as well as the Tingley HazProof® 82230.

Evaluators noted several disadvantages with the Kappler Class 2 ensemble. They stated that the garment was bulky and heavy, and they experienced limited range of motion in the shoulder area. The hood constantly shifted during the assessment activities, forcing them to adjust their body movements. Several evaluators stated they had to remove their hands from the gloves and pull their arms out of the garment sleeves to access and view the SCBA gauges. In addition, the garment did not provide enough room in the rear to easily slide over the SCBA during donning.

Like the Lakeland garment, the Kappler faceshield was also constructed of two separate layers, and several evaluators commented that the layers caused added distortion. Evaluators noted that they had a difficult time looking down without pushing the bottom of the faceshield inward. They experienced some faceshield fogging, but it was not as significant as with the Lakeland and Geomet.

Evaluators found it difficult to remove their hands to remove faceshield fogging without turning the inner gloves inside out. They noted it was very difficult to get their hands back in the gloves. The butyl rubber middle gloves limited dexterity to gross motor movements, and the Kevlar outer glove slipped against the butyl rubber glove–making fine motor movements even more difficult. This difficulty was especially evident when trying to write with the fine point markers used in the assessment.

Geomet

The Geomet ensemble received the fourth highest overall evaluator score and tied for the highest affordability score. Evaluators agreed that the garment material was very sturdy and appeared to be puncture resistant. They reported that the garment was comfortable and roomy. The garment felt protective yet allowed adequate mobility. The hood section of this fully encapsulating garment was very stable and evaluators experienced little or no hood movement during their activities. The size and shape of the ensemble garment easily accommodated the SCBA. In addition, evaluators did not experience as much visual distortion with the garment's single layer faceshield.

Pros

- Easy to don
- Roomy garment
- Minimal moisture buildup in inner gloves
- Stable faceshield
- Certified with any CBRN SCBA certified by NIOSH as compliant with NFPA 1981
- Protects SCBA

Cons

- Limited glove sizes
- Limited glove dexterity and grip
- Small zipper pull
- Faceshield fogging
- Limited peripheral vision
- Difficult-to-follow user manual
- No carry/storage case
- Unspecified manufacture date/expiration date
- Exposed exhaust valve

Geomet — **Composite Assessment Score: 63**

Evaluators reported that the ONEGlove Hazmat glove system was the only glove system certified with this ensemble, and the glove system was included in the garment price. Evaluators were confident that the glove interface remained sealed during the assessment activities.

The ONGUARD Hazmax 87012 boot is the only boot currently certified for use with the Geomet ensemble. Evaluators were confident that the boot interface remained sealed during the assessment activities. They agreed the leg wells were long enough to ensure that no garment bootie material was exposed, and the boot flaps sufficiently covered the boot. Evaluators reported the bootie material was slightly bulky, but the excess material folded easily into the boot and caused no discomfort. The boots allowed sufficient movement while bending and squatting in the garment.

Evaluators noted disadvantages while wearing the Geomet during the assessment. Several evaluators indicated that they had to remove their hands from the gloves and pull their arms out of the garment sleeves to access and view the gauges, while others stated they could easily view the gauges without doing this. Evaluators noted that they experienced difficulty getting arms into sleeves and inner gloves, and they commented that it was difficult to locate the thumb hole on the attached gloves. Once evaluators located the thumb hole, donning became easier. The zipper pull was small and difficult for evaluators to grasp while wearing gloves. The small pull was also difficult to grasp for the data recorders providing donning assistance. The zipper pull broke on one evaluator's suit during doffing. Evaluators noted that peripheral vision was limited. They experienced more heat and moisture buildup and faceshield fogging in this ensemble during the assessment activities. Evaluators noted that the Geomet garment has only one exhaust valve, which may have contributed to the added moisture buildup.

Most evaluators noted that the fingers of the inner gloves did not fit well, and the outer gloves were slightly bulky. Evaluators commented that the gloves did not provide good dexterity. They said the outer gloves were slippery and that plastic items (e.g., permanent markers and swabs) were difficult to manipulate. The O-ring on one evaluator's glove came out of the cuff assembly while doffing, but

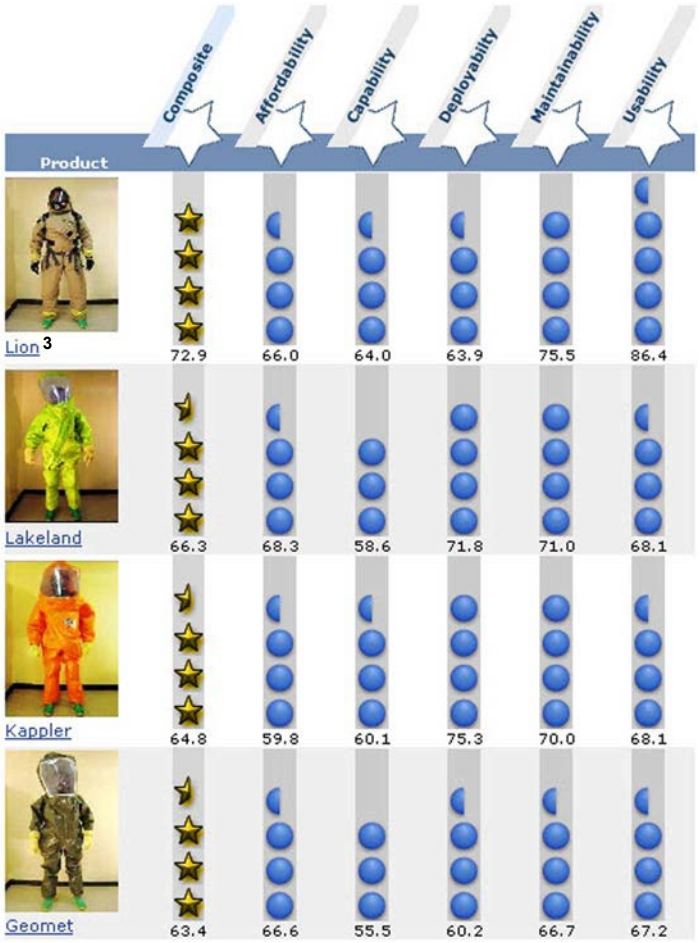
evaluators were able to replace the O-ring using the suit's other glove interface as an example.

Conclusion

Evaluators successfully assessed four Class 2 protective ensembles for use by emergency responders in hazardous environments. Evaluator comments and scores revealed these conclusions:

- Comfort, mobility, and visibility are key factors in overall ensemble satisfaction. Non-encapsulating Class 2 garments are more comfortable to wear, allowing more mobility, and offering better visibility than the totally encapsulating models.
- Glove dexterity is the key factor in glove system satisfaction. Evaluators expressed a strong preference for the GORE CHEMPAK Ultra Barrier glove system.
- Boot sizing is very dependent on the size and type of garment bootie material. Jurisdictions may require a larger or smaller size boot than usual to accommodate the garment bootie material.
- Evaluators expressed more confidence in the protection level of the totally encapsulated garments. Jurisdictions purchasing Class 2 ensembles with non-encapsulating garments may need to provide additional training to ensure their responders fully understand the conditions that allow for the use of an NFPA 1994 Class 2 ensemble.
- Although these components are certified as an ensemble, it appears that the garment manufacturers address only the garments and gloves in their user manuals and maintenance procedures.

QuickLook Snapshot[2]



Notes:

[2] The SAVER QuickLook, available on the SAVER Web site, allows users to select the SAVER categories that are most important to their department and view results according to their specific needs.

[3] Scores contained in the assessment report may be displayed differently. For purposes of the QuickLook, all SAVER category scores are normalized using a 100-point scale.

All reports in this series as well as reports on other technologies are available by request at https://www.rkb.us/saver.

Table 2. SAVER Category and Criteria Scores

KEY Least Favorable → Most Favorable	 Lion	 Lakeland	 Kappler	 Geomet
Assessment Criteria				
Affordability				
Shelf life				
Reusability				
Maintenance cost				
Ensemble testing costs				
Training costs				
Capability				
Puncture resistance				
Faceshield visibility				
Operating conditions				
SCBA selections				
Front or rear model availability				
Glove selections				
Boot selections				
Color availability				
Deployability				
Donning and doffing time				
Ensemble case				
Vehicle space requirements				
Quick reference guide				
Maintainability				
Warranty				
Specific storage requirements				
User maintainability				
Inspection requirements				
Ensemble testing				
Deconability				
Maintenance instructions				
Usability				
Ease of donning and doffing				
Communications abilities				
Comfort				
SCBA interface				
SCBA accessibility				
Glove dexterity				
Hood stability				
Ensemble flexibility				
Glove interface				
Glove sizing				
Boot interface				
User-friendly operation				