Field Durability of Barrier and Seam Performance of GORE® CHEMPAK® Selectively Permeable Fabric in XRT Suits

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Abstract: Law enforcement professionals are concerned about the durability of current ChemBio PPE. To evaluate improved functionality and durability of one of the GORE® CHEMPAK® selectively permeable fabrics, W. L. Gore & Associates undertook an eight-hour field trial of the fabric used in Extended Response Team (XRT) suits. Based on chemical permeation tests, the study indicated that the GORE® CHEMPAK® barrier used in these suits met representative chemical permeation criteria per NFPA 1994, Class 3 requirements after eight hours of wear. Additionally, suit inspection and end-users’ feedback indicated the suit was more durable and comfortable than standard CBRN protective suits.

Objective¹

Many first responders point out that ChemBio personal protective equipment (PPE) tends to lose protective capabilities after extended use. This is extremely detrimental, as any loss of protection increases risk of harm to the first responder. Additionally, the suits tend to be extremely hot and cause first responders to be delayed due to lengthy donning time. Gore undertook an eight-hour field trial to evaluate and quantify the chemical permeation performance of GORE® CHEMPAK® selectively permeable fabric, as used in the Extended Response

¹ Warning: The data in this paper is derived from specific reported and evaluated field data. This paper does not represent data or performance that will necessarily result from other field tests or in use. No products, including garments, footwear, or gloves can provide absolute protection, even when new. Additionally, product performance will decline with wear, tear, abrasion, and other damage associated with use.
Team (XRT) suit, after a long period of use. Furthermore, this study was used to elicit feedback from end-users on the reliability and breathability of the lightweight XRT suit.

**Background**

W. L. Gore & Associates developed a ChemBio protective fabric to be used in the XRT suit, a single-use, breathable suit designed for quick donning without requiring any additional chemical taping. The fabric used in the suit is tailored to meet the demands of ChemBio protection, durability, and comfort from the first responder community. Since ChemBio protective materials can be tested in a variety of ways, which can often lead to confusion about the level of protection actually offered by a material, Gore certifies its ChemBio products to relevant third-party standards. Although several standards are in development, *NFPA 1994 Standard on Protective Ensembles for First Responders for CBRN Terrorism Incidents, 2007 edition* is the only one recognized by the Department of Homeland Security as of January 2009.

This standard offers an excellent basis for characterizing a barrier material’s permeation resistance against chemical warfare agents and toxic industrial chemicals. However, since NFPA 1994 does not specify minimum standards for permeation performance after wear, Gore undertook this field trial to provide additional information for first responders regarding material and seam durability after realistic usage.

**Trial Details**

The XRT ensemble used in the trial was a single-piece coverall with an attached hood and fully integrated gloves and booties. It was created to Gore’s specifications using a GORE® CHEMPAK® selectively permeable fabric, and this ensemble was given to members of a participating law enforcement team. All
members were required to wear a full-face air purifying respirator, and some members chose to wear additional equipment such as gun belts, load-bearing vests, etc.

The trial was a single extended evaluation of the suit during simulated warm zone operations in response to a CBRN terrorism incident. During the eight-hour period, the suits underwent two full don-and-doff cycles and three partial don-and-doff cycles.

Temperatures during the day ranged from 58°F to 83°F, and it was bright and sunny while the participants underwent various selected activities: a two-mile brisk hike, range shooting with hand guns and shotguns, navigation through an obstacle course, and on-scene intelligence gathering. In addition, the entire group was asked to respond to fourteen questions about the performance of the garment and provide feedback using a ranking system.

**Testing and Analysis**

All participants successfully completed the eight-hour field trial without experiencing discomfort due to heat stress, thermal burden, or sweat buildup. After the field trial was completed, Gore performed chemical permeation tests on material and seams according to methodology specified in NFPA 1994 [2007 edition] for Class 3 garments. Thirty representative samples were selected from the garments, and ten samples each were used for three chemicals from the standard: a blister agent, a nerve agent, and a toxic industrial chemical. The results for each chemical permeation test were then tabulated and compared to the Class 3 performance requirements as stated in NFPA 1994 [2007 edition].

**Results and Conclusions**

Inspection of the suits after the wear trial revealed no seam failures, rips, or
punctures through the protective barrier. The permeation test results indicated that the GORE® CHEMPAK® selectively permeable fabric used in the XRT suit exceeded the NFPA 1994, class 3 requirements — even after eight hours of wear — for permeation of the selected chemicals. These results should give the user a great deal of confidence in the barrier’s protective properties in similar situations. Furthermore, the end-user feedback solicited from this test showed that the XRT suit was more comfortable, allowed longer engagement, and was easier to doff and don than traditional CBRN ensembles.

Selection of ChemBio PPE is a critical and multifaceted decision that must take into account both “out-of-bag” and “after-wear” protective performance. While there are many lab tests that can be useful in determining these factors, the only true test is actual field usage. As always, common sense, regular inspection, good judgment, and compliance with manufacturer’s care instructions should be used to maximize the protective capability and life of PPE.

For further details regarding this field trial, please contact Gore at 800.431.GORE (800.431.4673) or at fabrics@wlgore.com.