# Chempak®

## *ULTRA BARRIER FABRIC*

*Enhanced Functionality in Chemical and Biological Environments*

# Chempak®

## ULTRA BARRIER FABRIC

*Enhanced Functionality in Chemical and Biological Environments*

**GORE® CHEMPAK® Ultra Barrier Fabric is ideal when there is a need to complete a physically demanding mission in a chemical or CBRN hazardous environment.**

GORE® CHEMPAK® Ultra Barrier Fabric provides a high level of protection against a broad range of toxic industrial chemicals and chemical and biological warfare agents. This lightweight and flexible protective fabric allows the wearer to have unencumbered movement, increased range of motion, improved peripheral visibility and dexterity.

**Personal Protective Equipment (PPE) garments made of GORE® CHEMPAK® Ultra Barrier Fabric are best suited for performing tactically demanding operations such as:**

- Search and Rescue
- Technical Rescue
- SWAT and High Risk Entry
- Hazardous Material Emergency
- WMD or Terrorist Incident
- Containment and Decontamination

### *Sustainability on scene.*

Wetting down the outer textile layer of GORE® CHEMPAK® Ultra Barrier Fabric promotes heat loss through water evaporation off the garment's surface. When performed during a mission, this practice can significantly reduce the impact of heat stress on the wearer.

### *PROTECTION FROM CHEM/BIO AGENTS AND TOXIC INDUSTRIAL CHEMICALS*

Blister Agents
Nerve Agents
Industrial Chemicals
Bloodborne Pathogens

### *FLAME AND ANTISTAT PROTECTION*

Flame Resistant
Static Dissipative
Non-melt, Non-drip
Incorporates Nomex® Textiles

### *HIGH PERFORMANCE FABRIC*

Excellent Durability
Superior Abrasion
Cut and Tear Resistance
High Strength and Durable Seams

### *COMFORTABLE WEAR*

Lightweight and Flexible
Form Fitting
Quiet

### *REUSABLE*

Maintained protective barrier properties when worn and washed five times in a rigorous field trial[1]

### *USER-FRIENDLY DESIGN FOR RAPID RESPONSE*

Easy to Don and Doff
Comfortable Integrated Booties
Replaceable Gloves
No Taping

### *IDEAL STORAGE CAPABILITY*

Compactable
Long Shelf and Locker Life

[1] "Wear Trial Performance Results of GORE® CHEMPAK® Ultra Barrier Fabrics: Multi-Threat Garment Application," 2005. For a copy of the full wear trial report contact W. L. Gore & Associates.

**Rubber face seal provides secure mask interface with no taping necessary. Accommodates a variety of different mask styles.**

**Replaceable two part glove system is the most dextrous and tactile Chem/Bio protective glove available today.**

**Integrated protective bootie provides comfort and added security. Allows the user more flexibility when selecting footwear.**

FAQs

RE-USABILITY

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CHEMICAL PERMEATION GUIDE

# Chempak®

*ULTRA BARRIER FABRIC*

**Garments made of GORE® CHEMPAK® Ultra Barrier Fabric are certified to meet the following NFPA performance requirements:**

- NFPA 1994 Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, Class 2
- NFPA 1992 Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

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FAQs

# Chempak®

## ULTRA BARRIER FABRIC

# MULTI-THREAT

# Frequently Asked Questions

*Multi-Threat Garment made of GORE® CHEMPAK® Ultra Barrier Fabric*

## *In what operations would Multi-Threat garments be used?*

The Multi-Threat garment is ideally suited when there is a need to complete a physically demanding mission in an environment that poses a potential chemical or CBRN hazard. The Multi-Threat garment, made of GORE® CHEMPAK® Ultra Barrier Fabric, provides a high level of protection against a broad range of toxic industrial chemicals and chemical and biological agents while allowing the wearer to have unencumbered movement, increased range of motion, improved peripheral visibility and dexterity. This garment is best suited for performing tactically demanding operations such as:

***Search and Rescue***
***Technical Rescue***
***SWAT and High Risk Entry***
***Hazardous Material Emergency***
***WMD or Terrorist Incident***
***Containment and Decontamination***

## *What is GORE® CHEMPAK® Ultra Barrier Fabric made of?*

GORE® CHEMPAK® Ultra Barrier Fabric is a three-layer construction made of an impermeable high-strength fluoropolymer barrier film between two flame- and melt-resistant textile layers. For added durability and abrasion resistance, the outer layer is a high strength textile that resists cuts, tears and punctures. This lightweight and flexible multi-layer construction enhances garment fit and comfort while providing broad chemical protection.

## *Does it provide thermal protection?*

The outer layer of GORE® CHEMPAK® Ultra Barrier Fabric is comprised of a 4.5osy NOMEX® IIIA textile which resists melt, drip, and burn, and does not support combustion when exposed to intense heat and flame. The laminate also provides excellent anti-static performance. However, it has no additional insulative layer and does not provide protection for use in high temperature/high flux heat environments.

## *Is this fabric certified?*

Personal protective equipment (PPE) ensembles made with GORE® CHEMPAK® Ultra Barrier Fabric are certified to meet both NFPA 1994 *Standard on Protective Ensembles for First Responder to CBRN Terrorism Incidents, Class 2,* and NFPA 1992 *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies* . These standards apply to the design, manufacture, testing, and certification of new protective clothing ensembles. The fabric is not certified independently of the PPE ensemble.

## *What is the shelf life and proper storage procedure?*

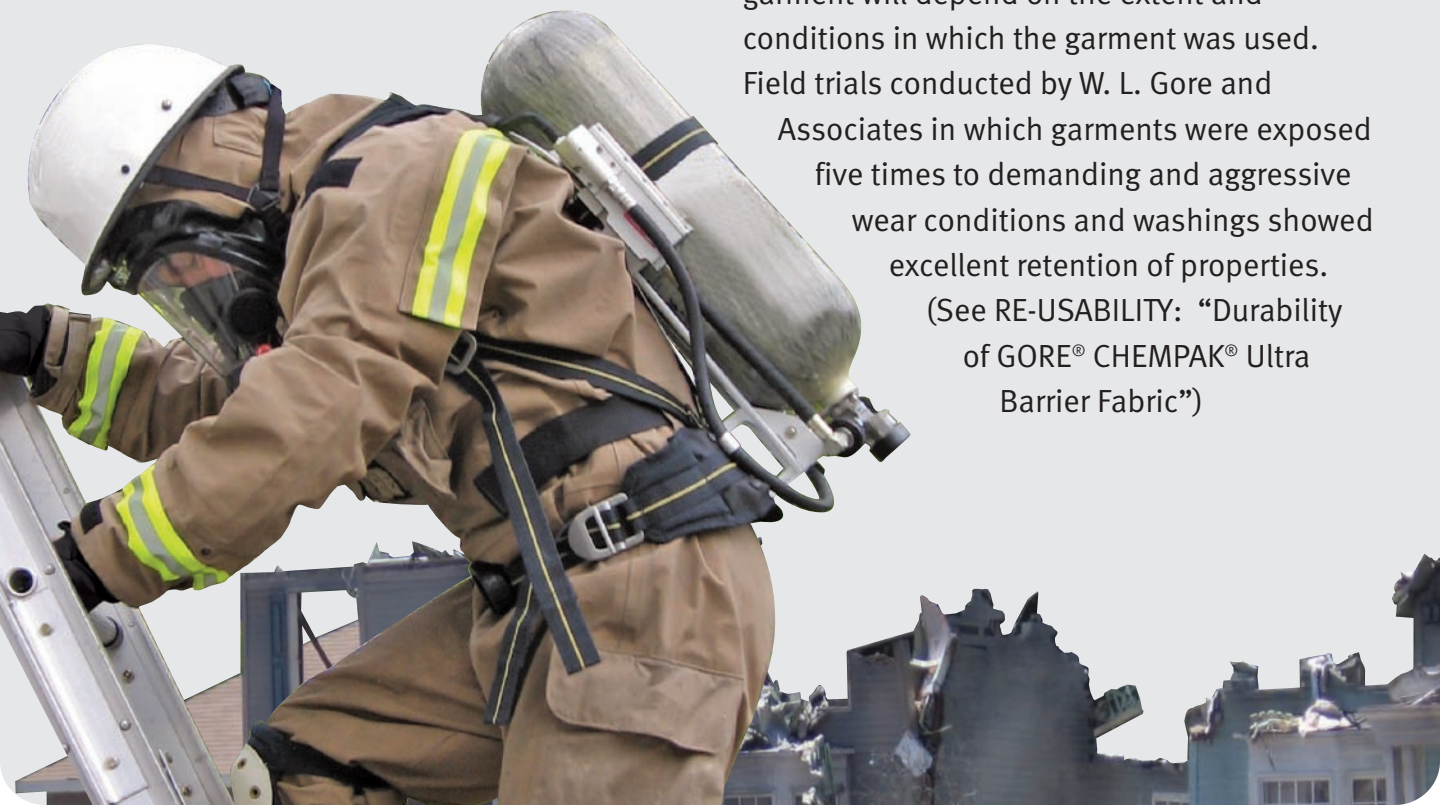
There is no data available indicating the shelf life of all components (e.g. zippers, rubber seals, fasteners, etc.) used in the manufacture of the full PPE ensemble. However, under proper conditions, garments made with GORE® CHEMPAK® Ultra Barrier Fabric can be stored for at least five years. Check the garment manufacturer's User Guide for specific storage instructions.

## *Do ultraviolet rays diminish the protection capability of the garment?*

Intermittent exposure to direct sunlight is acceptable during the normal service life of the garment. However, extended exposure to direct sunlight can cause degradation and discoloration of the flame retardant outer textile and other components of the garment. Therefore, it is recommended that the garment be stored in a cool, dark place.

## *Is the garment re-usable?*

A PPE ensemble made with the GORE® CHEMPAK® Ultra Barrier Fabric is a limited-use garment. As shipped from the manufacturer's factory, the garment is certified to meet both the NFPA 1994, Class 2 standards and NFPA 1992. The actual service life of the garment will depend on the extent and conditions in which the garment was used. Field trials conducted by W. L. Gore and Associates in which garments were exposed five times to demanding and aggressive wear conditions and washings showed excellent retention of properties. (See RE-USABILITY: "Durability of GORE® CHEMPAK® Ultra Barrier Fabric")



## *Can the garment be laundered?*

A garment made with GORE® CHEMPAK® Ultra Barrier Fabric should be cleaned after each use. Although NFPA 1994 addresses single exposure applications, a method for cleaning the garment can be found in NFPA *1851 Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural and Proximity Fire Fighting,* routine hand wash (section 7.2) or advanced machine wash (section 7.3) methods. See the garment manufacturer's User Guide for specific care and maintenance instructions.

## *Can the garment be decontaminated?*

Yes, it can be effectively decontaminated using typical HazMat wet decon methods. If the garment is exposed to a hazardous chemical, and its safe re-use cannot be confirmed by the Authority Having Jurisdiction, it is recommended that the garment be discarded. (See DECONTAMINATION: *"Residual Chemical Concentration Levels in Personal Protective Equipment (PPE) Materials after Chemical Exposure and Decontamination")*

## *Can the garment be repaired?*

Repairs of NFPA certified PPE must follow specific guidelines and must meet specific performance requirements. As such, repairs of garments made with GORE® CHEMPAK® Ultra Barrier Fabric can only be made by the original manufacturer or the manufacturers' authorized cleaning and repair facility. Refer to the garment manufacturer's User Guide for repair instructions.

## *How do I test the product after use?*

The garment should be inspected after every wear and wash for visible signs of damage or degradation. Leaks can be detected by inflation testing, however special care must be taken not to over-inflate at the risk of damage to the garment. The Gore Ensemble Inflation Tester, specifically designed for use with GORE® CHEMPAK® Ultra Barrier Fabric, should be used to test the garment. Contact the garment manufacturer to obtain a Gore Ensemble Inflation Tester. If there is any question regarding the integrity of the suit, discontinue use immediately.

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RE-USABILITY

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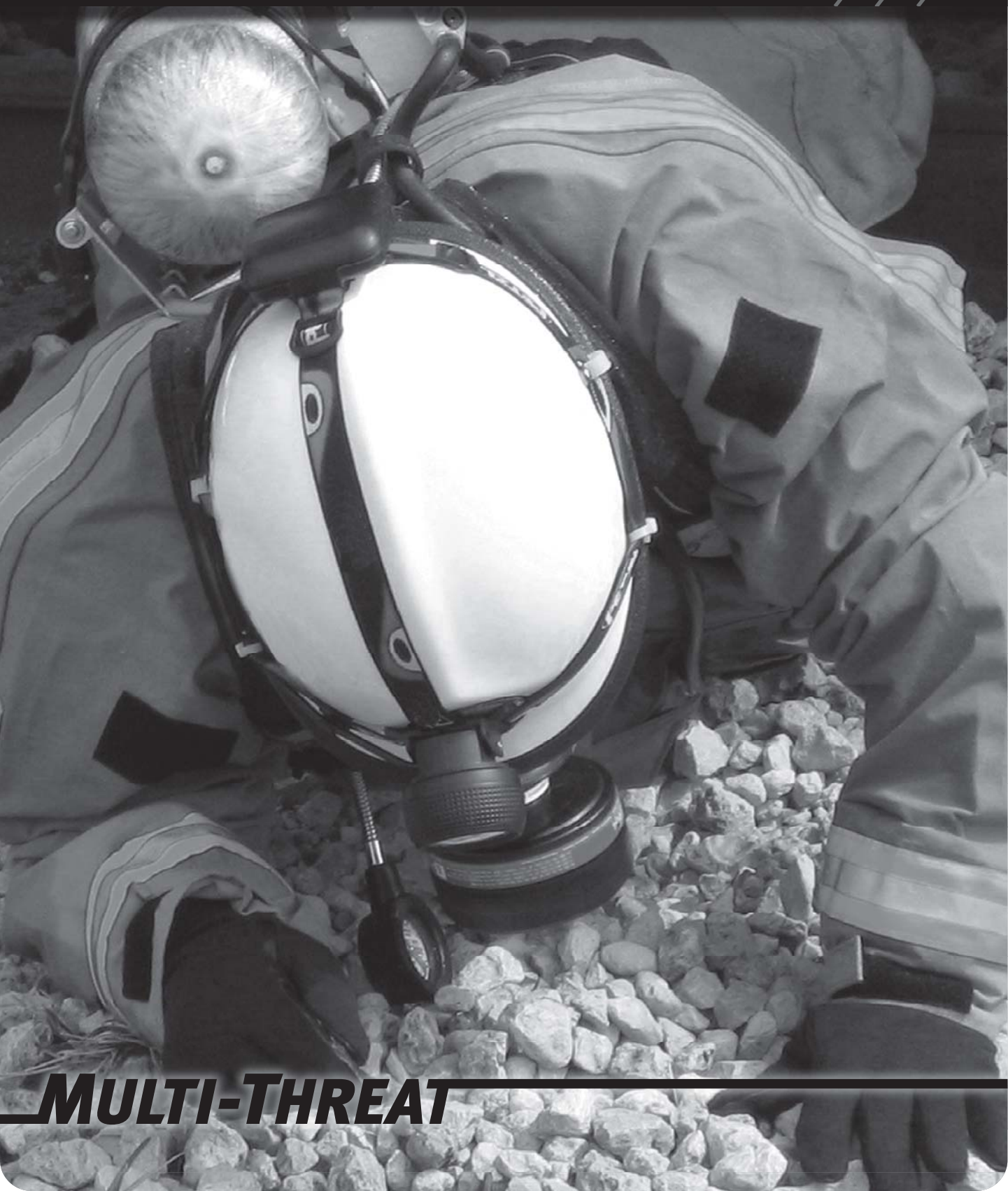

MULTI-THREAT

# Durability of GORE® CHEMPAK® Ultra Barrier Fabric

*Summary of Multi-Threat Garment Performance in a Multiple-Use Wear Trial*[1]

## *Summary*

A field trial was performed on Multi-Threat chemical/biological protective garments made of GORE® CHEMPAK® Ultra Barrier Fabric to determine durability and retention of properties after multiple wearings.

The garments were subjected to five wearings in demanding evolutions emphasizing the need for mobility and durability in abusive environments such as confined spaces and collapsed structures.

Evaluation of the garments' physical and chemical/biological barrier properties after the five wears and launderings revealed GORE® CHEMPAK® Ultra Barrier Fabric still met or exceeded applicable NFPA Standards minimum performance criteria for selected chemical warfare agent and toxic industrial chemical permeation resistance, liquid penetration resistance and barrier physical properties.

## *Background on Re-Usability*

Two standards associated with personal protective equipment for first responders in hazardous materials or terrorism environments *are NFPA 1994 Standard on Protective Ensembles for First Responder to CBRN Terrorism Incidents and NFPA 1992 Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*. Both standards apply to the design, manufacture, testing and certification of *new* protective clothing ensembles. While multiple uses of chemical biological PPE garments is not addressed by either of these standards, in actuality, the reuse of commercially available chemical protective garments is a practice that is often employed by emergency response and industrial personnel. Due to this practice, Gore tested the Multi-Threat garments to determine the properties of GORE® CHEMPAK® Ultra Barrier Fabric and the potential for reuse up to five (5) times.

## *Trial Conditions*

Each Multi-Threat garment was worn in a simulated contaminated environment for a total of five wearings. Each evolution was nominally thirty (30) minutes, but did not exceed sixty minutes, in duration. The garments were subjected to decontamination at the scene and were laundered at a cleaning facility after each evolution. The five wearings consisted of a combination of the following four exercise scenarios:

- Rubble pile victim search and rescue (including transport through culverts)
- Multi-story building victim search and extrication
- Chlorine railcar C-kit repair / leak mitigation
- Leaking 55-gallon drum overpack and transport

## *FIELD TRIAL RESULTS*

**DURABLE GARMENT CONSTRUCTION**
No seam ruptures
No fabric tears

**RETENTION OF MATERIAL PROPERTIES**
Puncture, Propagation, and Tear Strength
Burst Strength
Cold Temperature Stiffness
Shrinkage

**RETENTION OF PERMEATION RESISTANCE TO**
Chemical Warfare agents
Industrial Chemicals

**RETENTION OF PENETRATION RESISTANCE TO**
Viral Challenge
Industrial Chemicals

**RETENTION OF FLAME AND ANTISTAT PROPERTIES**
Vertical Flame
Char Length
Non-melt, Non-drip
Static Decay

[1] "Wear Trial Performance Results of GORE® CHEMPAK® Ultra Barrier Fabrics: Multi-Threat Garment Application," 2005. For a copy of the full wear trial report contact W.L. Gore & Associates.

| Agent and Chemical Permeation | Units | NFPA 1994, Class 2* Standard For New Garment | Field Trial Result After Five Wears and Launderings |
|---|---|---|---|
| **Material** | | | |
| Mustard (HD) | hrs | › 1 | 5.4 |
| Sarin (GB) | hrs | › 1 | › 12.0 |
| Ammonia, 1000 ppm | hrs | › 1 | ›› 3.0 |
| **Seam** | | | |
| Mustard (HD) | hrs | › 1 | › 12 |
| Sarin (GB) | hrs | › 1 | › 12 |
| Ammonia, 1000 ppm | hrs | › 1 | ›› 3 |
| * Tested per the NFPA 1994 standard (2001 Edition) in effect at the time of the study. Current garments are lab certified to the prevailing edition. | | | |

| Chemical and Viral Penetration | Units | NFPA 1992 Standard For New Garment | Field Trial Result After Five Wears and Launderings |
|---|---|---|---|
| **Material** | | | |
| Acetone | % Pass | 100% | 100% |
| Phi X-74 | % Pass | 100% | 100% |
| Air Leak | % Pass | 100%* | 100% |
| **Seam** | | | |
| Isopropyl Alcohol | % Pass | 100% | 100% |
| Phi X-74 | % Pass | 100% | 90% |
| Air Leak | % Pass | 100%* | 100% |
| * Program target, not a NFPA Standard requirement. | | | |

| Garment Strength | Units | NFPA 1994, Class 2 Standard For New Garment | Field Trial Result After Five Wears and Launderings |
|---|---|---|---|
| **Material** | | | |
| Puncture, Propagation, and Tear | $lb_f$ | › 7 | 24.8 |
| Burst Strength | $lb_f$ | › 35 | 334 |
| Cold Water Performance | Nm | ‹ 0.0570 | 0.0031 |
| **Seam** | | | |
| Seam Strength | lbs/2in | › 15 | 191 |
| **Shrinkage** | | | |
| Arm to Arm | % | ‹ 5* | 2 |
| Shoulder to Knee | % | ‹ 5* | 1.9 |
| * Program target, not a NFPA Standard requirement. | | | |

| Flame Resistance and Antistat | Units | Program Target | Field Trial Result |
|---|---|---|---|
| **Vertical Flame (FTM 191A/5903.1)** | | | |
| After Flame | sec | ‹ 2 | 0.5 |
| Char Length | cm | ‹ 10 | 2.7 |
| **Static Discharge (FTM 191A/5931)** | | | |
| Static Decay | sec | ‹ 0.5 | 0.13 |

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DECONTAMINATION

# Chempak®

ULTRA BARRIER FABRIC

MULTI-THREAT

# Residual Chemical Concentration Levels in Personal Protective Equipment (PPE) Materials After Chemical Exposure and Decontamination

*A Comparison of GORE® CHEMPAK® Ultra Barrier Fabric to a traditional multi-layer PPE material*

## Summary

The data from this simulated decontamination study indicate that the GORE® CHEMPAK® Ultra Barrier Fabric can be effectively decontaminated to a level comparable to competitive multi-layer laminate film PPE material.

## Background

This document describes the ability to decontaminate GORE® CHEMPAK® Ultra Barrier Fabric using a simulated HazMat incident wet decontamination method. The GORE® CHEMPAK® Ultra Barrier Fabric was exposed to various chemicals, treated to the simulated decontamination procedure, and tested for the presence of residual chemicals.

The efficacy of actual decontamination procedures and methods will vary depending on the incident and specific chemical to which the garment was exposed. It should be noted that any decision regarding decontamination and reuse of a garment that has been exposed to a hazardous chemical should be made by knowledgeable and informed personnel within the organization that are:

- aware of the type and extent of the chemical exposure
- aware of the toxicity and risks associated with chemical contaminant
- aware of the necessary methods to determine that the garment is safe to reuse
- able to consult with the garment manufacturer and other expertise as needed

## *Testing Protocol*


A FEMA commissioned study ("Non-Destructive Testing and Field Evaluation of Chemical Protective Clothing" EMW-89-C-3045, 1990) examined the efficacy of a simple method to detect residual chemicals in PPE after exposure, wash, and aeration. This procedure was used to evaluate the ability to decontaminate both GORE® CHEMPAK® Ultra Barrier Fabric and Tychem® TK multi-layer film laminate. Both are used as a barrier material for chemical personal protective equipment.

The approach used in the FEMA study is to expose the PPE material to a chemical, clean the material with light brushing using a commonly available detergent/water mixture, and allow the sample to air dry. A sample of the material is heated and off-gasses are collected and analyzed to determine the level of chemical residuals.

This method allows for evaluation of residual chemical at both "gross" and "matrix" contamination levels. Gross contamination is chemical on the material surface that is indicated by stains or discoloration, and is usually more easily removed. The level of gross contamination is determined visually after the material has been washed and dried. Matrix contamination is chemical that has been absorbed into the material, is not readily discernible by the naked eye, and is generally more difficult to remove. The level of matrix contamination is determined by quantitatively analyzing off-gassed residuals.

**The specific steps of the exposure and cleaning procedure are:**

- Saturate surface of specimen with chemical (see Table 1 for list of chemicals)
- After 30 minutes, rinse in cold water for 30 seconds
- Apply 1.2% Tide® Liquid and scrub with a soft brush for 30 seconds
- Rinse in cold water for 30 seconds
- Air dry in ventilated area for 16 hours, at ambient temperature

**The desorption and detection procedures are as follows:**

- Cut a test specimen from the contaminated sample
- Seal in an air tight vial
- Thermally desorb chemical residuals at 160°C for 30 minutes
- Collect and quantify off-gas residuals via gas chromatography

**PPE Materials Tested**

a) GORE® CHEMPAK® Ultra Barrier Fabric, a three-layer laminate construction made of an impermeable high-strength fluoropolymer film between two flame- and melt-resistant textile layers.

b) DuPont Tychem® TK, a three-layer film construction incorporating a nonwoven textile between two non-halogenated barrier films.

Table 1. Residual Chemical Levels after Decontamination

| Chemical | Gross Contamination [1] (Visual Observation) | | Matrix Contamination [2] (µg per 1" diameter specimen) | |
|---|---|---|---|---|
| | GORE® CHEMPAK® Ultra Barrier Fabric | DuPont Tychem® TK | GORE® CHEMPAK® Ultra Barrier Fabric | DuPont Tychem® TK |
| Carbon Disulfide | None | None | 2.2 | 1.5 |
| Hexane | None | None | 0.2 | 0.1 |
| Tetrachloroethylene | None | None | 5.3 | 181.5 |
| Toluene | None | None | 3.0 | 21.0 |
| Ethyl Acetate | None | None | 0.3 | 9.8 |
| Methanol | None | None | 2.6 | 2.9 |
| Acetone | None | None | 0.6 | 6.9 |
| Isooctane | None | None | ‹ 0.09 | 0.2 |
| Acrylonitrile | None | None | 2.1 | 11.9 |
| N,N-Dimethyl Formamide | None | None | 13.4 | 48.3 |
| Methylene Chloride | None | None | 0.3 | 17.5 |
| Diethyl Amine | None | None | 0.1 | 0.3 |

[1] Chemical residuals on a material [2] Chemical residuals held within a material

## Summary of Test Results

• The results indicate that the GORE® CHEMPAK® Ultra Barrier Fabric can be effectively decontaminated using typical wet decontamination methods. Every situation is unique and the user is advised that results may differ in actual use.

• Visual evaluation indicates no observable gross contamination on either PPE material after the wash/rinse/dry steps. No chemical stain or discoloration was visible on any of the specimens indicating that all gross contamination was removed upon washing.

• Analyses of the desorbed off-gasses indicate very low level matrix contamination of the samples. Residual levels measured for the GORE® CHEMPAK® Ultra Barrier Fabric laminate were well below 20 micrograms per one inch diameter sample. The Tychem® TK samples also had residual levels below 20 micrograms per inch diameter sample, except for two chemicals which had residual levels of ‹50 and ‹200 µg per inch diameter sample. Residual chemical levels varied depending on the specific chemical to which the samples were exposed.

• The GORE® CHEMPAK® Ultra Barrier Fabric laminate can be cleaned to a level comparable to the Tychem® TK multi-layer laminate film PPE material.

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HEAT STRESS MANAGEMENT

# Chempak®

## ULTRA BARRIER FABRIC

## MULTI-THREAT

## *Background*

Incident responders are at risk of heat stress when performing physically demanding activities in elevated temperature environments. This risk is further amplified by the use of personal protective equipment (PPE). Heat stress is the net heat load to which a person is exposed including environmental sources of heat, the ambient temperature and humidity, and metabolic heat generated by physical activity. If the body is unable to dissipate sufficient heat, its core temperature could rise above the level necessary to maintain normal function. Physical or mental function could be impaired, or worst case result in death. Individuals vary significantly in their ability to endure heat stress making it a challenge to establish definitive guidelines for managing heat stress (Havenith, 1997).

## *Managing Heat Stress*

Impermeable fabrics provide an excellent protective barrier to hazardous materials. Unfortunately, this protective layer can interfere with the body's most efficient method of cooling – sweating. Particularly in warm environments, donning chemically protective clothing contributes to the heat stress of the wearer.

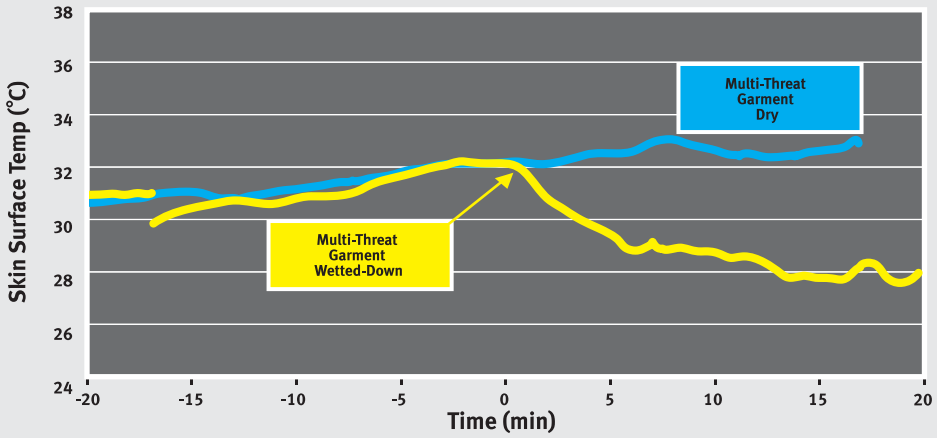
Acclimatization and hydration, the use of work/rest cycles and active cooling on scene are generally accepted practices for managing heat stress for incident responders. Proper PPE selection is also critical to managing heat stress. PPE is worn to protect incident responders from exposure to chemical and biological hazards that may be encountered during potential WMD or HazMat operations. Since no single protective garment is capable of protecting against all hazards, the potential risk factors must be considered when selecting PPE. Ideally, the protective garment will provide the appropriate level of protection while allowing the wearer adequate mobility and dexterity to complete his/her physically demanding activities in the hazardous environment.

## *Evaporative Cooling with Multi-Threat Garment*

While wearing the Multi-Threat garment made with GORE® CHEMPAK® Fabric, an effective way to extended sustainability on scene is to wet down the outside surface of the garment to promote evaporative cooling. This wet-down method entails fully saturating with water, from head to toe, the external textile surface of the Multi-Threat garment. Wetting down the garment has been shown to effectively dissipate metabolic heat generated by the responder. Periodic wet-down results in greater comfort for the wearer and increased ability to stay on scene.

## AVERAGE SKIN TEMPERATURE

**Multi-Threat Garment Wetted-Down at Time = 0**




Reference: "Wear Trial Performance Results of GORE® CHEMPAK® Ultra Barrier Fabrics: Multi-Threat Garment Application," 2005. For a copy of the full wear trial report contact W. L. Gore & Associates.

In a wear trial conducted by W. L. Gore & Associates, incident responders wearing the Multi-Threat garments engaged in physically demanding evolutions. They experienced significant cooling effects when the outside of the garment was wetted-down. The participants' subjective perception of cooling was substantiated by a detectable drop in their skin surface temperature. The skin temperature (average of temperature measured at the chest, back, and thigh) of the participants wearing wetted-down garments was lower by an average of 3˚ to 4˚C than those who wore garments that were dry.

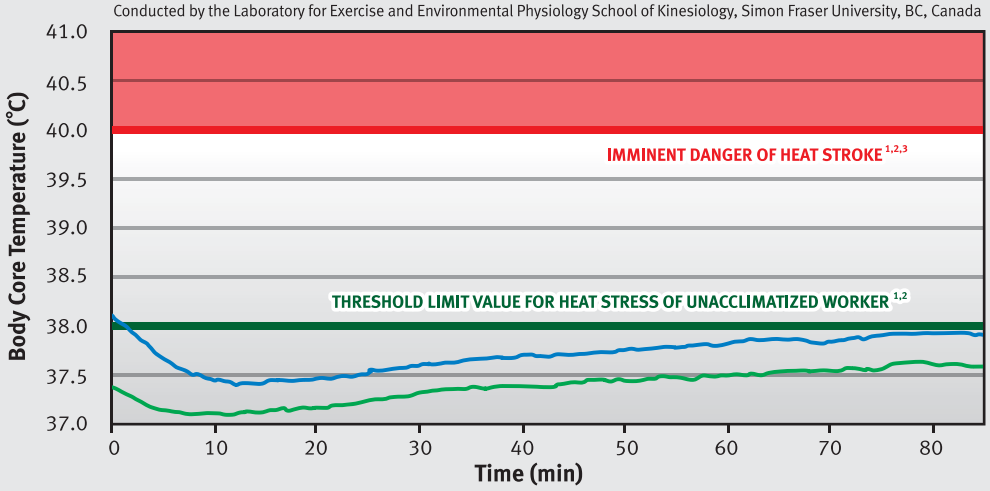
A follow up controlled study performed by the Laboratory for Exercise and Environmental Physiology, School of Kinesiology, Simon Fraser University in Canada, and supported by Gore, confirmed the substantial cooling effect of wetting-down the Multi-Threat garment. (For additional information on the study contact Gore.)

The core body temperature of human subjects was measured as they performed moderate physical exercise in a warm environment. In the study, eight subjects walked on a treadmill in a chamber at 30˚C and 30% relative humidity, maintaining 25% of their maximal heart rate level.

## BODY CORE TEMPERATURE

**Moderate Work Load at 30˚C, 30% Relative Humidity**

Conducted by the Laboratory for Exercise and Environmental Physiology School of Kinesiology, Simon Fraser University, BC, Canada




[1] American Conference of Government Industrial Hygienists
[2] National Institute for Occupational Safety and Health
[3] Malchaire, et al

The subjects conducted the exercise wearing two types of clothing: 1) shorts and a t-shirt and 2) Multi-Threat garment, initially wetted-down prior to the start of exercise, and then every 20 minutes during exercise.

As expected with this level of exercise and environmental conditions, the subjects' core body temperature rose as they generated metabolic heat. The average core body temperature of the subjects wearing only shorts and a t-shirt increased by less than 1˚C over the span of the trial. When wearing wetted-down Multi-Threat garments, the average core temperature rose slightly higher, but still increased to less than 38ºC or the Threshold Limit Value for heat stress of unacclimatized workers (ACGIH, 2007).

## *Selection of GORE® CHEMPAK® Fabric*

The Multi-Threat garment, constructed of GORE® CHEMPAK® Ultra Barrier Fabric, is the PPE of choice for incident responders who balance the need to have a high level of chemical/biological protection with the demands of completing physically demanding missions. This garment meets the performance requirements of *NFPA 1994, Class 2, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents and NFPA 1992 Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*. Made of lightweight and flexible fabric, it provides mobility, dexterity, fit, and comfort to the wearer. The additional benefit of evaporative cooling imparted by wetting-down the garment allows the wearer to extend his/her sustainability on scene. Protective garments made of GORE® CHEMPAK® Ultra Barrier Fabric enhance the incident responder's overall functionality and ability to complete tactically demanding missions in a hazardous environment.

**References:**


American Congress of Government Industrial Hygienists (ACGIH) (2007), Threshold limit values for chemical substances and physical agents and biological exposure indices.

Havenith, G., (1997) Individual heat stress response, Catholic University Nijmegen.

Malchaire, J., Kampmann, B., Havenith, G., Mehnert, P., and Gebhardt, H.J., (2000), Criteria for estimating acceptable exposure times in hot working environments: a review. Int Arch Occup Environ Health, 73, 215-220.

National Institute for Occupational Safety and Health (NIOSH) (1986), Revised criteria for recommended standard - occupational exposure to hot environments.



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NFPA STANDARDS
AND FABRIC COLOR SWATCHES

# Chempak®

ULTRA BARRIER FABRIC


## MULTI-THREAT

## *NFPA STANDARDS*

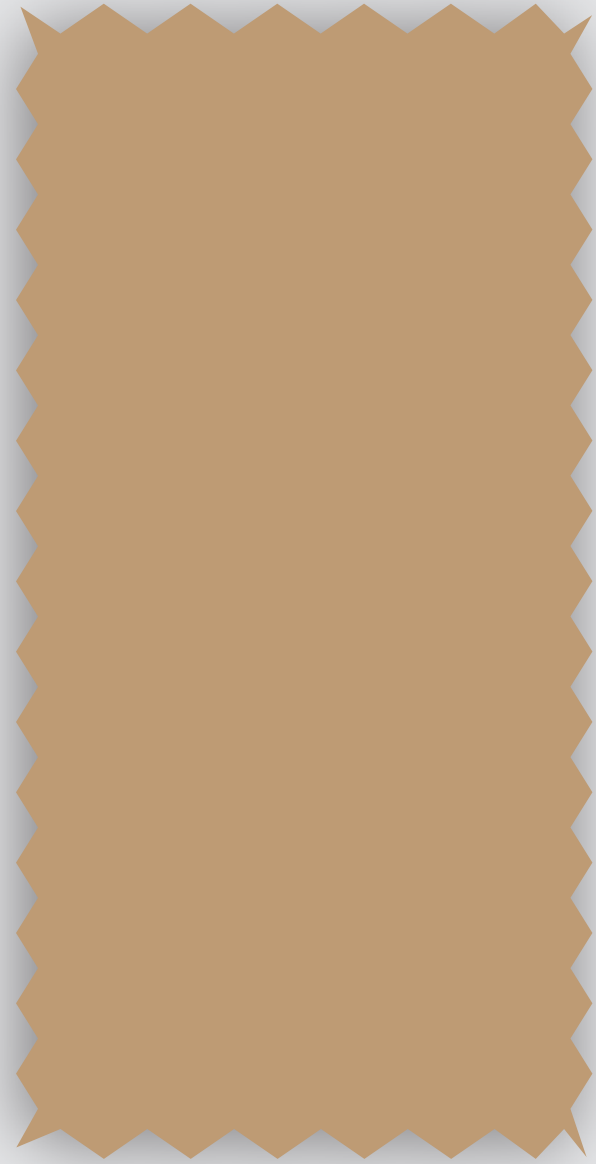
Two NFPA standards address the need to protect first responders from threats encountered in hazardous materials emergencies or domestic terrorism incidents. These standards apply to the design, manufacture, testing, and certification of *new* protective clothing ensembles.

- *NFPA 1994 Standard on Protective Ensembles for First Responder to CBRN Terrorism Incidents* establishes requirements for personal protective equipment (PPE) for personnel operating in chemical or biological terrorism incidents.
- *NFPA 1992 Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies* is designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments.

GORE® CHEMPAK® Ultra Barrier Fabric is used to manufacture PPE garments that meet the requirements for NFPA certification. The Multi-Threat garment, made with GORE® CHEMPAK® Ultra Barrier Fabric and certified to meet both NFPA 1994 and NFPA 1992 standards, provides a high level of protection against a broad range of toxic industrial chemical and biological agents.

***GORE® CHEMPAK® Ultra Barrier Fabric is available in the following colors.***

Tan



Navy

# NFPA 1994 STANDARD ON PROTECTIVE ENSEMBLES FOR FIRST RESPONDERS TO CBRN TERRORISM INCIDENTS (CLASS 2), 2007 Ed.

| NFPA 1994, CLASS 2 ENSEMBLE OVERALL FUNCTION AND INTEGRITY | | | |
|---|---|---|---|
| | | Requirement | MULTI-THREAT Typical Results |
| Man-in-Simulant Test* (MIST) | Physiological Protective Dosage Factor (PPDF) | ≥ 360 PPDF | › 2100 PPDF |
| Liquid Tight Integrity | 20 min Spray | No Liquid Penetration | PASS |
| Overall Ensemble Function and Integrity | Task Complete within 20 Minutes | Qualitative Evaluation | PASS |

* Complete ensemble tested with gloves, footwear, and respirator.

| NFPA 1994, CLASS 2 GARMENT AND SEAM ELEMENT REQUIREMENTS | | | |
|---|---|---|---|
| CHEMICAL PERMEATION | Max Level | Minimum Required Time | MULTI-THREAT Typical Results |
| Mustard (HD) | ‹ 4 µg/cm² | 60 min | › 720 min |
| Soman (GD) | ‹ 1.25 µg/cm² | 60 min | › 720 min |
| Dimethyl Sulfate (DMS) | ‹ 6 µg/cm² | 60 min | › 480 min |
| Acrolein | ‹ 6 µg/cm² | 60 min | › 480 min |
| Acrylonitrile | ‹ 6 µg/cm² | 60 min | › 480 min |
| Ammonia ($NH_3$) | ‹ 6 µg/cm² | 60 min | › 480 min* |
| Chlorine ($Cl_2$) | ‹ 6 µg/cm² | 60 min | › 480 min* |

* Test stopped due to equipment limitations.

| VIRAL PENETRATION | Requirement | Minimum Required Time | MULTI-THREAT Typical Results |
|---|---|---|---|
| Phi-X-174 Resistance | No Penetration | 60 min | PASS |

| MATERIAL PERFORMANCE | Requirement | MULTI-THREAT Typical Results |
|---|---|---|
| Burst Strength | › 35 lbf | › 310 lbf |
| Puncture, Propagation, and Tear Resistance | ≥ 7 lbf | › 12 lbf |
| Cold Temperature Bending Moment, @ -25˚C and 60 degree angle | ≤ 0.057 N-m | ‹ 0.007N-m |
| Seam Break Strength | ≥ 15 lbf/2 in | › 190 lbf/2 in |

# NFPA 1992 STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2005 Ed.

| NFPA 1992, GARMENT OVERALL FUNCTION AND INTEGRITY | | | |
|---|---|---|---|
| | | Requirement | Typical Results |
| Liquid Tight Integrity | 20 min Spray | No Liquid Penetration | PASS |
| Overall Garment Function and Integrity | Task Complete within 20 Minutes | Qualitative Evaluation | PASS |

| NFPA 1992, GARMENT ELEMENT AND SEAM REQUIREMENTS | | | | |
|---|---|---|---|---|
| CHEMICAL PENETRATION | Chemical | Requirement | Minimum Required Time | Typical Results |
| MATERIAL | Acetone | No Visible Penetration | 60 min. | PASS |
| | Dimethylformamide | | | PASS |
| | Ethyl Acetate | | | PASS |
| | Nitrobenzene | | | PASS |
| | Sodium Hydroxide | | | PASS |
| | Sulfuric Acid | | | PASS |
| | Tetrahydrofuran | | | PASS |
| SEAMS | Isopropyl Alcohol | No Visible Penetration | 60 min. | PASS |
| | Sulfuric Acid | | | PASS |

| MATERIAL PERFORMANCE | Requirement | Typical Results |
|---|---|---|
| Burst Strength | ≥ 30 lbf | › 310 lbf |
| Puncture, Propagation, and Tear Resistance | ≥ 5.6 lbf | › 12 lbf |
| Cold Temperature Bending Moment, @ - 25˚C and 60 degree angle | ≤ 0.68 N-m | ‹ 0.007N-m |
| Seam Strength | ≥ 15 lbf/2 in | › 190 lbf/2 in |

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CHEMICAL PERMEATION GUIDE

# Chempak®

ULTRA BARRIER FABRIC

## MULTI-THREAT

# CHEMICAL PERMEATION GUIDE

This information is intended to provide guidance to those with technical ability to evaluate the applicability of this data to the specific hazards for their end-use application. The user has the responsibility to determine the proper protective equipment needed for their actual conditions of use.

All data are based on *ASTM F 739 Standard Test Method for Permeation of Liquids and Gases through Protective Clothing Materials under Conditions of Continuous Contact* (chemical challenge 100% concentration and 0.1 µg/cm²/min breakthrough end point) except where modification is footnoted.

| CHEMICAL | Time to Breakthrough (minutes) | Footnote |
|---|---|---|
| Acetone | >480 | |
| Acrolein | >480 | (1) |
| Acrylonitrile | >480 | (1) |
| Ammonia | >480 | |
| Benzyl Chloride | >480 | |
| Carbonyl Chloride (CG) | >390 | (2,6) |
| Chlorine | >480 | (2) |
| Chloroform | >480 | |
| Cyanogen Chloride (CK) | >450 | (2,6) |
| Dimethy Sulfate (DMS) | >480 | (3) |
| Ethyl Ether | >480 | |
| Hexane | >480 | |
| Hydrogen Fluoride, HF (Gas) | 43 | |
| Hydrofluoric Acid (48%) | >480 | |
| Hydrochloric Acid (37%) | >480 | |

| CHEMICAL | Time to Breakthrough (minutes) | Footnote |
|---|---|---|
| Hydrogen Chloride (Gas) | >480 | |
| Hydrogen Cyanide (HCN) | >480 | (2) |
| Hydrogen Peroxide (50%) | >480 | |
| Hydroiodic Acid (55%) | >480 | |
| Lewisite (L) | >720 | (4) |
| Methanol | >480 | |
| Mustard (HD) | >720 | (4) |
| Nitric Acid (70%) | >480 | |
| Sarin (GB) | >720 | (5) |
| Sodium Hydroxide (50%) | >480 | |
| Soman (GD) | >720 | (5) |
| Sulfuric Acid (98%) | >480 | |
| Thionyl Chloride | >480 | |
| Toluene | >480 | |
| V-Agent (VX) | >720 | (5) |

**Footnotes:**

Industrial chemicals and chemical warfare agents are tested per method outlined in NFPA 1994 Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents, Class 2, Edition 2001 or 2007.

(1) Chemical challenge concentration 350 ppm and 6 µg/cm² breakthrough end point.
(2) Chemical challenge concentration 1000 ppm and 0.1 µg/cm²/min breakthrough end point.
(3) Chemical challenge concentration 10 g/m² and 0.1 µg/cm²/min breakthrough end point.
(4) Chemical challenge concentration 10 g/m² and 4 µg/cm² breakthrough end point.
(5) Chemical challenge concentration 10 g/m² and 1.25 µg/cm² breakthrough end point.
(6) Test stopped due to equipment limitation.

All permeation data presented are believed to be reliable. They are generated using swatches of fabric under controlled laboratory conditions by independent and accredited third party laboratories.
The data in this guide are subject to revision as additional information and knowledge become available.

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