



CALIFORNIA OFFICE OF EMERGENCY SERVICES

Fire and Rescue Division
3650 Schriever Ave
Mather, CA. 95655
Phone (916) 845-8711
Night-Weekends: (916) 845-8911
Fax: (916) 845-8396



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Fire & Rescue Division Hazardous Materials Section

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SUBJECT: RELIABILITY OF NFPA CERTIFIED 1991 AND 1994 CHEMICAL PROTECTIVE CLOTHING ENSEMBLES TO VIRAL THREAT ENVIRONMENTS

The current focus and attention regarding the Ebola virus outbreaks has attracted a great deal of attention in the media and civilian world. There have been many instances of assumptions, misinformation, and in some cases a creation of a general atmosphere of confusion. We must guard against this situation spreading into the Emergency Response arena.

The most important question a typical emergency responder, and especially members of a hazardous materials response team, would want to ask is:

Do the chemical protective clothing garments as carried by a Type 3, Type 2, and Type 1 HMRT in California provide adequate protection against Ebola (and other viral threats)?

The answer is – YES. Provided that the following stipulations are followed:

- The garments must meet an appropriate NFPA standard (1991 and/or 1994).
- Proper donning and doffing protocols are strictly followed.
- No exposed skin can be allowed.
- Proper decontamination protocols for viral/bacteria threat contaminants are followed.

NFPA STANDARD 1991: (Totally Encapsulating)

The testing criteria included in **NFPA Standard 1991** are designed around 21 specific aggressive target industrial chemicals. Chemical resistance performance of a CPC garment material is measured as to how well it repels (prevents) the movement of a target industrial chemical through the CPC material. This is at the molecular level and is called a “permeation” test. These are very tough tests. No permeation of the target chemical, in each of the separate tests, can be allowed for one hour of continuous contact – not even one molecule. This test is repeated 21 times.

The Ebola virus is about 80 nanometers wide and about 1000 nanometers long, like a piece of spaghetti. A chlorine molecule is about 0.015 nanometers wide, or over 5000 times smaller than the Ebola.

Therefore, it can be postulated with confidence that the permeation resistance capability of a certified **NFPA Standard 1991** garment is an adequate and excellent barrier to viral substances.

NFPA STANDARD 1994 – Class 2 Garment:

The testing criteria included in **NFPA Standard 1994 – Class 2 Garment** are designed around only five (5) industrial chemicals, and two (2) WMD chemicals. Performance is again measured as to how well it repels (prevents) the movement of a target chemical through the CPC material at the molecular level (permeation).

However, this CPC standard also includes a specific test to measure the resistance to viral substances in liquid form. This is a “penetration” resistance test. Please refer to the table below. It will explain further the purpose and the performance of the “*Viral Penetration Resistance Test*”, as well as a “*Liquid Tight Integrity*” test.

NFPA Standard 1994 – Class 2 Ensembles: Applicable Test Results

Section and Test	Description	Purpose	Performance	Analysis
8.4 - LIQUID TIGHT INTEGRITY TEST # 1	Entire Garment Ensemble, mounted on a mannequin, shall be sprayed with water from all directions for a period of 20 minutes.	To confirm and document penetration resistance to water molecules through the garment material, gloves, and footwear, and to all associated interfaces.	Any amount of liquid water found on the inside of the ensemble or on the interior surface, shall constitute failure. Evidence of water migration through the garment material or interfaces is not allowed.	1994-Class 2 Ensembles, when properly donned, provide a suitable barrier to the inward migration of liquid water (water molecules) for at least 20 continuous minutes of direct contact.
8.22 – LIQUID TIGHT INTEGRITY TEST # 2	Surfactant treated (softened) water shall remain inside the specimen (glove, footwear) for a period of 1 hour, in accordance with ASTM D5151: <i>Standard Test Method for Detection of Holes in Medical Gloves</i>	A more demanding test for liquid-tight integrity.	Any evidence of outward leakage of the softened water shall constitute failure.	1994-Class 2 glove and footwear components, when properly donned, provide a suitable barrier to the migration of water for at least 1 full hour of continuous contact.
8.21 – VIRAL PENETRATION RESISTANCE TEST	A bacteriophage test using ASTM F1671 <i>Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens</i> , for 1 hour.	To confirm and document penetration resistance to viral threats through the garment material, gloves, and footwear, and to all associated interfaces.	Any evidence of liquid bacteriophage leakage (penetration) through the material shall constitute failure.	1994-Class 2 Ensembles, gloves, and footwear, when properly donned, provide an excellent barrier to the migration of viral-threat liquids for at least 1 hour.

Therefore, it can be postulated that the protection that an **NFPA Standard 1994 – Class 2** garment ensemble can afford the wearer in providing a reliable resistance barrier to liquid viral threats is very good to excellent.

DECONTAMINATION – CPC:

For cleansing and decontamination of Chemical Protective Clothing, the USAMRIID document recommends preparing a solution of 5% sodium hypochlorite. Common household bleach (i.e. Chlorox®, Purex®) is already about 5%. Set up a Decontamination Corridor in accordance to your local protocols. Be sure to use large and adequately spacious collection stations (portable sumps) to collect all runoff contaminant water at each station. The entire area should be well tarped to trap all overspray.

It is recommended by the USAMRIID document to cleanse for at least 3-5 minutes. Then follow by a cleanse regimen using a soft liquid soap. The soft liquid soap will act as a surfactant to trap the sodium hypochlorite solution which now can be easily rinsed off. The use of long handled car wash type scrub wands with soft bristles will encourage the reduction of overspray upon the Decon Worker. The recommendation not to use short handled brushes and sponges will also encourage the reduction of overspray upon the Decon Worker.

- DO NOT USE STIFF-BRISTLED BRUSHES
- DO NOT USE SHORT HANDLED BRUSHES
- DO NOT USE SPONGES
- DO NOT USE LIQUID DETERGENT or HARSH STRONG SOAPS
- DO NOT USE THE 5% HYPOCHLORITE SOLUTION ON HUMAN SKIN

The above information regarding the use of the sodium hypochlorite decontamination solution is based upon:

Medical Management of Biological Casualties, Handbook, by the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), Fort Detrick, Maryland, page 110.

Management of Chemical Warfare Agent Casualties, Dr. Frederick R. Sidell, U.S. Army Medical Department, Department of Defense, Fort Detrick, Maryland, page 15.