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SWATCH TEST RESULTS OF COMMERCIAL CHEMICAL PROTECTIVE GLOVES TO CHALLENGE BY CHEMICAL WARFARE AGENTS: EXECUTIVE SUMMARY

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Swatches from eleven commercially available chemical protective gloves were challenged with liquid droplets of Sarin (GB) and mustard (HD) using modifications of the static diffusion described in TOP 8-2-501. The cumulative mass of each agent that permeated each swatch was determined over time and the results for all swatches were used to determine an average cumulative mass for each glove. From these data, a breakthrough time was calculated for each glove/agent combination for purposes of comparisons.

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Executive Summary

As part of the Domestic Preparedness Program, eleven commercially available glove designs were tested to assess their capability to protect in a chemical warfare (CW) agent environment. Swatches of material from each glove design were tested for resistance to permeation for Sarin (GB) and mustard (HD). From this data, the author calculated the estimated time it would take to permeate the glove with sufficient agent to cause physiological effects in a person wearing the glove. The tests are described and the calculated breakthrough times are presented.

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Preface

The work described herein was authorized under the Expert Assistance (Equipment Test) Program for the U. S. Army Soldier and Biological Chemical Command (SBCCOM) Program Director for Domestic Preparedness.

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CONTENTS

TABLES

SWATCH TEST RESULTS OF COMMERCIAL CHEMICAL PROTECTIVE GLOVES TO CHALLENGE BY CHEMICAL WARFARE AGENTS: EXECUTIVE SUMMARY

1. INTRODUCTION

In 1996, responding to Public Law 104–201 (Defense Against Weapons of Mass Destruction Act of 1996), the Department of Defense (DoD) formed the Domestic Preparedness Program. One of the objectives was to enhance federal, state, and local emergency and hazardous material (HAZMAT) response to nuclear, biological and chemical (NBC) terrorism incidents. In some cases, chemical protective gloves may be required to enter a contaminated or potentially contaminated area. Limited data was available concerning the effectiveness of commercially available and commonly used chemical protective gloves as protection against chemical warfare (CW) agents. Recognizing this need, the U.S. Army Soldier Biological and Chemical Command (SBCCOM) established a program to test some of the glove designs, using CW agents and test procedures developed for assessment of military-issue CW protective equipment. A detailed technical report was generated for each glove design tested, and a summary report was prepared that presented the essential results for all the gloves in a single document. Because those reports are rather lengthy and technical, this report was prepared. This report is an overview of the results of the evaluation and is intended primarily for federal, state and local emergency and HAZMAT personnel as an aid in their evaluation (and possible modification) of current work rules regarding specific chemical protective gloves currently in inventory and as an aid in future procurement of appropriate chemical protective gloves.

The glove materials were tested in new, as-received condition. The effects of aging, temperature extremes, laundering, and other factors were beyond the scope of this test program. These tests addressed percutaneous (i.e. skin) protection only.

Each glove design was examined with swatch tests using test methodology taken from Test Operations Procedure (TOP) 8-2-501, Permeation and Penetration of Air-Permeable, Semipermeable and Impermeable Materials with Chemical Agents or Simulants (Swatch Testing). U.S. Army Dugway Proving Ground, UT. 3 March 1997, UNCLASSIFIED Report (AD A322329). In the swatch tests, sample swatches were cut from three pairs of each glove design; two swatches per glove, one from the palm and one from the cuff. These swatches were then exposed to liquid droplets of chemical agents Mustard (HD) and Sarin (GB), and the passage of agent vapor through them measured. Sarin is a non-persistent (volatile) nerve agent, and HD is a persistent blister agent.

2. LIQUID CHALLENGE/VAPOR PERMEATION TEST (SWATCH TEST)

For each glove design under test, twelve swatches (six to be tested with GB and six with HD) were taken from three pairs of gloves. The swatches were placed in a test fixture and a predetermined (10 g/m^2) liquid agent challenge, GB or HD, was applied to the top surface of each swatch, and the fixture sealed. Periodically, over 24 hr, gas samples were taken from below the swatches. The amount of agent vapor that permeated the test swatch at each sampling time was measured using a highly sensitive, accurate, miniaturized gas chromatograph and sampling system known as MINICAMS™ (OI Analytical, CMS Field Products Group, Birmingham, AL).

The cumulative mass of agent vapor, which has permeated each of the swatches at each sampling time, divided by the area of the swatch, is defined as the permeation, M_f.

The permeation for each glove design tested was compared with other glove designs. Normally, continuous exposure to chemical agent would not exceed 8 hr (480 min) because of heat stress and fatigue, so the permeation, which occurs in the subsequent 16 hr, is of less interest.

An average cumulative permeation value (M_f) for each glove design and agent combination was calculated by averaging the M_f values for the six swatches.

Mustard vapor can produce skin irritation (erythema) on the backs of the hands at a dosage (product of concentration and exposure time) of approximately 1039 mg-min/cm^3. Sarin vapor can produce incapacitation at a dosage of approximately 8000 mg-min/m^3. Threshold M_f values were calculated using these dosages. The threshold M_f for HD was 2078 ng/cm^2 and the threshold M_f for GB was 9512 ng/cm^2. The breakthrough time was the time at which the average M_f reached the threshold M_f.

The breakthrough times from all the glove designs are collected and presented in Table 1.

Table 1. Swatch Test Results for Gloves

Item	Breakthrough time, minutes	
	HD	GB
Best Butyl 878-10, 30 mil	810	>1440
Ansell Edmont Thermaprene, 9-024	119	298
Bayside Latex Examination Glove	23	83
Safety Zone Gloves, GL1-NPFL	54	114
MAPA Neoprene, PN1-N450	298	>1440
Ansell Edmont TNT Nitrile, 92-500	20	106
Ansell Edmont PVA, 15-554	577	110
Hahn Fat, PVC, GL1-VC7714R	97	161
Safety 4H Glove	>1440	>1440
Ansell Edmont Sol-Vex, 37-155	109	>1440
Best Viton 890-10, 30 mil	638	>1440

3. CONCLUSIONS AND RECOMMENDATIONS

The test data reveals that the chemical protective glove designs tested can protect the wearers from liquid CW agents. Breakthrough times should not be interpreted as the time that a glove can be safely worn, either for HD or GB. Breakthrough times should only be used to compare glove materials.