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TITLE: Protection Factor of First Responder's Garment

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63. PROTECTION FACTOR OF FIRST RESPONDER'S GARMENT

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PROTECTING OUR FIRST RESPONDERS

First responders to a chemical release at a civilian site need to understand the level of protection offered by its existing equipment. As part of DSO National Laboratories' effort to assist these first responders in responding to chemical release, we conducted a study on the chemical protective properties of some fireman garment. These garment were tested against chemical in both liquid and vapour forms.

TEST MATERIALS

The fireman garment tested was made up of 4 different fabric composites. For instance, at some locations the fabric is 3-layered, while some are 6-layered. Test swatches were obtained from 4 different parts of the garment that have different fabric composites (Fabric Composites A, B, C & D).

CHALLENGE CHEMICAL

The challenge chemical used was 2-chloroethylphenyl sulphide (CEPS), which is a simulant for sulphur mustard (HD). Figure 1 illustrates the structural similarities between the two compounds.

TESTING AGAINST LIQUID CHEMICAL: LIQUID SPOT TEST

About 4 cm² samples were cut from the firemen garment for testing. 1(l droplets of challenge chemical were spiked onto the test sample at contamination level of 10 g/m² (NATO standard). An air stream was passed through the test sample at a flow rate of 200 ml/min and the chemical penetrating through the test material was collected onto a Perkin-Elmer sampling tube packed with Tenax TA adsorbent. The sampling time was 60 minutes. The sampling tubes were analysed using the Perkin Elmer Automatic Thermal Desorption System (PE ATD 400) coupled to Hewlett Parkard 6890 Gas Chromatograph equipped with flame ionisation detector (FID).

TESTING AGAINST CHEMICAL VAPOUR: STATIC DIFFUSION TEST

Circular swatches (diameter 4 cm²) of the garment material were used to evaluate their effectiveness as a physical barrier against the chemical vapour of CEPS. The outer side of the suit material is contacted with static, saturated CEPS vapour while the inner side is lined with an indicator paper which changes from red to blue in the presence of CEPS.

The indicator paper is made from coating filter paper with Congo red and 2,4-dichlorophenyl benzoyl nitrogen chloride C₁₂H₃N(Cl)C(O)C₆H₅. Reaction between CEPS and the nitrogen chloride caused the evolution of an acidic product, which turns the red Congo indicator blue.

The indicator paper is observed for colour change at intervals of 30, 60, 90, 120 and 240 minutes. Full penetration is marked by complete colour change of the indicator paper, which happens when about 0.02 ug/cm² has penetrated. This value corresponds to the US standard for maximum allowable amount of HD for skin contact.

RESULTS

The results of the liquid and vapour tests against the 4 fabric composites are tabulated below. The maximum allowable penetration level for the Liquid Spot Test is 0.02mg.

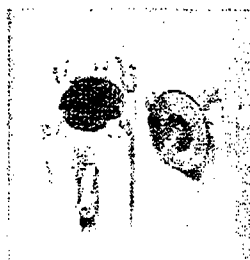
CONCLUSION

The firemen garment as a whole does not provide any appreciable protection against liquid chemicals, even though some parts of the garment (those made from Fabric Composite D) are particularly protective. It is recommended that in situations involving liquid chemical threats, the firemen garment must not be used as a substitute for proper chemical protective suits.

On the other hand, the garment provides protection against chemical vapour for about 30 minutes. Thereafter, ingress of toxic chemicals begins. It is therefore recommended that great caution be exercised when firemen wearing these garments are to operate in a chemical vapour contaminated environment.

FIGURES AND TABLES

Figure 1. The Liquid Spot Test
Preparing the Liquid Spot Test



Liquid Spot Test Underway

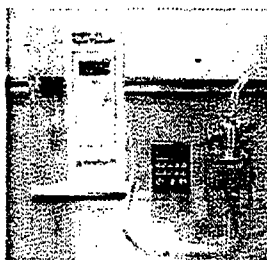


Figure 2: The SD test set-up
SD test Set-up



Blue coloration indicates agent breakthrough.



Table 1. Results of liquid spot and static diffusion tests.

Liquid Spot Test

Fabric	Amount Penetrated in mg
Fabric Composite A	0.75
Fabric Composite B	1.25
Fabric Composite C	0.1
Fabric Composite D	0.01

Static Diffusion Test

Fabric	Initial breakthrough	Complete breakthrough
Fabric Composite A	30 mins	120 mins
Fabric Composite B	30mins	120 mins
Fabric Composite C	> 240 mins	>240 mins
Fabric Composite D	> 240 mins	>240 mins