An Interim Summary Report for Law Enforcement, and Emergency Medical Services Protective Ensemble Testing

Prepared by

The Chemical Weapons Improved Response Program

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Disclaimer

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Preface

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This report has been approved for public release.
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1. Test Objectives.

The lack of affordable Personnel Protective Equipment (PPE) has been identified as a major shortfall in preparing Law Enforcement and EMS personnel to respond to an incident of Chemical Weapon (CW) terrorism. To assist these responder communities, a study/test effort was undertaken to identify a range of low cost commercially available ensembles that could be used on the perimeter of an incident where very low levels of CW contamination may be present. The ensembles consisted of a high quality negative pressure mask, butyl rubber gloves, and a range of chemically protective overgarments.

In responding to this type of event, quality respiratory protection is the most critical aspect of the ensemble. Butyl rubber gloves provide superior protection against CW agents and the addition of a commercially available overgarment (elastic hood & wrist closures with built in boots) will provide liquid splash and some minimal vapor protection. It must be emphasized that this ensemble is intended for responder use in the cold zone only.

Figure 1. APG-EA Entrance
The testing that was conducted is called Man-In-Simulant Test (MIST) and it evaluates skin protection provided by the entire ensemble against chemical agent vapors. The intent of this particular MIST test effort is to demonstrate to the responder communities the levels of protection afforded by these types of protective clothing ensembles. A final report will be published in the summer of 1999 as a follow-on to this interim report.

2. Test Overview.

MIST vapor tests measure the actual absorption of agent vapor simulant (methyl salicylate, basically wintergreen oil) into human skin by using passive samplers located on 17 skin regions of the body. Methyl salicylate is a safe non-toxic ingredient that is commonly used in rubbing compounds such as Bengay®. The samplers are applied directly to the test subject’s skin using a “peel and stick” adhesive on the back of the sampler. Figure 2 shows a passive sampler that has been applied to the neck area of a test volunteer. The sampler’s small plastic pouches are filled with TENAX® powder that adsorbs the simulant vapor (methyl salicylate) at approximately the same rate as human skin.

Figure 2. Sampler Applied to Neck Region

The test subjects dress in either the standard Maryland State Police duty uniform or one of the protective ensembles under evaluation. They are then directed to enter a
chamber filled with methyl salicylate vapor simulant while performing a series of simulated Law Enforcement activities for 30 minutes. After testing is completed, the samplers are removed from the test subjects and the TENAX® adsorbent is carefully removed from the plastic sample pouch and loaded into stainless steel sorbent tubes. The simulant vapor that has been captured by the TENAX® powder is then thermally desorbed and analyzed on a gas chromatograph to determine how much methyl salicylate was adsorbed on each sampler.

3. Test Conduct.

Testing was conducted in partnership with the Maryland State Police at SBCCOM’s MIST Test Facility. The protective suit ensembles that were worn during testing consisted of the following low cost items:

- Commercially available protective suits
- Thin (7 mils) butyl rubber gloves
- Commercially available rubber boots
- Standard respiratory protection (MCU2P Mask)

The only item changed during testing was the suit. This was done because the suit was the only item that was being compared during testing, therefore, all other items were required to be held constant to maintain a valid suit comparison. The reason for basing testing on the suit was twofold. First butyl rubber gloves and rubber boots are standard low cost items used for chemical agent protection, in other words it is well known that variations in the suit and its closures makes the only significant difference in skin vapor protection for protective ensembles. Therefore, the gloves and boots were selected as part of the Law Enforcement protective ensemble with no need for comparison testing. Secondly, MIST testing does not test respiratory protection so a standard negative pressure mask was selected (typical of one that might be used by police officers).

The following is a listing (least expensive to most expensive) and short description of suit configurations tested:

- Standard MD State Police Uniform (Baseline with no suit): Tested to provide a baseline comparison without wearing a protective suit. Was tested wearing the MCU2P mask and butyl rubber gloves. Standard duty dress shoes were worn instead of rubber boots since no protective suit was worn with the standard duty uniform. Also the standard police uniform was worn beneath all suits during testing.
- Tyvek Garage-Type Protective Suit: Used in automobile shops for protection against asbestos when grinding brake pads. Cost less than two dollars.
- TyChem SL Protective Suit, manufactured by Mar Mac, Model # not available (similar to the Lakeland Model # 72150): An upgraded Tyvek suit with an additional layer of chemical agent resistant liner material bonded to the basic Tyvek material. Cost about $15.
• TyChem 9400 Protective Suit, manufactured by Mar Mac, Model 94122: A thicker suit than the TyChem SL, also contains a layer of chemical agent resistant liner material. Noisier, and a little more difficult to move around in. Cost about $35.

• Kappler CPF4 Protective Suit, Model 4T436: Another thicker suit similar to the TyChem 9400. Also contains a layer of chemical agent resistant liner material. Thicker than any of the suits tested; difficult to move around in and noisy. Cost about $35.

• Tyvek ProTech F Protective Suit, Model CE 0120 (CCA LTD SL172TF): Similar to the TyChem SL. Also contains a layer of chemical agent resistant liner material. This suit was deemed the easiest to move around in by the test participants. Cost about $45.

Photos of each suit configuration during actual testing in the MIST chamber are shown in Figures 3-8 below:

Figure 3. Standard Duty Uniform

Figure 4. Tyvek Garage-Type Protective Suit
Figure 5. TyChem SL Protective Suit

Figure 6. TyChem 9400 Protective Suit
Figure 7. Kappler CPF4 Protective Suit

Figure 8. Tyvek ProTech F Protective Suit
4. Test Results.

The laboratory analysis of all passive samplers is used to determine the protection provided to the wearer in terms of a protection factor (PF). The ensemble’s protection factor (PF) is defined as the average exterior dosage divided by the average dosage inside the suit (police officer’s measured skin dosage):

\[ PF = \frac{\text{Exterior Dosage}}{\text{Dosage Inside Suit}} \]

In other words, PF indicates how well the protective ensemble protects the police officer’s skin from chemical agent vapors as compared to the potential exposure without wearing the suit. For example, looking in Table 1 the average PF is 43 for a police officer wearing the Tyvek ProTech F suit with butyl rubber gloves, rubber boots, and MCU2P Mask. That means that the police officer’s skin protection from chemical agent vapors while wearing the Tyvek ProTech F suit will be 43 times better than would be experienced while wearing no protection at all. Listed in Table 1 are the average PF’s for the five suit configurations and the standard Maryland State Police uniform that were tested.

<table>
<thead>
<tr>
<th>Suit Configuration</th>
<th># Suits Tested</th>
<th>Average Overall PF</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard MD State Police Uniform</td>
<td>3</td>
<td>2</td>
<td>0.7</td>
</tr>
<tr>
<td>Tyvek Garage-Type Protective Suit</td>
<td>4</td>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>TyChem SL Protective Suit</td>
<td>5</td>
<td>26</td>
<td>12.0</td>
</tr>
<tr>
<td>TyChem 9400 Protective Suit</td>
<td>4</td>
<td>17</td>
<td>4.3</td>
</tr>
<tr>
<td>Kappler CPF4 Protective Suit</td>
<td>4</td>
<td>18</td>
<td>3.0</td>
</tr>
<tr>
<td>Tyvek ProTech F Protective Suit</td>
<td>5</td>
<td>43</td>
<td>13.0</td>
</tr>
</tbody>
</table>

The Tyvek ProTech F suit demonstrated the best overall protection of the suits evaluated (PF of 43) and provided the greatest freedom of movement as reported by the test volunteers. However, the Tyvek ProTech F suit ripped during previous firefighter testing indicating that the material is not as durable as ensembles made of thicker materials. The firefighter that tore the Tyvek ProTech F suit was the tallest test participant. It was apparent that his large size was also a factor in the suit ripping; which indicates the need for oversized garments to be worn for the Tyvek ProTech F suit. As a result, it is recommended that for any protective suit worn by Law Enforcement agencies, that the officers should wear oversized garments (i.e., one or two sizes larger than normal). The Tyvek ProTech F was also the most costly suit at approximately $45 per suit.
The TyChem SL was the next best suit overall (PF of 26) and was very inexpensive at approximately $15 per suit.

The TyChem 9400 and Kappler CPF4 suits offered comparable protection (PFs of 17 and 18 respectively). These suits had lower protection than the Tyvek ProTech F and TyChem SL suits primarily because they had larger openings around the neck area (see figure 9 below). Other models of the TyChem 9400 suit were found (after the testing) that had better seals around the neck area (Lakeland Model # 94165). Also the test participants indicated the TyChem 9400 and Kappler CPF4 suits (because of their thickness) were harder to move around in than the Tyvek ProTech F and TyChem SL suits.

The Tyvek garage-type suit offered only slightly better protection than the MD State Police standard duty uniform. Vapor seemed to pass right through this suit.

Figure 9. Open Area at Neck (TyChem 9400)
5. Conclusions.

This analysis effort demonstrates that Law Enforcement and EMS personnel can be equipped with an effective low-cost clothing ensemble when responding to an incident of CW terrorism. An ensemble consisting of a high quality respirator, butyl rubber gloves and a commercial chemical overgarment (elastic wrists & hood closures with built in boots) provides liquid splash and some minimal vapor protection to the responder. This level of protection is excellent for personnel working on the perimeter (cold zone only) of an incident. However, it must be emphasized that this clothing ensemble is inadequate protection for areas where significant levels of CW agent vapor concentration may be present (hot zone) i.e.: the immediate vicinity of the actual weapon or the weapon’s release.

For Law Enforcement use, the application of this ensemble is to support the needs of the “average patrol officer” responding to the incident scene. It is anticipated that the patrol officer will be on the incident perimeter (cold zone) directing traffic, evacuating casualties, and maintaining control of the incident site. SWAT teams, Bomb Squads, evidence recovery teams and other specialty units that may be closer to the weapons release point would require higher levels of protective clothing. Personal protective equipment for these specialty and tactical teams is not addressed in this interim report but will be addressed in our final report (summer 1999).