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Original title on 712 A/B: Analysis of Masking Guidance With Respect to Biological Warfare Trigger Events

(Please use the same title listed on MORSS Form 712 A/B. If the title was changed please list the revised title below.) Revised title:

Presented in: WG(s) # 02, CG. Special Session, Demonstration, Tutorial, or Focus Session #

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Developing Masking Guidance With Respect to BW Trigger Events

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13. SUPPLEMENTARY NOTES
Developing Masking Guidance With Respect to BW Trigger Events

Military Operations Research Society Symposium
Presented by: Dan Cinotti
Sponsoring Organization: HQ AF/A3SC
14 June 2007
KFE Analytic Approach

- Estimate BW hazard environment
  - Threat analysis: plausible weapons, agents, and weather
  - Use HPAC to model atmospheric transport and dispersion of agent for each plausible attack scenario
  - Reject non-effective attacks → Threat Spectrum

- Evaluate equipment / procedure performance against each attack in the threat spectrum

- Determine how much of the threat spectrum is covered by equipment or procedures that are adequate/inadequate

- Develop / adjust ConOps accordingly
Overview of KFE Threat Analysis

The KFE threat analysis was a predecessor to other KFE analyses.
## KFE Delivery Systems, Agents, and Weather Conditions

<table>
<thead>
<tr>
<th>5 Delivery Systems</th>
<th>7 Agents</th>
<th>9 Weather Conditions</th>
<th>Other Key Attack Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBM (bulk)</td>
<td>A</td>
<td>3 seasons:</td>
<td>Stand-off distance</td>
</tr>
<tr>
<td>TBM (submunitions)</td>
<td>N</td>
<td>- Summer</td>
<td>Source strength</td>
</tr>
<tr>
<td>Ground/Sea-based Sprayer (mobile)</td>
<td>T</td>
<td>- Winter</td>
<td>Number of munitions</td>
</tr>
<tr>
<td>Aerial Sprayer (mobile)</td>
<td>H</td>
<td>- Fall/Spring</td>
<td>Footprint radius (TBMs with submunitions)</td>
</tr>
<tr>
<td>Backpack Sprayer (stationary)</td>
<td>R</td>
<td>3 times of day:</td>
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<td></td>
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</tbody>
</table>

A case matrix was developed for each delivery system. Each matrix:
- **Specifies the combinations of attack parameters to be modeled**
- **Determines the total number of computer simulations required**
Hazard Prediction and Assessment Capability (HPAC), v 4.04 was used to model atmospheric transport and dispersion (ATD) of BW agents.

For a given BW attack scenario, HPAC models dispersion of particles in the atmosphere, and estimates:

- The dosage resulting from primary inhalation of BW agent
- The concentration of BW agent over time at a specific location, (i.e., what a detector would “see”)

**Example Dosage Plot**

- **Example Concentration Profile**
Objective

Use KFE threat spectrum data to develop BW masking guidance for weapon and detector events

- Is it beneficial to mask when a bio detector alarms, or has the cloud already dissipated?
- When should personnel don/doff masks with respect to various trigger events?
  - Intel
    - Weapon Event
    - Detector Alarm
  - Sentinel Casualties
BW Masking Analysis
Technical Approach

- Simulate performance of BW point detectors installed at Kunsan AB
  - Trigger
  - Sampler
  - Identification technology (immunoassay)
  - Alarm Criteria

- Challenge point detectors with attacks (concentration profiles) in the KFE Threat Spectrum

- Develop guidance for donning / doffing masks that would minimize the percentage of attacks exceeding a particular risk level
Useful Definitions

- Trigger Events (listed on the previous slide)
  - Discrete events that *trigger* specific decisions / actions

- Detector Trigger
  - A device that turns on an air sampler, typically by detecting an increase in aerosol concentration

- Automatic Identification (Auto-ID)
  - Occurs when agent is identified in a sample that was automatically collected by Portal Shield operated in Smart Mode

- Network Alarm (Alarm)
  - Occurs when auto-ID occurs at 2 or more Portal Shields

- Manual Identification (Manual-ID)
  - Occurs when Auto-ID is corroborated by HHA using caddies with a different lot number
Chronology of Cloud Passage

De-masking Guidance:
- Doffing masks before this time defined as high risk
- Doffing masks after this time defined as low risk

Masking Guidance:
- Benefit of masking before this time defined as significant
- Benefit of masking after this time defined as minimal

Cloud Arrival Time

Peak Concentration

Concentration (kg/m³)

Time (sec)

Shaded Area: residual dosage resulting in a 16% casualty rate
“Time After Which Dosage is Less than the ECt_{16}”

- ECt_{16} is the dosage level at which 16% (aprox. 1/6) of an exposed population are expected to be incapacitated.

- Was not correlated to operational consequences on an air base.

- If a detector alarms when the remaining dosage is less than the ECt_{16}, the benefit from masking at that location is relatively small.
  - Personnel near that detector may already be infected.

- The benefit from masking at other locations, however, may be significant (i.e., the remaining dosage may exceed the ECt_{16}).
Sample Concentration Profile for 14 BW Point Detectors at Kunsan AB

Time After Release (min)

Concentration (kg/m³)

Detector 3

Detector 8

Detector 12
The second auto-ID occurs at Detector 13 apx. 58 min after the weapon event; the residual dosage at this location is less than the EC_{16}.

But there are 6 other detector locations where the remaining dosage exceeds the EC_{16}.
By this time there are no detector locations where the remaining dosage exceeds $E_{16}$

Manual ID by HHA (on the sample from detector 13) occurs apx. 30 minutes after the second auto-ID
At this time, the aerosol cloud has arrived, but has not yet triggered sample collection or agent identification at any of the 14 BW point detectors.
**Notional Back Pack Spray Attack on Kunsan AB (2)**

- At this time, the aerosol cloud has identified agent at 2 or more detectors resulting in a detector alarm.
- Some personnel may have already been exposed to an effective dose.
- Others would benefit from donning their mask.
At this time, doffing masks would expose some personnel to a residual risk level greater than 16%.

This corresponds to the high-risk demasking guidance.
At this time, the aerosol cloud has mostly dissipated.

Doffing masks at this time is not expected to expose personnel to a residual risk level greater than 16%.

This corresponds to the low-risk demasking guidance.
Tolerance for Risk

- Risk is based on the likelihood that masking or de-masking will protect against a remaining dosage greater than the ECt\textsubscript{16}
  - Says nothing about the dosage received prior to masking

- Masking guidance was developed for two risk levels:
  - Lower risk guidance is protective (at the ECt\textsubscript{16} risk level) for all attacks in the KFE Threat Spectrum
  - Higher risk guidance is protective (at the ECT\textsubscript{16} risk level) for most attacks in the KFE Threat Spectrum

- Higher risk guidance equates to masking later or de-masking sooner than the lower risk guidance

- Higher risk guidance might be justified if ops tempo is high:
  - Mission more likely to succeed, but with more expected casualties
### Masking / De-masking Guidance

Guidance can be organized by trigger event and tolerance for risk.

<table>
<thead>
<tr>
<th>Trigger Event</th>
<th>Mask</th>
<th>De-Mask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel</td>
<td>SOP</td>
<td></td>
</tr>
<tr>
<td>Weapon Event (by Delivery System)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Risk</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Detector Alarm (by Agent)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Risk</td>
<td>High Risk</td>
<td></td>
</tr>
<tr>
<td>Sentinel Casualties</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **Intel:** Information gathering and verification.
- **SOP:** Standard Operating Procedure.
- **Low Risk:** Low threat or risk level.
- **High Risk:** High threat or risk level.
Masking Guidance
Weapon Event: Lower Risk

- Trigger Event
- Mask
- De-Mask
- Intel
- Detector Alarm
  (by Agent)
- Sentinel Casualties
- Weapon Event
  (by Delivery System)
- SOP
- Low Risk
  High Risk
- Low Risk
  High Risk
- Low Risk
  High Risk

I n t e g r i t y  -  S e r v i c e  -  E x c e l l e n c e
Current guidance is to *mask* after an observed weapon event.

But when is it safe to *de-mask*?
De-Masking Guidance
Weapon Event: Lower Risk

- Trigger Event
- Mask
- De-Mask

- Intel
- Weapon Event (by Delivery System)
- SOP
- Low Risk
- High Risk

- Detector Alarm (by Agent)
- Low Risk
- High Risk

- Sentinel Casualties
- Low Risk
- High Risk

Integrity - Service - Excellence
De-Masking Guidance
Weapon Event: Lower Risk

- When is it safe to *de-mask* after an observed weapon event? That is…
- How long might a bio cloud remain *hazardous* (remaining dosage > ECt_{16}) after an observed
  - Sprayer attack? ~ 5 hours
  - TBM Attack? ~ 4 hours
- De-masking sooner may be appropriate if:
  - Testing confirms that the weapon event was not CBW
  - Personnel are adequately protected by ColPro, vaccination or prophylaxis OR…
  - Ops tempo is high

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Agent Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max Time (hrs) After Which Remaining Dosage &lt; ECt_{16} (Across All Detectors)</td>
</tr>
<tr>
<td>Sprayer Attacks</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>4.65</td>
</tr>
<tr>
<td>H</td>
<td>4.74</td>
</tr>
<tr>
<td>N</td>
<td>4.66</td>
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<tr>
<td>Q</td>
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<tr>
<td>R</td>
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<tr>
<td>T</td>
<td>4.74</td>
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<tr>
<td>Y</td>
<td>4.74</td>
</tr>
<tr>
<td>Total</td>
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<tr>
<td>TBM Attacks</td>
<td></td>
</tr>
<tr>
<td>A</td>
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<tr>
<td>Y</td>
<td>4.74</td>
</tr>
<tr>
<td>Total</td>
<td>4.74</td>
</tr>
</tbody>
</table>
De-Masking Guidance
Weapon Event: Higher Risk

- Trigger Event
  - Mask
  - De-Mask
  - Intel
- Weapon Event (by Delivery System)
  - SOP
  - Low Risk
  - High Risk
- Detector Alarm (by Agent)
  - Low Risk
  - High Risk
  - Sentinel Casualties
  - Low Risk
  - High Risk

I n t e g r i t y - S e r v i c e - E x c e l l e n c e
De-masking sooner may be appropriate if the ops tempo justifies a higher tolerance for risk

- De-masking sooner than 4 hrs increases the likelihood of being exposed to a residual dosage greater than the ECt₁₆
- The risk from de-masking sooner than 4 hrs after an attack increases more gradually for sprayer attacks than for TBM attacks
Masking Guidance

Detector Event

- Trigger Event
- Mask
- De-Mask

Intel

- Weapon Event
  (by Delivery System)
- SOP
- Low Risk
- High Risk

- Detector Alarm
  (by Agent)
- Low Risk
- High Risk

Sentinel Casualties

Low Risk
High Risk
For observed weapon events, it is assumed that personnel will have already masked.

No current guidance exists indicating when personnel should mask in relation to a Portal Shield alarm.

The likelihood that a hazard remains after a detector alarm is time and agent dependent:

Masking after a PS alarm is significantly more protective than masking after manual ID, particularly for agents Q and T.

Two sides of the same coin: Masking after manual ID increases the likelihood that personnel will have already been exposed to a significant hazard, and decreases the likelihood that a significant hazard remains.

Masking Guidance

Detector Event
De-Masking Guidance

Detector Event: Low vs High Risk

- Trigger Event
- Weapon Event (by Delivery System)
- Detector Alarm (by Agent)
- Intel

Mask

De-Mask

Low Risk

High Risk

SOP

Sentinel Casualties

Low Risk

High Risk

Low Risk

High Risk
For all identified spray attacks, the remaining dosage 4 hrs after alarm is less than the ECt_{16}

De-masking sooner than 4 hrs after alarm increases the likelihood of being exposed to a residual dosage greater than the ECt_{16}

The risk from de-masking less than 1 hr after alarm increases most significantly for agent Q

De-masking sooner may be appropriate if:
- Ops tempo is high
- Personnel are adequately protected by vaccination or prophylaxis
# Masking Guidance Matrix

<table>
<thead>
<tr>
<th>Trigger Event</th>
<th>Don Mask</th>
<th>Doff Mask: Low Risk $^a$</th>
<th>Doff Mask: High Risk $^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intel</strong></td>
<td>Guidance for masking after intelligence events was not supported by the KFE dataset.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weapon Event</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TBM</td>
<td>Immediately after declaration of Alarm Red (Alarm Blue in Korea)</td>
<td>$\bullet$ 4 hrs after observed attack, OR $\bullet$ If surface samples near point of impact test negative</td>
<td>$\bullet$ 3 hrs after observed attack, OR $\bullet$ If surface samples near point of impact test negative</td>
</tr>
<tr>
<td>Sprayer</td>
<td>Immediately after declaration of Alarm Red (Alarm Blue in Korea)</td>
<td>$\bullet$ 5 hrs after observed attack</td>
<td>$\bullet$ 1 hrs after observed attack</td>
</tr>
<tr>
<td><strong>Detector Alarm (Covert Attacks)</strong></td>
<td>Immediately after a Portal Shield system alarm $^c$</td>
<td>$\bullet$ 4 hrs after Portal Shield system alarm $^c$, OR $\bullet$ If personnel are adequately protected by vaccination or prophylaxis</td>
<td>$\bullet$ 1 hr after Portal Shield system alarm $^c$, OR $\bullet$ If personnel are adequately protected by vaccination or prophylaxis</td>
</tr>
<tr>
<td><strong>Sentinel Casualties</strong></td>
<td>Guidance for masking after sentinel casualties was not supported by the KFE dataset.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

- a. Low risk: a dosage $> EC_{t_{16}}$ did not occur after de-masking for any attacks in KFE threat spectrum.
- b. High risk: a dosage $> EC_{t_{16}}$ occurred after de-masking for some attacks in KFE threat spectrum.
- c. System alarm means that BW agent was identified in at least 2 samples that were automatically collected by biological point detectors.
Masking Guidance Conclusions

- Masking is like using sun screen
  - If put on **before** exposure you won’t get burned
  - The sooner it’s put on **during** exposure, the less likely you are to get burned
  - Putting on **after** burn can prevent additional insult

- Masking after two auto-IDs (performed by Portal Shield) can reduce risk to base personnel
  - If masking is delayed until further testing is performed (manual IDs), the benefit of masking is minimal
De-masking Guidance Conclusions

- De-masking from 1 to 5 hours after a weapon or detector event mitigates the risk to personnel that are not already infected; additional casualties are possible.

- Specific de-masking guidance will depend on:
  - The type of attack (TBM or sprayer)
  - Whether or not the attack is detected
  - Which agent is identified (if any)
  - Ops tempo (tolerance for risk)
Possible Follow-on Analyses

- Expand guidance to include agent and weather-specific de-masking guidance
- Account for casualties incurred prior to masking
- This analysis evaluated the inhalation hazard *in the vicinity of each detector*; more relevant is the hazard *in the vicinity of airbase personnel*
- Masking guidance should be integrated for both BW and CW
Questions

- ?
- ?
- ?
- ?
- ?
- ?