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12-14 June 2007, at US Naval Academy, Annapolis, MD

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# ***Headquarters U.S. Air Force***

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## **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**



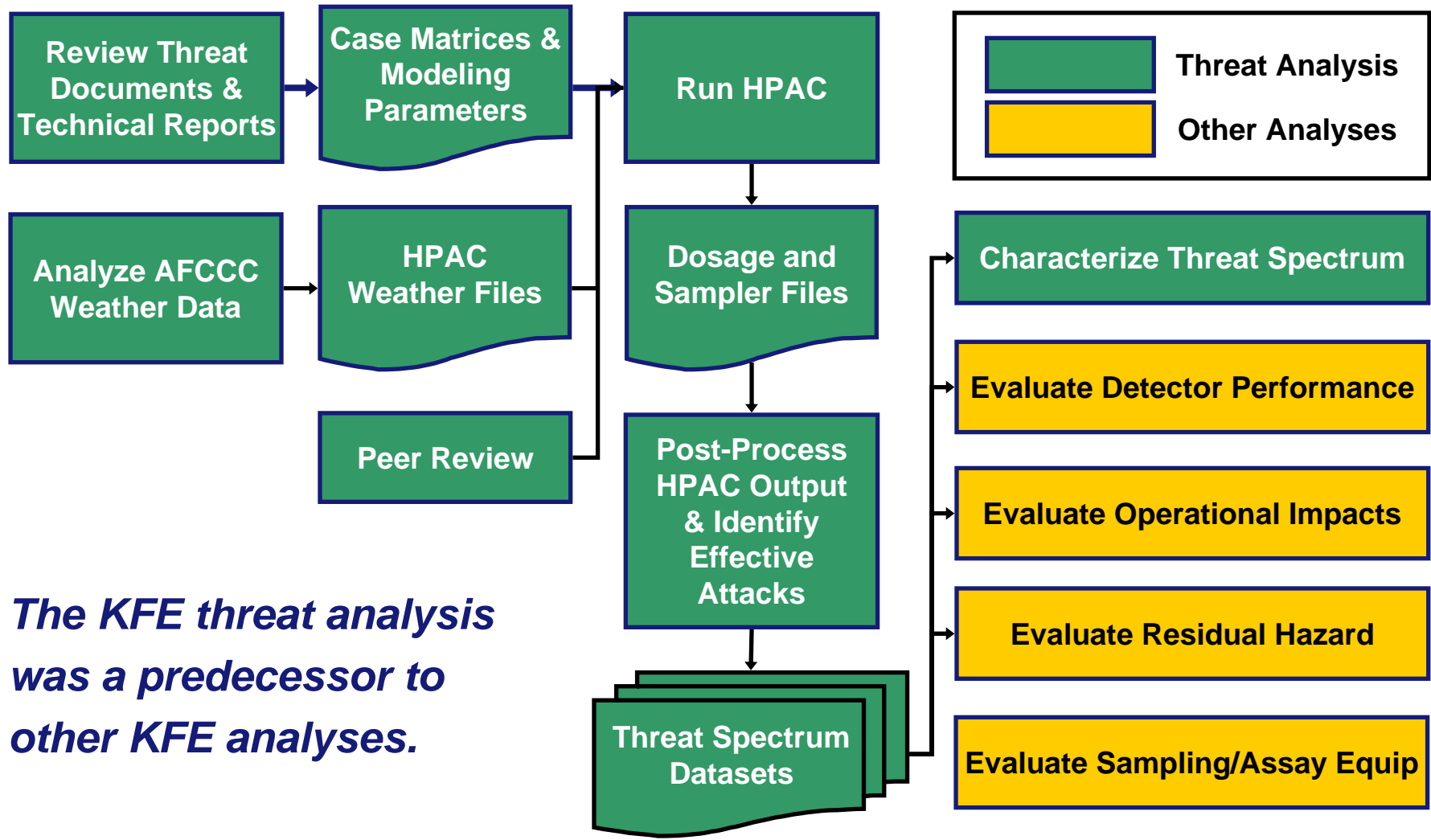
## ***KFE Analytic Approach***

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- **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





# ***KFE Delivery Systems, Agents, and Weather Conditions***

<b>5 Delivery Systems</b>	<b>7 Agents</b>	<b>9 Weather Conditions</b>	<b>Other Key Attack Parameters</b>
<ul style="list-style-type: none"> <li>■ TBM (bulk)</li> <li>■ TBM (submunitions)</li> <li>■ Ground/Sea-based Sprayer (mobile)</li> <li>■ Aerial Sprayer (mobile)</li> <li>■ Backpack Sprayer (stationary)</li> </ul>	A N T H R Y Q	<ul style="list-style-type: none"> <li>■ 3 seasons:               <ul style="list-style-type: none"> <li>- Summer</li> <li>- Winter</li> <li>- Fall/Spring</li> </ul> </li> <li>■ 3 times of day:               <ul style="list-style-type: none"> <li>- 0500L</li> <li>- 1200L</li> <li>- 2200L</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>■ Stand-off distance</li> <li>■ Source strength</li> <li>■ Number of munitions</li> <li>■ Footprint radius (TBMs with submunitions)</li> </ul>

***A case matrix was developed for each delivery system. Each matrix:***

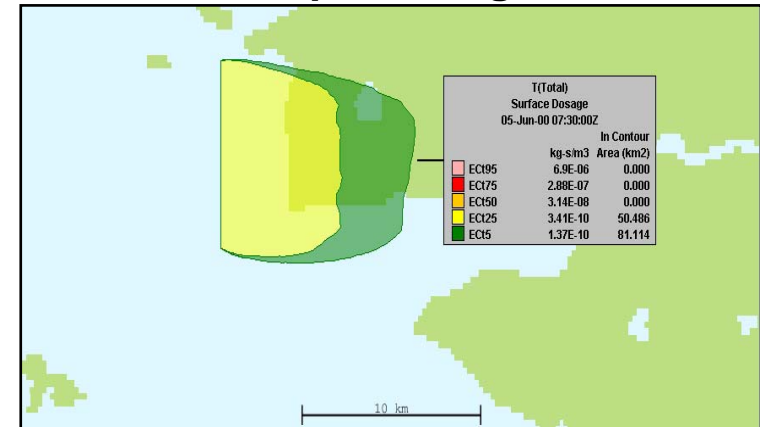
- ***Specifies the combinations of attack parameters to be modeled***
- ***Determines the total number of computer simulations required***



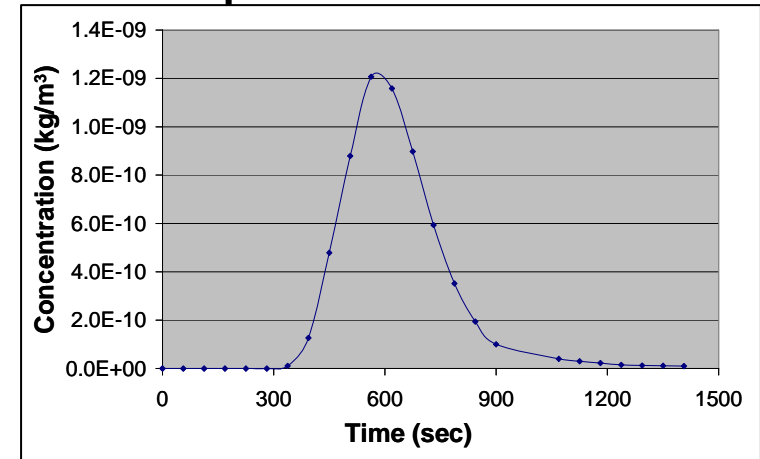
# Modeling the Atmospheric Dispersion of BW Agents

- 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





# ***BW Masking Analysis Objective***

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***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***

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- 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



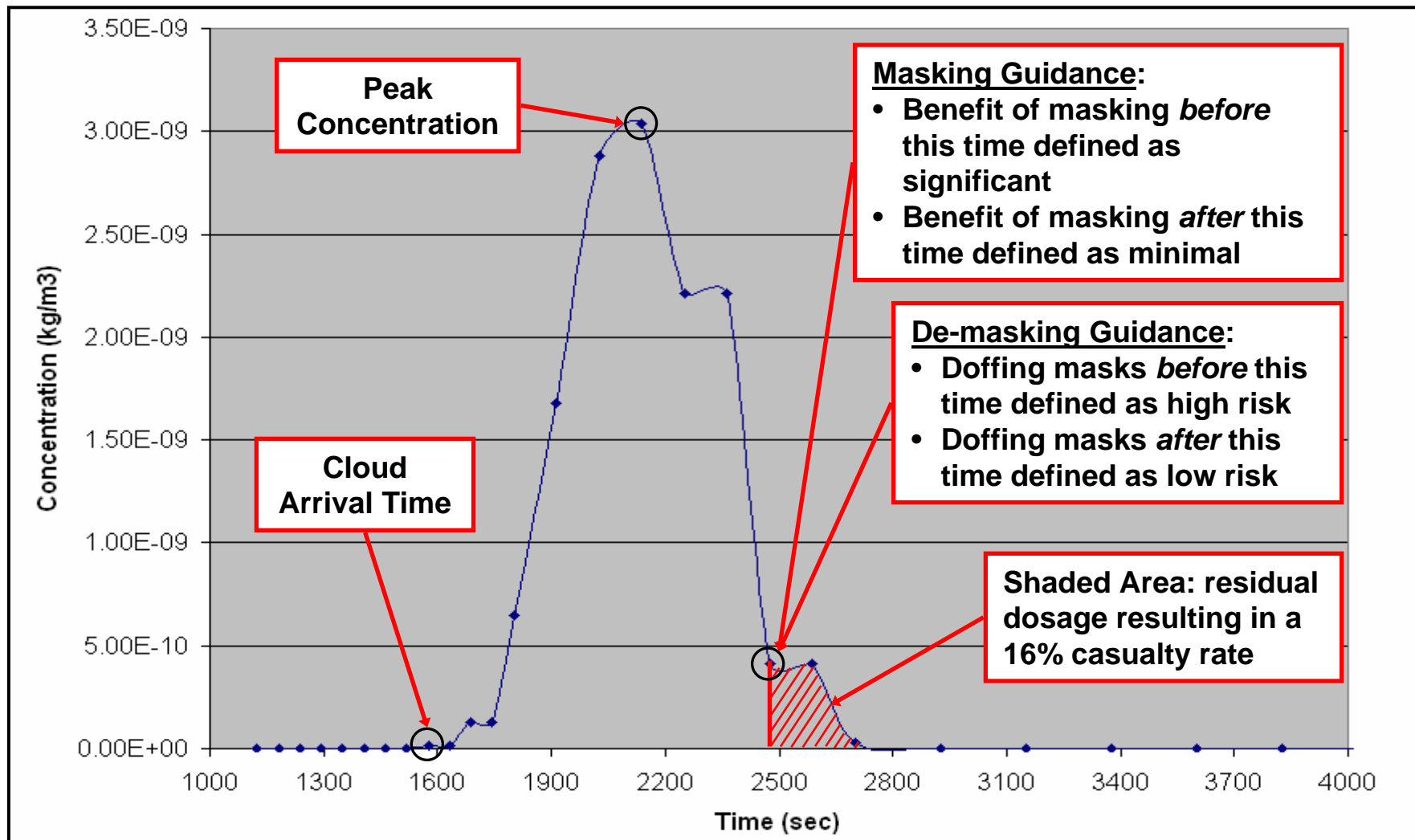
# *Useful Definitions*

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- **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





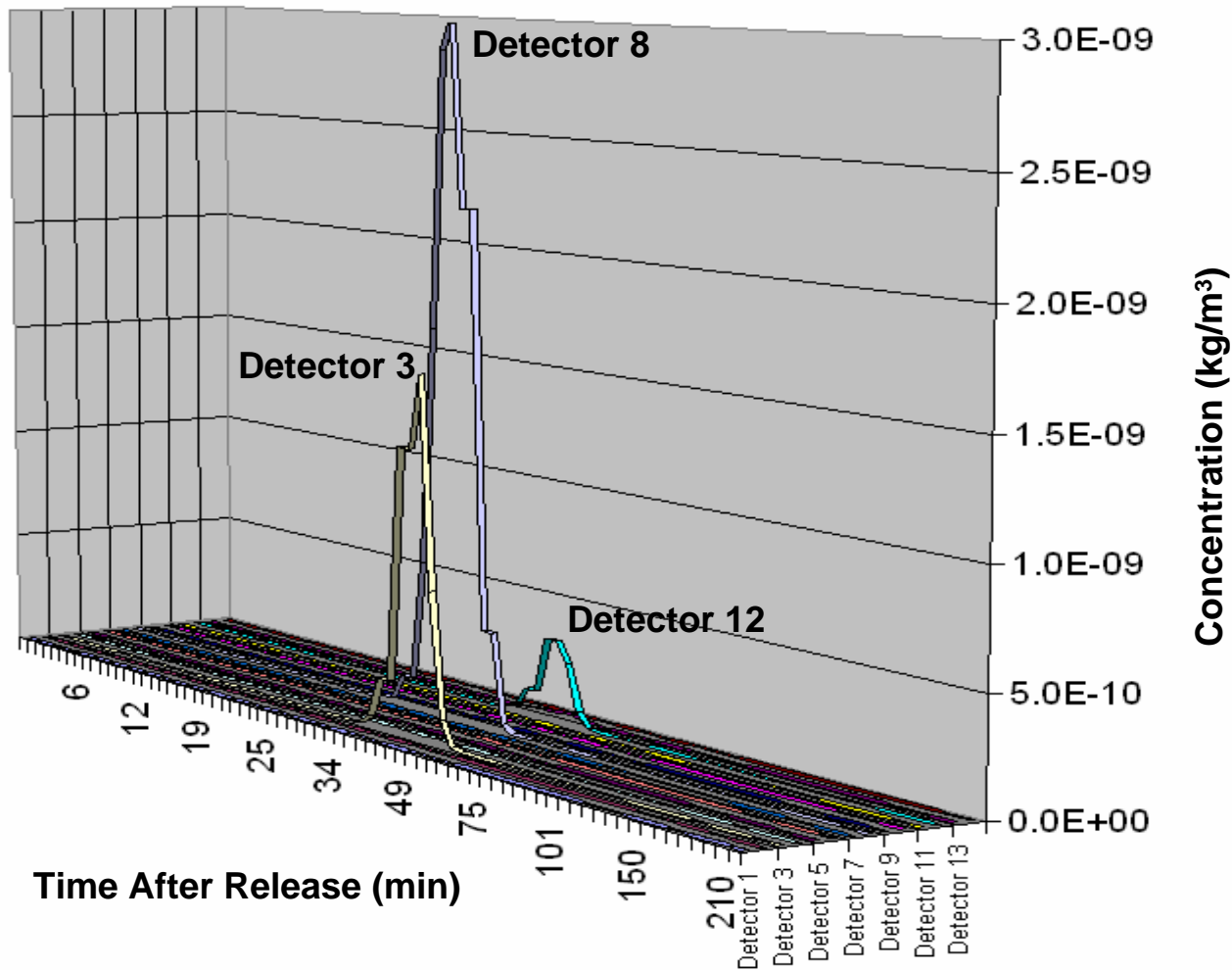
## ***“Time After Which Dosage is Less than the $ECt_{16}$ ”***

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- $ECt_{16}$  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




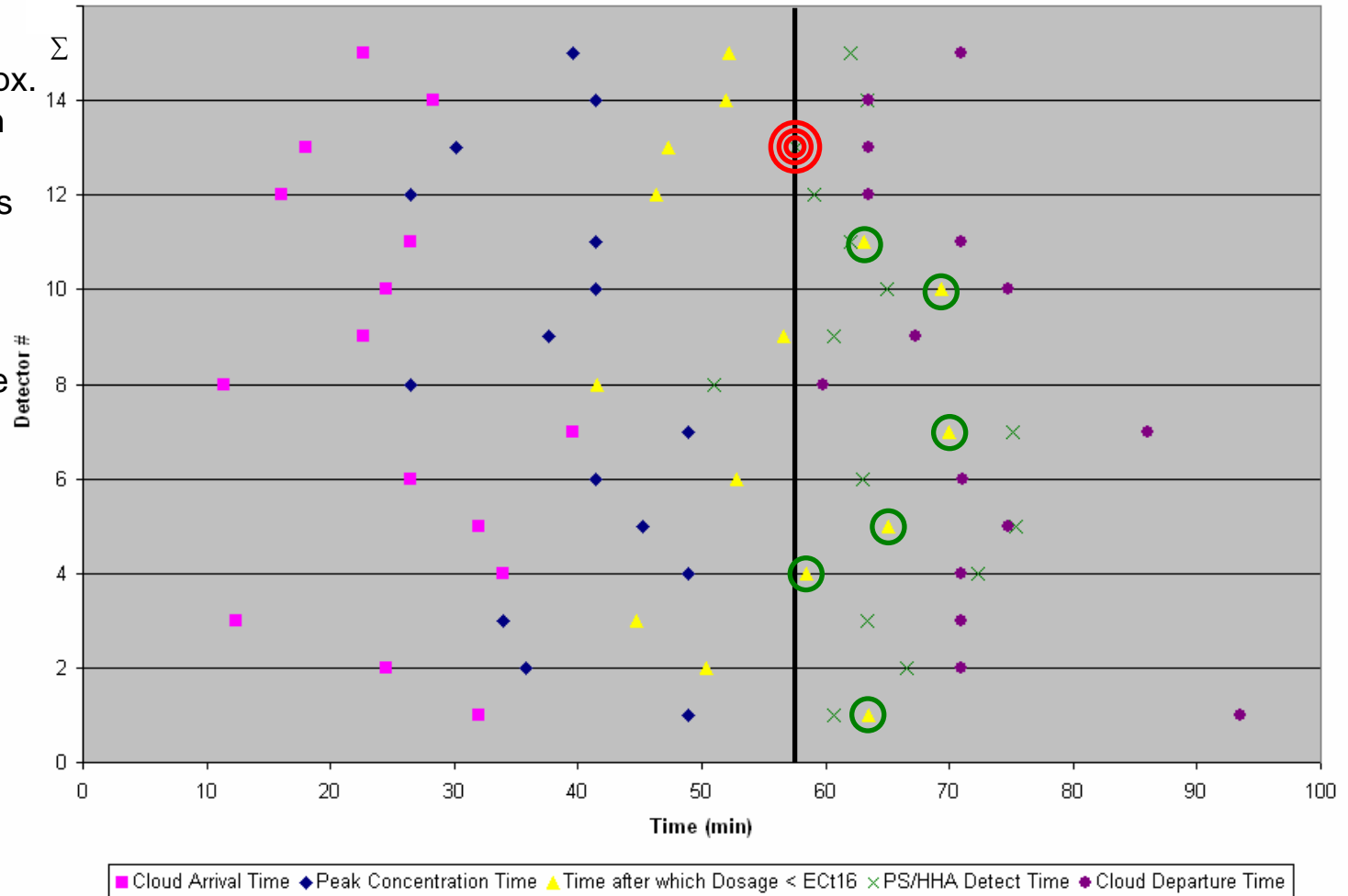
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# Detector Chronology (1)


 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  $ECT_{16}$

 But there are 6 other detector locations where the remaining dosage exceeds the  $ECT_{16}$

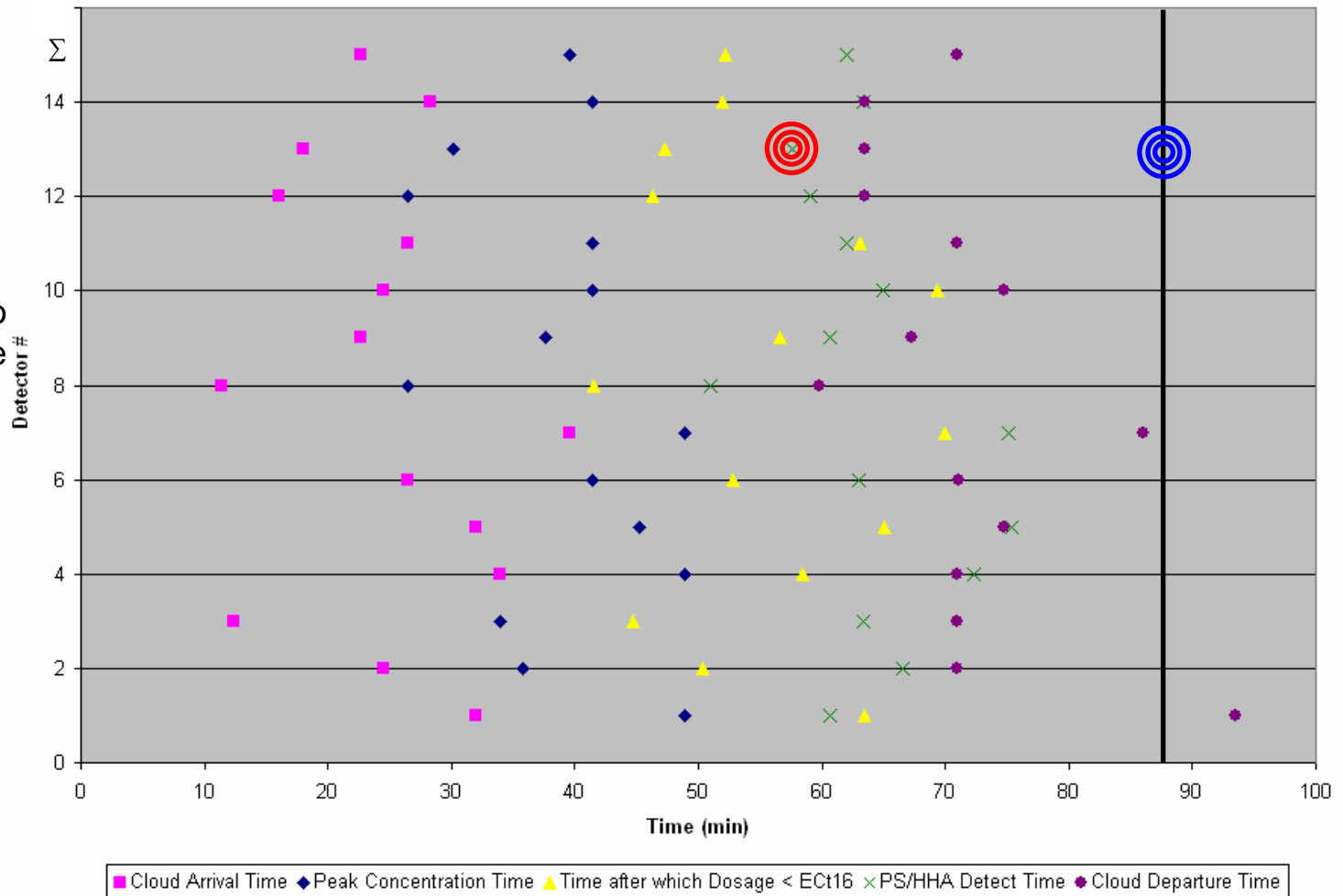




# Detector Chronology (2)

 Manual ID by HHA  
 (on the sample from  
 detector 13) occurs apx.  
 30 minutes after the  
 second auto-ID

By this time there are no  
 detector locations where  
 the remaining dosage  
 exceeds  $ECT_{16}$

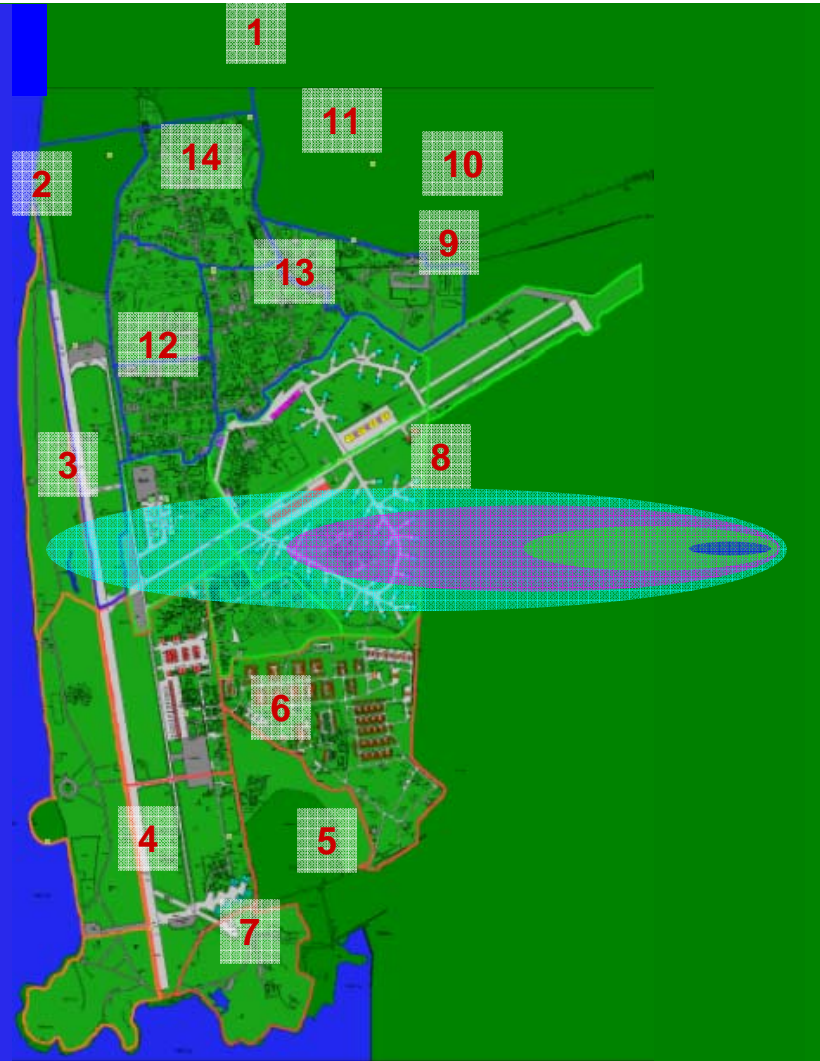




# Notional Back Pack Spray Attack on Kunsan AB (1)

- 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

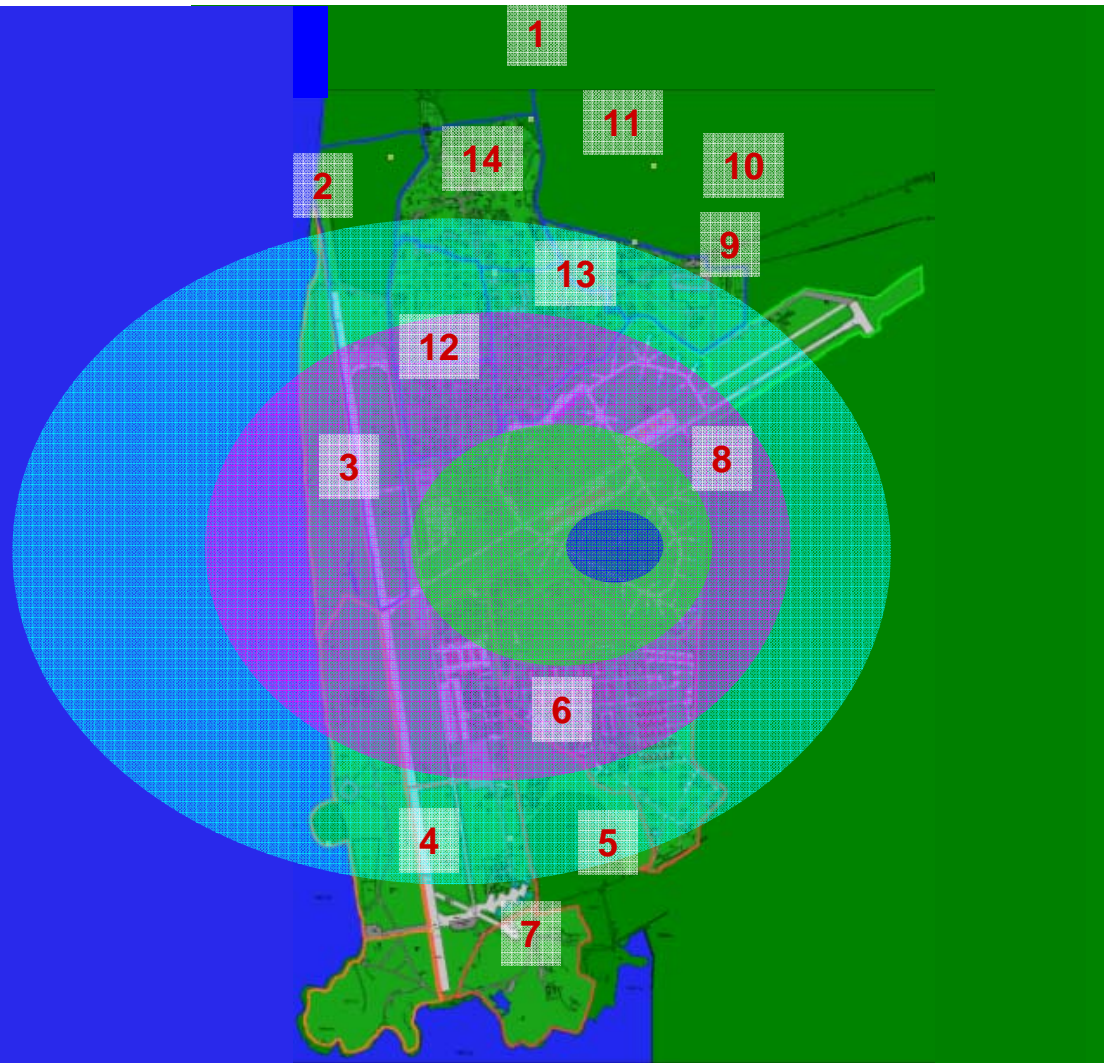
# Detector Locations





## *Notional Back Pack Spray Attack on Kunsan AB (2)*

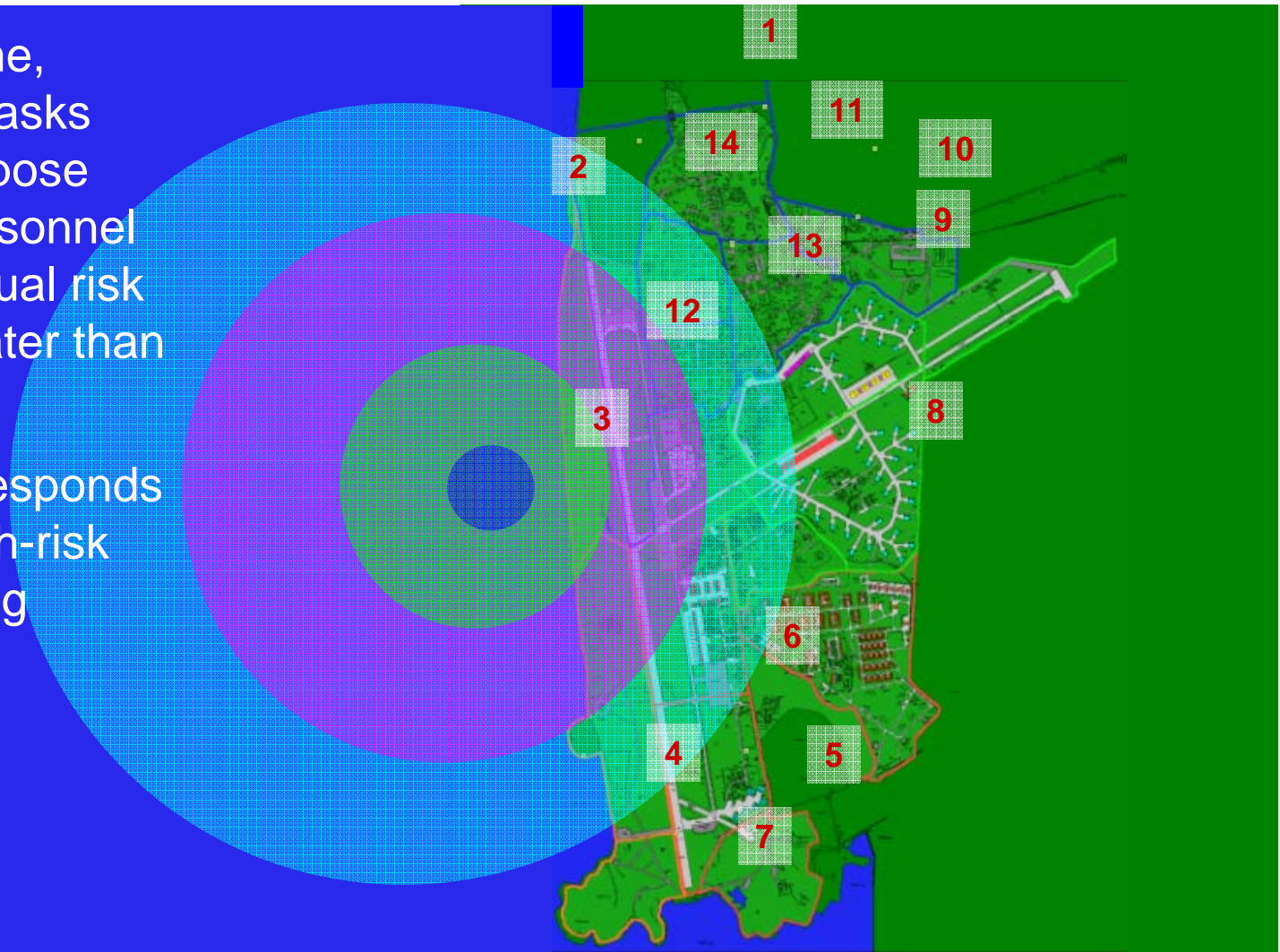
- At this time, the aerosol cloud has identified agent at 2 or more detectors resulting in a detector alarm.
- Some personnel may have already been exposed to an effective dose.
- Others would benefit from donning their mask.





# Notional Back Pack Spray Attack on Kunsan AB (3)

- 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.





# Notional Back Pack Spray Attack on Kunsan AB (4)

- 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*

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- **Risk is based on the likelihood that masking or de-masking will protect against a remaining dosage greater than the  $ECT_{16}$** 
  - Says nothing about the dosage received prior to masking
- **Masking guidance was developed for two risk levels:**
  - Lower risk guidance is protective (at the  $ECT_{16}$  risk level) for *all* attacks in the KFE Threat Spectrum
  - Higher risk guidance is protective (at the  $ECT_{16}$  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 Guidance Conceptual

**Masking / De-masking Guidance can be organized by trigger event and tolerance for 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	Low Risk High Risk
Sentinel Casualties		



# 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	Low Risk High Risk
Sentinel Casualties		



# *Masking Guidance Weapon Event: Lower Risk*

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- 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	Low Risk / High Risk
Sentinel Casualties		



# 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<sub>16</sub>) 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

KFE Data		
Source Type	Agent Code	Max Time (hrs) After Which Remaining Dosage < ECt <sub>16</sub> (Across All Detectors)
Sprayer Attacks	A	4.65
	H	4.74
	N	4.66
	Q	2.87
	R	4.74
	T	4.74
	Y	4.74
	<b>Total</b>	<b>4.74</b>
TBM Attacks	A	3.88
	H	3.99
	N	3.93
	Q	1.27
	R	3.95
	T	3.98
	Y	3.99
	<b>Total</b>	<b>3.99</b>
All Attacks	A	4.65
	H	4.74
	N	4.66
	Q	2.87
	R	4.74
	T	4.74
	Y	4.74
	<b>Total</b>	<b>4.74</b>



# De-Masking Guidance Weapon Event: Higher Risk

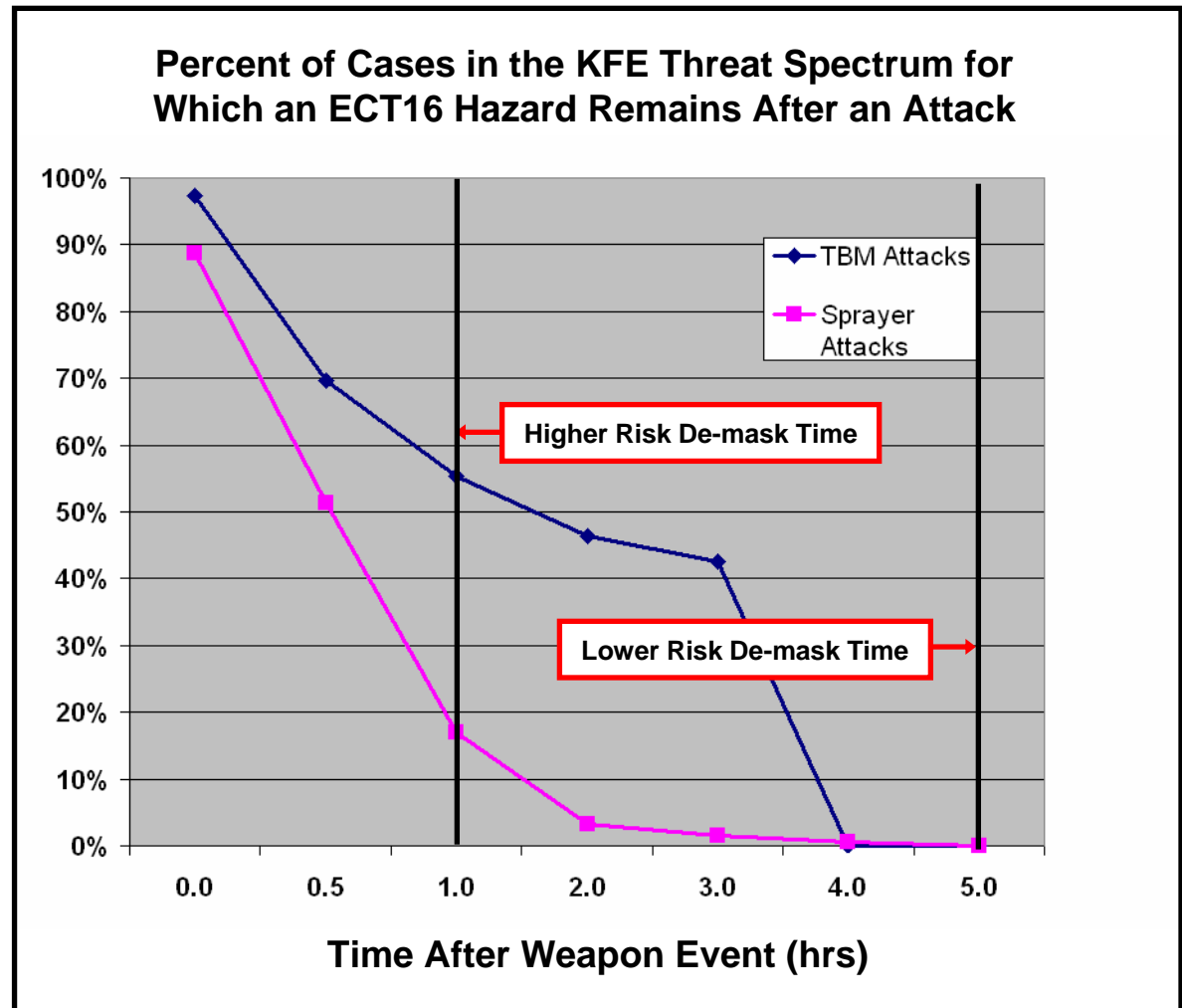
Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



# De-Masking Guidance Weapon Event: Higher Risk

*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  $ECT_{16}$
- The risk from de-masking sooner than 4 hrs after an attack increases more gradually for sprayer attacks than for TBM attacks





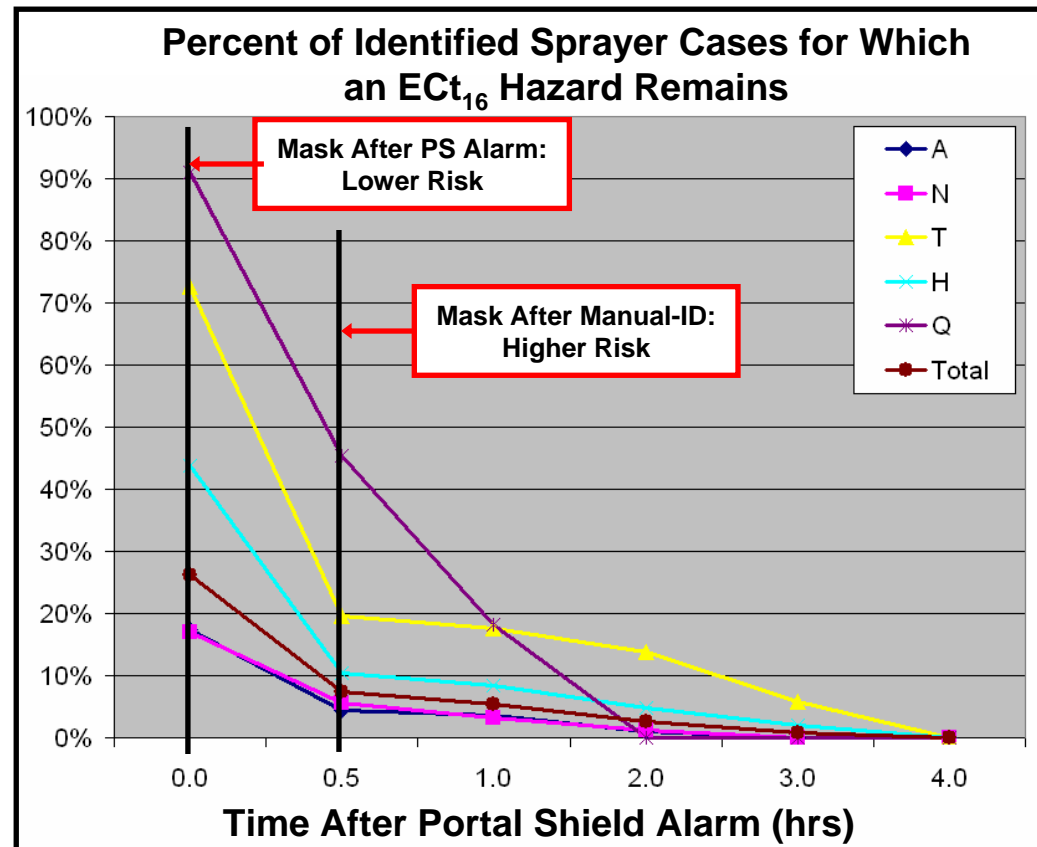
# Masking Guidance Detector Event

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



# Masking Guidance Detector Event

- 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***



# De-Masking Guidance

## Detector Event: Low vs High Risk

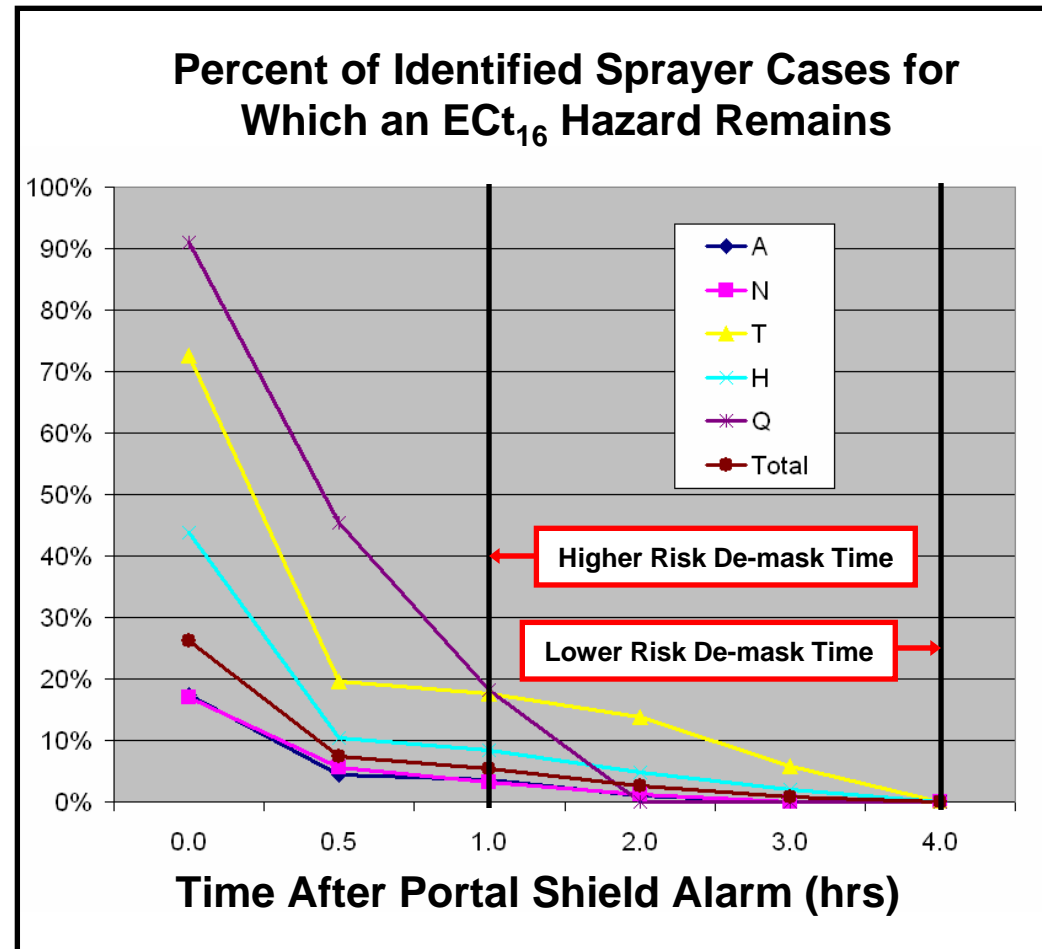
Trigger Event	Mask	De-Mask
Intel		
Weapon Event (by Delivery System)	SOP	Low Risk High Risk
Detector Alarm (by Agent)	Low Risk High Risk	Low Risk High Risk
Sentinel Casualties		



# De-Masking Guidance

## Detector Event: Low vs 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

Trigger Event		Don Mask	DoFF Mask: Low Risk <sup>a</sup>	DoFF Mask: High Risk <sup>b</sup>
Intel		Guidance for masking after intelligence events was not supported by the KFE dataset.		
Weapon Event	TBM	Immediately after declaration of Alarm Red (Alarm Blue in Korea)	<ul style="list-style-type: none"> <li>• 4 hrs after observed attack, OR</li> <li>• If surface samples near point of impact test negative</li> </ul>	<ul style="list-style-type: none"> <li>• 3 hrs after observed attack, OR</li> <li>• If surface samples near point of impact test negative</li> </ul>
	Sprayer	Immediately after declaration of Alarm Red (Alarm Blue in Korea)	<ul style="list-style-type: none"> <li>• 5 hrs after observed attack</li> </ul>	<ul style="list-style-type: none"> <li>• 1 hrs after observed attack</li> </ul>
Detector Alarm (Covert Attacks)		Immediately after a Portal Shield system alarm <sup>c</sup>	<ul style="list-style-type: none"> <li>• 4 hrs after Portal Shield system alarm <sup>c</sup>, OR</li> <li>• If personnel are adequately protected by vaccination or prophylaxis</li> </ul>	<ul style="list-style-type: none"> <li>• 1 hr after Portal Shield system alarm <sup>c</sup>, OR</li> <li>• If personnel are adequately protected by vaccination or prophylaxis</li> </ul>
Sentinel Casualties		Guidance for masking after sentinel casualties was not supported by the KFE dataset.		
<p><b>NOTES:</b></p> <p>a. Low risk: a dosage &gt; ECt<sub>16</sub> did not occur after de-masking for any attacks in KFE threat spectrum.</p> <p>b. High risk: a dosage &gt; ECt<sub>16</sub> occurred after de-masking for some attacks in KFE threat spectrum.</p> <p>c. System alarm means that BW agent was identified in at least 2 samples that were automatically collected by biological point detectors.</p>				



# *Masking Guidance Conclusions*

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- 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*

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- 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*

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- 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

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