



SAND2012-6175C

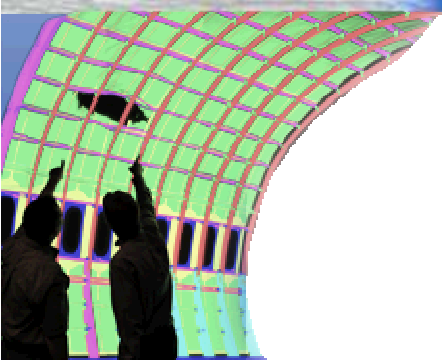


Threat Probability to Action Process

Sandia/CA Intern Symposium

Akhil Reddy

Sandia National Laboratories
August 2nd, 2012



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2011-XXXXP



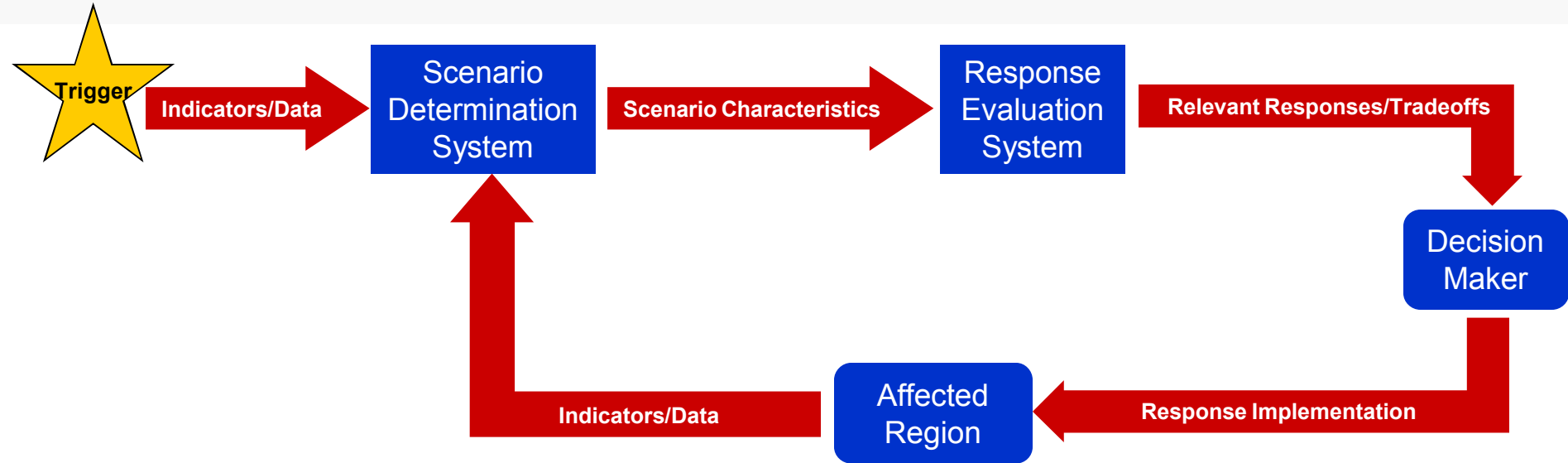


Motivation

Following a bio-incident, timely implementation of the proper public health and environmental response is important for minimizing consequences. However, in an emerging bio-scenario, response decisions must be made in the context of limited, disparate, and uncertain information.

The Threat Probability to Action Process will help decision-makers (e.g., public health officials, elected officials, military commanders) select effective public health and environmental response strategies during emerging bio-scenarios.

Threat Probability to Action Process



Example Indicators:

- BioWatch BAR
- Intelligence
- Elevated hospital admissions
- Diagnosis Data
- OTC drug sales

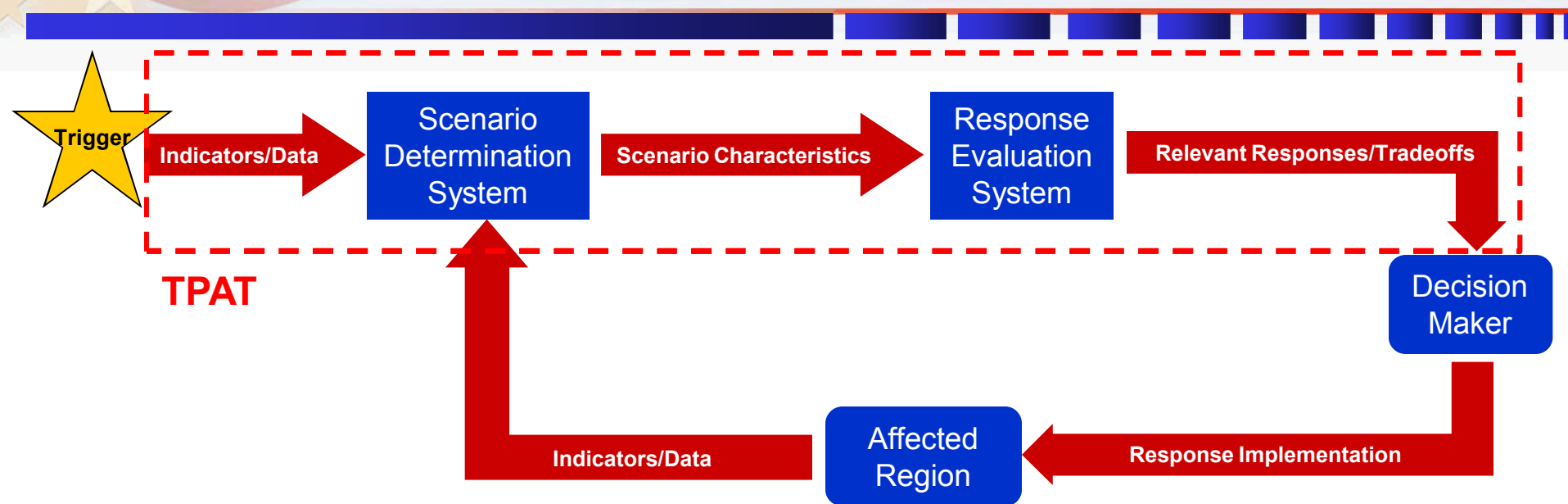
Example Scenario Characteristics:

- Pathogen
- Origin/location
- Date/time
- Area of contamination
- Population exposed

Example Response Options:

- Hospital adjustment
- Mass Rx
- Evacuation
- Shelter in place
- Decontamination

Threat Probability to Action Process



Example Indicators:

- BioWatch BAR
- Intelligence
- Elevated hospital admissions
- Diagnosis Data
- OTC drug sales

Example Scenario Characteristics:

- Pathogen
- Origin/location
- Date/time
- Area of contamination
- Population exposed

Example Response Options:

- Hospital adjustment
- Mass Rx
- Evacuation
- Shelter in place
- Decontamination

Notional bio-scenario to illustrate the Threat Probability to Action Process

- Day 0 – Today there was a significant increase in number of hospital admissions in San Francisco and Oakland. Dozens of patients are reporting to hospitals with severe flu-like symptoms, though no deaths have been reported. Public health officials have been notified and must decide: Is this a public health emergency? If so, what is it? How should we respond?
- Scenario Assumptions
 - No history of similar increase in hospital admission rates for flu-like symptoms in region
 - A biological environmental surveillance system, BioWatch, is currently deployed in both cities
 - Epidemiological modeling is available for event reconstruction

Day 1: Officials collect the triggering data and other relevant information and input it into TPAT

- **Hospital admissions data from across the bay area is collected**
 - Admissions rates are above normal levels and appear to be increasing
 - Patients have flu-like symptoms
- **BioWatch filter sample and analysis rates are increased to 2x/day**
 - Filters show no positives for any biological pathogens of concern
- **Intelligence information is collected**
 - No threats have been identified

Within TPAT, the Scenario Determine System aggregates this information and assesses scenario characteristics and likelihood

Scenario Characteristics, <u>Day 1</u>											
	Is there a threat?	What is the threat?									
	Threat	Pathogen					Source			Scale of Incident	
<u>Indicators</u>	Public Health Incident (e.g., terrorist attack)?	Type?	Aerosolizable?	Infectious?	Contagious?	Persistent?	Time?	Location?	Amount?	Potentially Affected Area?	People Potentially Affected / exposed?
Increased Hospital Admissions , flu like symptoms	1, Suggests an unusual public health incident	1, Suggests that the pathogen targets the respiratory system	1, suggests that the pathogen is aerosolizable, based on the presence of lung infections	2, Confirms that the pathogen is infectious based on the presence of ill people	0, Does not suggest or confirm	0, Does not suggest or confirm	1, Suggests that release occurred within 1 week, based on typical incubation periods	1, Suggests that the source location is in the San Francisco and Oakland area, based on hospital locations	0, Does not suggest or confirm	1, a 100 sq mile area may be affected, based on the hospital locations	1, As many as 5 million people may be affected based on census data
No BioWatch Positives	-1, Suggests that a terrorist attack involving pathogens A,B,C has NOT occurred, based on the lack of BioWatch positives	1, Suggests that the pathogen is not pathogen A,B, or C (however BioWatch inefficiencies limit the value of this information)	-1, Suggests that the agent is not aerosolizable OR that an attack involving pathogens A,B,C has not occurred	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm	0, Does not suggest or confirm
Results and Likelihood	Likely a public health incident, not likely a terrorist attack	Likely pathogen targets the respiratory system	Unknown	Confirmed Infectious	Unknown	Unknown	Likely within one week	Likely in the San Francisco/Oakland region	Unknown	Possibly a 100 square mile area or greater	Possibly a 5 million, those within affected area

Potential scenarios and associated likelihoods are summarized and output

■ Most Likely Scenario:


- Public health incident has occurred →Likely
- Pathogen
 - ◆ Targets the Respiratory System →Likely
 - ◆ Infectious→Confirmed
 - ◆ Not Contagious→ Likely
- Source
 - ◆ Within 1 week before spike in hospital admissions→Likely
 - ◆ San Francisco/Oakland Region →Likely
- Scale
 - ◆ 100 square mile area or greater→Possibly
 - ◆ Up to 5 million people exposed→Possibly

- ## ■ This example will go through only the most likely scenario. When using TPAT, the user would assess response options for a wide range of scenarios.

Based on response thresholds and scenario probabilities, relevant response strategies and options are identified

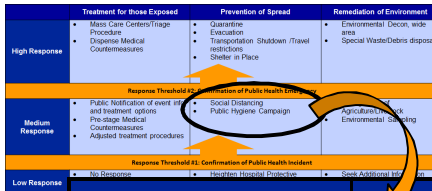
	Treatment for those Exposed	Prevention of Spread	Remediation of Environment
High Response	<ul style="list-style-type: none"> • Mass Care Centers/Triage Procedure • Dispense Medical Countermeasures 	<ul style="list-style-type: none"> • Quarantine • Evacuation • Transportation Shutdown /Travel restrictions • Shelter in Place 	<ul style="list-style-type: none"> • Environmental Decon, wide area • Special Waste/Debris disposal
Response Threshold #2: Confirmation of Public Health Emergency			
Medium Response	<ul style="list-style-type: none"> • Public Notification of event info and treatment options • Pre-stage Medical Countermeasures • Adjusted treatment procedures 	<ul style="list-style-type: none"> • Social Distancing • Public Hygiene Campaign 	<ul style="list-style-type: none"> • Management of Agriculture/Livestock • Environmental Sampling
Response Threshold #1: Confirmation of Public Health Incident			
Low Response	<ul style="list-style-type: none"> • No Response • Seek Additional Information 	<ul style="list-style-type: none"> • Heighten Hospital Protective Measures • Seek Additional Information 	<ul style="list-style-type: none"> • Seek Additional Information

Based on response thresholds and scenario probabilities, relevant response strategies and options are identified

	Treatment for those Exposed	Prevention of Spread	Remediation of Environment
High Response	<ul style="list-style-type: none"> • Mass Care Centers/Triage Procedure • Dispense Medical Countermeasures 	<ul style="list-style-type: none"> • Quarantine • Evacuation • Transportation Shutdown /Travel restrictions • Shelter in Place 	<ul style="list-style-type: none"> • Environmental Decon, wide area • Special Waste/Debris disposal
Response Threshold #2: Confirmation of Public Health Emergency			
Medium Response 	<ul style="list-style-type: none"> • Public Notification of event info and treatment options • Pre-stage Medical Countermeasures • Adjusted treatment procedures 	<ul style="list-style-type: none"> • Social Distancing • Public Hygiene Campaign 	<ul style="list-style-type: none"> • Management of Agriculture/Livestock • Environmental Sampling
Response Threshold #1: Confirmation of Public Health Incident			
Low Response	<ul style="list-style-type: none"> • No Response • Seek Additional Information 	<ul style="list-style-type: none"> • Heighten Hospital Protective Measures • Seek Additional Information 	<ul style="list-style-type: none"> • Seek Additional Information

TPAT provides an evaluation of the response trade-offs and allows decision makers to respond more effectively

Medium Response, Prevention of Spread

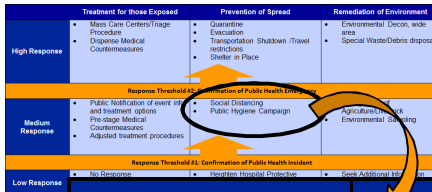


Response Options	Benefits	Impacts	Conditions when Effective
Social Distancing	<ul style="list-style-type: none"> Prevents person to person transmission of disease 	<ul style="list-style-type: none"> Economic Toll Operational disruption in the region 	<ul style="list-style-type: none"> Pathogen is contagious Pathogen is high risk
Public Hygiene Campaign	<ul style="list-style-type: none"> Reduces person to person transmission of disease Reduces exposure of individuals to the environment 	<ul style="list-style-type: none"> Minimal to none 	<ul style="list-style-type: none"> Robust across most scenarios Increased hospital admissions for an infectious disease

- Evaluation of responses in other medium level bins indicates that adjusted medical procedure and environmental sampling are also effective options

TPAT provides an evaluation of the response trade-offs and allows decision makers to respond more effectively

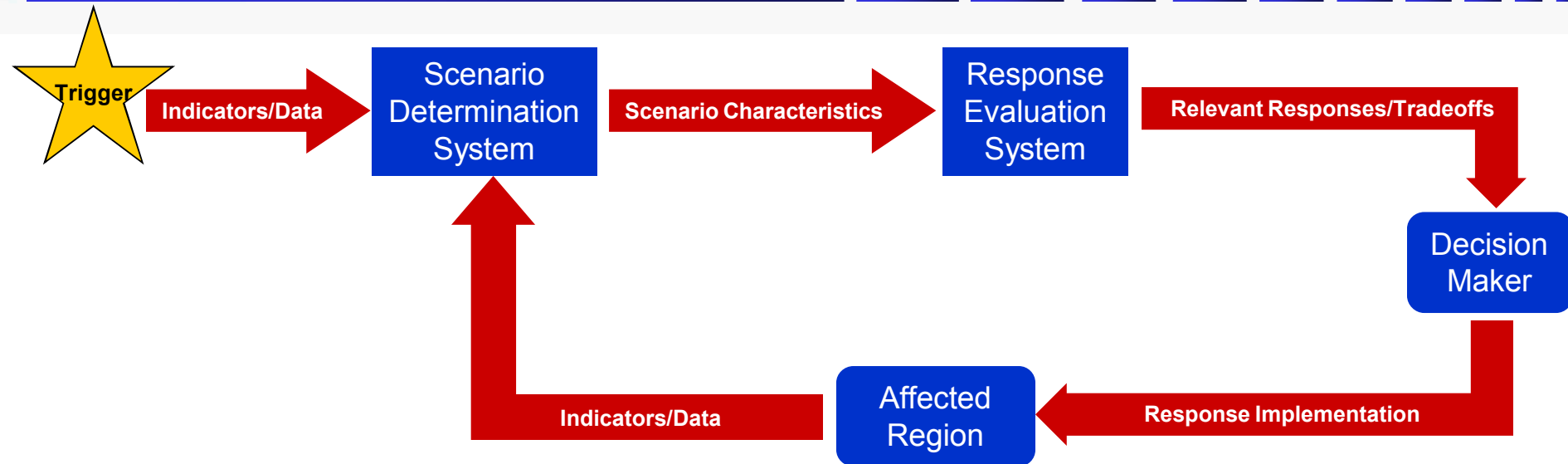
Medium Response, Prevention of Spread



Response Options	Benefits	Impacts	Conditions when Effective
Social Distancing	<ul style="list-style-type: none"> Prevents person to person transmission of disease 	<ul style="list-style-type: none"> Economic Toll Operational disruption in the region 	<ul style="list-style-type: none"> Pathogen is contagious Pathogen is high risk
Public Hygiene Campaign	<ul style="list-style-type: none"> Reduces person to person transmission of disease Reduces exposure of individuals to the environment 	<ul style="list-style-type: none"> Minimal to none 	<ul style="list-style-type: none"> Robust across most scenarios Increased hospital admissions for an infectious disease

- Evaluation of responses in other medium level bins indicates that adjusted medical procedure and environmental sampling are also effective options

Day 3: Officials re-collect all info relevant to the incident and input it into TPAT



- **Hospital admissions data from across the bay area is collected**
 - Admissions rates have increased significantly above normal levels and continue to increase
- **Lab cultures and diagnosis data is returned**
 - Results indicate that patients are infected with anthrax
- **Environmental sampling is performed**
 - Testing indicates that Region X in San Francisco is contaminated with Anthrax spores

Within TPAT, the Scenario Determine System aggregates this information and assesses scenario characteristics and likelihood

Scenario Characteristics, <u>Day 3</u>											
	Is there a threat?	What is the threat?									
	Threat	Pathogen					Source			Scale of Incident	
<u>Indicators</u>	Public Health Incident (e.g., terrorist attack)?	Type?	Aerosolizable?	Infectious?	Contagious?	Persistent?	Time?	Location?	Amount?	Potentially Affected Area?	People Potentially Affected / exposed?
Increased Hospital Admissions Anthrax Infection	1, Suggests a public health emergency, due to high risk pathogen and magnitude of increase	2, Confirms that the pathogen is anthrax	1, Suggests pathogen is aerosolizable, based on the presence of lung infections	2, Confirms that the pathogen is infectious based on the presence of ill people	1, Suggests not contagious, based on prior knowledge of anthrax	1, Suggests persistent, based on prior knowledge of anthrax	1, Suggests release occurred within 1 week, based on typical incubation periods	1, Suggests source location is in the San Francisco and Oakland area, based on hospital locations	0, Does not suggest or confirm	1, Suggests a 100 sq mile area may be affected, based on the hospital locations	1, Suggests as many as 5 million people may be affected based on census data
Environmental Sampling Anthrax is found	1, Suggests a public health emergency 1, Suggests a terrorist attack	2, Confirms the presence of anthrax	2, Confirms aerosolizable based on the presence of spores	0, Does not suggest or confirm	0, Does not suggest or confirm	2, Confirms persistent based on the presence of spores	0, Does not suggest or confirm	1, Suggests source is within Region X	1, Suggests a large size release, modeling based on sampling conc. and location	0, does not suggest or confirm	0, does not suggest or confirm
Results and Likelihood	Very Likely a public health emergency, likely a terrorist attack	Confirmed Anthrax	Confirmed Aerosolizable	Confirmed Infectious	Likely Contagious	Confirmed Persistent	Likely within one week	Very Likely within San Francisco, Region X	Likely a large size release	Possibly a 100 square mile area or greater	Possibly a 5 million, those within affected area

Potential scenarios and associated likelihoods are summarized and output

■ Most Likely Scenario:


- Public health emergency has occurred → **Very Likely**
- Pathogen
 - ♦ Anthrax, Aerosolizable, Infectious, Persistent → **Confirmed**
 - ♦ Not Contagious → **Likely**
- Source
 - ♦ Within 1 week before spike in hospital admissions → **Likely**
 - ♦ Within San Francisco, Region X → **Very Likely**
 - ♦ Amount is a large release → **Likely**
- Scale
 - ♦ 100 square mile area or greater → **Possibly**
 - ♦ Up to 5 million people exposed → **Possibly**

- ## ■ This example will go through only the most likely scenario. When using TPAT, the user would assess response options for a wide range of scenarios.

Based on response thresholds and scenario probabilities, response strategies and options are identified

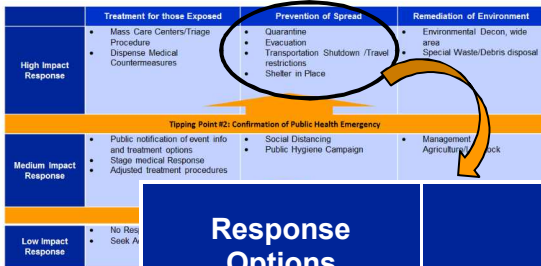
	Treatment for those Exposed	Prevention of Spread	Remediation of Environment
High Response	<ul style="list-style-type: none"> • Mass Care Centers/Triage Procedure • Dispense Medical Countermeasures 	<ul style="list-style-type: none"> • Quarantine • Evacuation • Transportation Shutdown /Travel restrictions • Shelter in Place 	<ul style="list-style-type: none"> • Environmental Decon, wide area • Special Waste/Debris disposal
Response Threshold #2: Confirmation of Public Health Emergency			
Medium Response	<ul style="list-style-type: none"> • Public Notification of event info and treatment options • Pre-stage Medical Countermeasures • Adjusted treatment procedures 	<ul style="list-style-type: none"> • Social Distancing • Public Hygiene Campaign 	<ul style="list-style-type: none"> • Management of Agriculture/Livestock • Environmental Sampling
Response Threshold #1: Confirmation of Public Health Incident			
Low Response	<ul style="list-style-type: none"> • No Response • Seek Additional Information 	<ul style="list-style-type: none"> • Heighten Hospital Protective Measures • Seek Additional Information 	<ul style="list-style-type: none"> • Seek Additional Information

Based on response thresholds and scenario probabilities, response strategies and options are identified

	Treatment for those Exposed	Prevention of Spread	Remediation of Environment
High Response 	<ul style="list-style-type: none"> • Mass Care Centers/Triage Procedure • Dispense Medical Countermeasures 	<ul style="list-style-type: none"> • Quarantine • Evacuation • Transportation Shutdown /Travel restrictions • Shelter in Place 	<ul style="list-style-type: none"> • Environmental Decon, wide area • Special Waste/Debris disposal
Response Threshold #2: Confirmation of Public Health Emergency			
Medium Response	<ul style="list-style-type: none"> • Public Notification of event info and treatment options • Pre-stage Medical Countermeasures • Adjusted treatment procedures 	<ul style="list-style-type: none"> • Social Distancing • Public Hygiene Campaign 	<ul style="list-style-type: none"> • Management of Agriculture/Livestock • Environmental Sampling
Response Threshold #1: Confirmation of Public Health Incident			
Low Response	<ul style="list-style-type: none"> • No Response • Seek Additional Information 	<ul style="list-style-type: none"> • Heighten Hospital Protective Measures • Seek Additional Information 	<ul style="list-style-type: none"> • Seek Additional Information

TPAT provides an evaluation of the response trade-offs and allows decision makers to respond more effectively

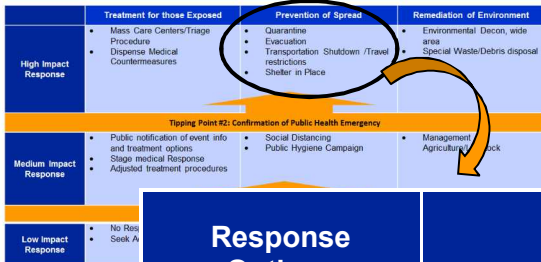
High Impact Response, Prevention of Spread



Response Options	Benefits	Impacts	Conditions when Effective
Quarantine	<ul style="list-style-type: none"> Eliminates Person to Person transmission Halts Environmental Spread Easily Directed treatment 	<ul style="list-style-type: none"> Logistics/Personnel Social/Political ramifications Legal Considerations 	<ul style="list-style-type: none"> Pathogen is very Contagious Pathogen is high risk Extent of Contamination is well known
Evacuation	<ul style="list-style-type: none"> Eliminates exposure to pathogen Allows for easier decon and investigation 	<ul style="list-style-type: none"> Logistics/Personnel to facilitate Significant Economic toll Facilitates Spread if Contagious 	<ul style="list-style-type: none"> Pathogen is not contagious Pathogen is Persistent in the environment Pathogen is high risk ↑Time: ↑exposure and ↓effectiveness
Transportation Shutdown/Travel Restrictions	<ul style="list-style-type: none"> Reduces spread to outside affected area 	<ul style="list-style-type: none"> Significant Economic toll Social/political ramifications 	<ul style="list-style-type: none"> Pathogen is Persistent in the environment Pathogen is High Risk Incident is in a high traffic area ↑Time: ↑outside exposure and ↓effectiveness

Evaluate response trade-offs and make selection

High Impact Response, Prevention of Spread



Response Options	Benefits	Impacts	Conditions when Effective
Quarantine	<ul style="list-style-type: none"> Eliminates Person to Person transmission Halts Environmental Spread Easily Directed treatment 	<ul style="list-style-type: none"> Logistics/Personnel Social/Political ramifications Legal Considerations 	<ul style="list-style-type: none"> Pathogen is very Contagious Pathogen is high risk Extend of Contamination is well known
Evacuation	<ul style="list-style-type: none"> Eliminates exposure to pathogen Allows for easier decon and investigation 	<ul style="list-style-type: none"> Logistics/Personnel to facilitate Significant Economic toll Facilitates Spread if Contagious 	<ul style="list-style-type: none"> Pathogen is not contagious Pathogen is Persistent in the environment Pathogen is high risk ↑Time: ↑exposure and ↓effectiveness
Transportation Shutdown/Travel Restrictions	<ul style="list-style-type: none"> Reduces spread to outside affected area 	<ul style="list-style-type: none"> Significant Economic toll Social/political ramifications 	<ul style="list-style-type: none"> Pathogen is Persistent in the environment Pathogen is High Risk Incident is in a high traffic area ↑Time: ↑outside exposure and ↓effectiveness



Future Directions

- **Incorporation of time as a more central parameter during response option evaluation**
- **Evaluation of quantitative data and techniques as components in the scenario determination and response evaluation procedures**
- **Characterization of the value and uncertainty of the information provided by the indicators using expert opinion and prior publications**