CBRN Terrorism Risk Assessments

Methods and Applications

Homeland Security
Science and Technology

28 July 2016
Military Operations Research Society (MORS)

Scott White, PhD

Terrorism Risk Assessment Program Manager
Chemical Biological Defense Division
HSARPA

Mandates for the Terrorism Risk Assessments (TRAs)

- HSPD-10 Biodefense for the 21st Century
  - Ongoing periodic assessment of bioterrorism risk
  - Evaluates progress in implementing investments
  - Identifies gaps or vulnerabilities
- HSPD-18 Medical Countermeasures Against Weapons of Mass Destruction
  - Ongoing periodic assessment of CBRN terrorism risk
  - Inform Medical Countermeasure (MCM) development and acquisition
- HSPD-22 Domestic Chemical Defense
  - Ongoing periodic assessment of chemical terrorism risk
  - Inform chemical terrorism preparedness and response planning efforts

BIODEFENSE FOR THE 21ST CENTURY

"Bioterrorism is a real threat to our country. It's a threat to every nation that loves freedom. Terrorist groups seek biological weapons; we know some rogue states already have them…It's important that we confront these real threats to our country and prepare for future emergencies."

PRESIDENT GEORGE W. BUSH
JUNE 12, 2002

"Armed with a single vial of a biological agent…small groups of fanatics, or failing states, could gain the power to threaten great nations, threaten the world peace. America, and the entire civilized world, will face this threat for decades to come. We must confront the danger with open eyes, and unbending purpose."

PRESIDENT GEORGE W. BUSH
FEBRUARY 11, 2004

Biological weapons in the possession of hostile states or terrorists pose unique and grave threats to the safety and security of the United States and our allies.

Biological weapons attacks could cause catastrophic harm. They could inflict widespread injury and result in massive casualties and economic disruption. Bioterror attacks could mimic naturally-occurring disease, potentially delaying recognition of an attack and creating uncertainty about whether one has even occurred. An attacker may thus believe that he could escape identification and capture or retaliation.

and life sciences -- including the spread of expertise to create modified or novel organisms -- present the prospect of new toxins, live agents, and bioregulators that would require new detection methods, preventive measures, and treatments. These trends increase the risk for surprise. Anticipating such threats through intelligence efforts is made more difficult by the dual-use nature of biological technologies and infrastructure, and the likelihood that adversaries will use denial and deception to conceal their illicit activities.

The stakes could not be higher for our Nation. Attacks with biological weapons

numbers of acute
rm disease and
gical trauma, and

rs of our economy
lives of Americans;

ernational effects by

Administration of George W. Bush, 2007 / Feb. 7

Homeland Security Presidential Directive/HSPD–18—Medical Countermeasures Against Weapons of Mass Destruction
January 31, 2007

Subject: Medical Countermeasures against Weapons of Mass Destruction

BACKGROUND

(1) Weapons of Mass Destruction (WMD)—chemical, biological, radiological, and nuclear agents (CBRN)—in the possession of hostile states or terrorists represent one of the greatest security challenges facing the United States. An attack utilizing WMD potentially could cause mass casualties, compromise critical infrastructure, adversely affect our economy, and inflict social and psychological damage that could negatively affect the American way of life.

(2) Our *National Strategy to Combat Weapons of Mass Destruction* (December 2002) and *Biodefense for the 21st Century* (April 2004) identify response and recovery as key components of our Nation's ability to manage the consequences of a WMD attack. Our primary goal is to prevent such an attack, but we must be fully prepared to respond to and recover from an attack if one occurs. Accordingly, we have made significant investments in our WMD consequence management capabilities in order to mitigate impacts to the public's health, the economy, and our critical infrastructure. The development and acquisition of effective medical countermeasures to mitigate illness, suffering, and death resulting from CBRN agents is central to our consequence management efforts.

(3) It is not presently feasible to develop and stockpile medical countermeasures against every possible threat. The development of vaccines and drugs to prevent or mitigate adverse health effects caused by exposure to biological agents, chemicals, or radiation is a time-consuming and costly process. This directive builds upon the vision and objectives articulated in our *National Strategy to Combat Weapons of Mass Destruction* and *Biodefense for the 21st Century* to ensure that our Nation's medical countermeasure research, development, and acquisition efforts:

(a) Target threats that have potential for catastrophic impact on our public health and are subject to medical mitigation;

(b) Yield a rapidly deployable and flexible capability to address both existing and evolving threats;

(c) Are part of an integrated WMD consequence management approach informed by current risk assessments of threats, vulnerabilities, and capabilities; and

(d) Include the development of effective, feasible, and pragmatic concepts of operation for responding to and recovering from an attack.

(4) In order to address the challenges presented by the diverse CBRN threat spectrum, optimize the investments necessary for medical countermeasures development, and ensure that our activities significantly enhance our domestic and international response and recovery capabilities, our decisions as to the research, development, and acquisition of medical countermeasures will be guided by three overarching principles:

(a) Our preparations will focus on countering current and anticipated threat agents that have the greatest potential for use by state and non-state actors to cause catastrophic public health consequences to the American people.

(b) We will invest in medical countermeasures and public health interventions that have the greatest potential to prevent, treat, and mitigate the consequences of WMD threats.

Homeland Security
Science and Technology

What are the Goals of the TRAs?

- **Primary Objective**: Produce risk analyses that can be used by DHS and other federal agencies to BUY DOWN RISK of a CBRN terrorism attack

BTRA (Bioterrorism Risk Assessment)

- Addresses HSPD 10 and feeds into Integrated Terrorism Risk Assessment (ITRA)
- Informs DHS and partners on **bioterrorism risk**
- Supports bioterrorism preparedness & response planning
- Informs biothreat research & select agent rules

CTRA (Chemical Terrorism Risk Assessment)

- Addresses HSPD 22 and feeds into Integrated Terrorism Risk Assessment (ITRA)
- Informs DHS and partners on **chemical terrorism risk**
- Supports chemical terrorism preparedness & response planning
- Informs decisions on industrially useful toxic industrial chemicals & materials (TICs & TIMs)

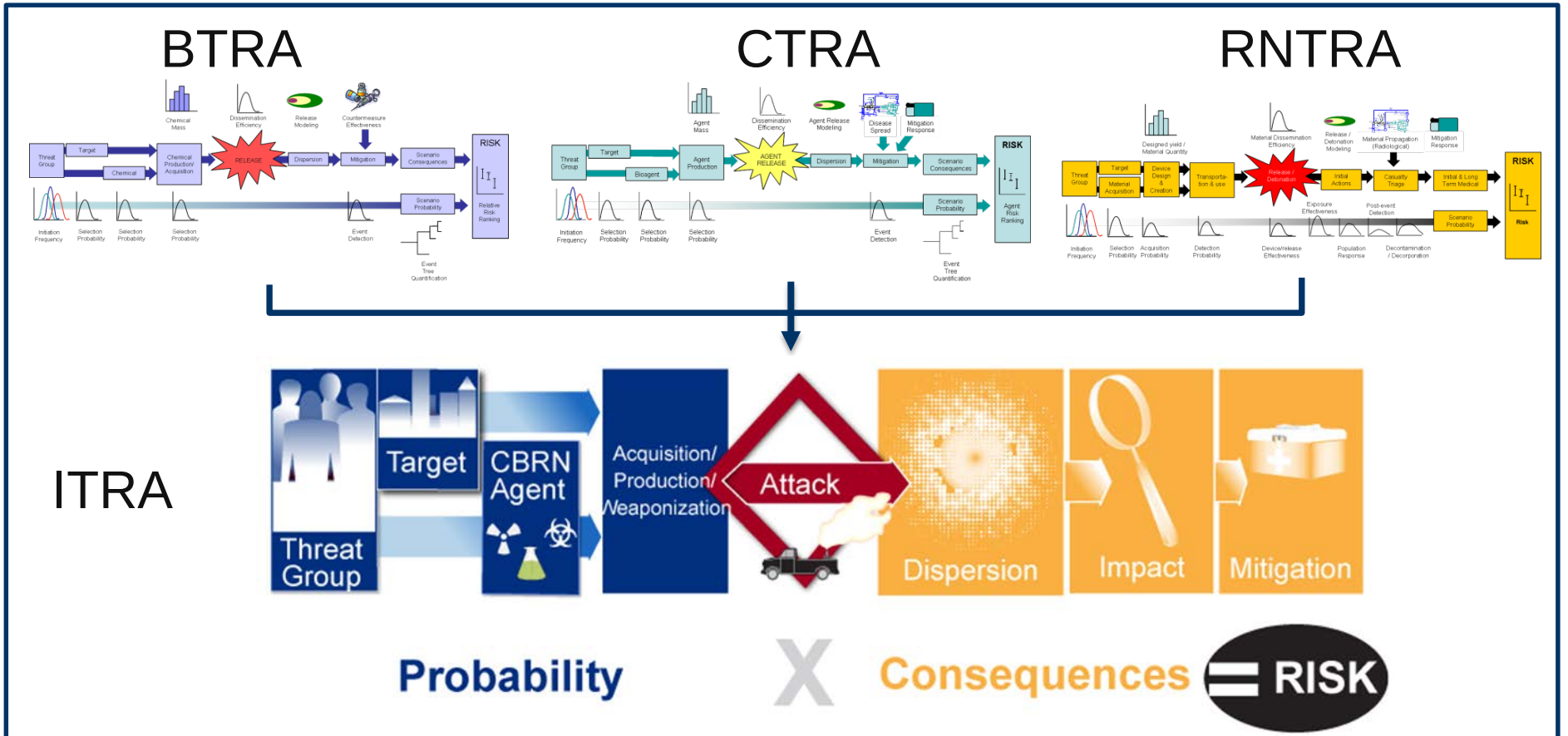
RNTRA (Radiological and Nuclear Terrorism Risk Assessment)

- Addresses HSPD 18 and feeds into ITRA
- Informs DHS and partners on **radiological and chemical terrorism risk**
- Supports radiological and nuclear terrorism preparedness & response planning
- Supports the Domestic Nuclear Detection Office's (DNDO) analysis of the Global Nuclear Detection Architecture

Homeland Security
Science and Technology

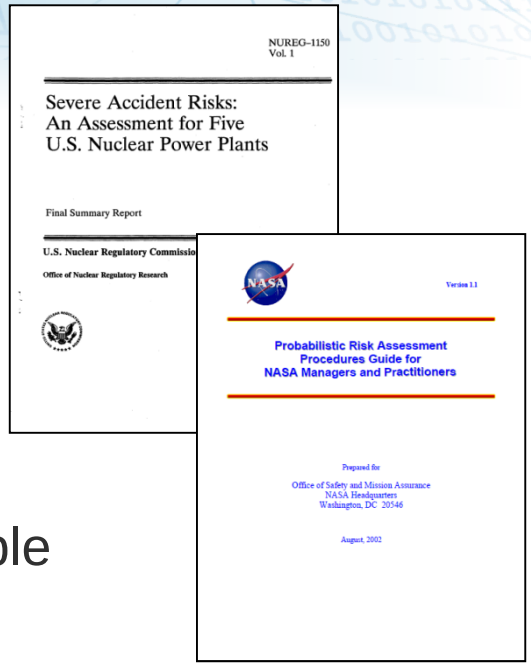
TRAs Address Domestic CBRN Terrorism

- ITRA (Integrated Terrorism Risk Assessment) – Addresses HSPD 18
  - Informs countermeasure development and acquisition (recently completed SNS study)
  - Assesses mitigation options and inform CBRN terrorism investments
  - Integrated into the Material Threat Assessment (MTA) and Material Threat Determination (MTD) processes



(U) BTRA uses Probabilistic Risk Assessment Methodology

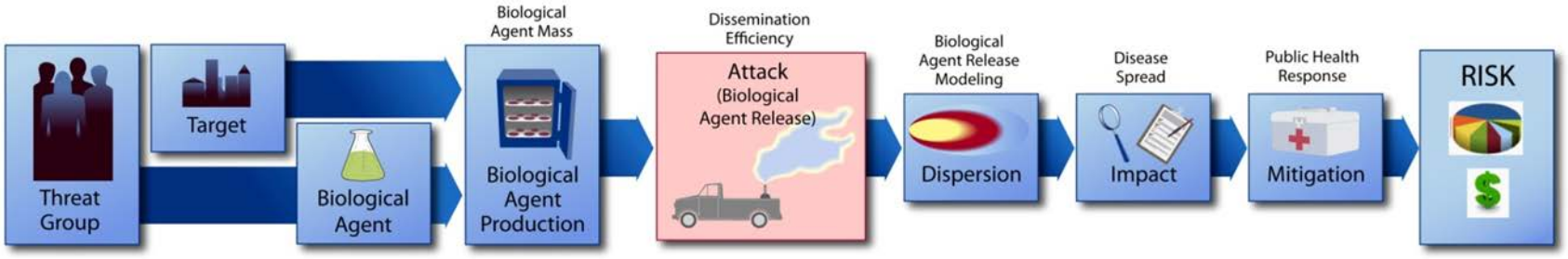
- Why Probabilistic Risk Assessment (PRA)?
  - Quantify risk for rare, catastrophic events
  - Proven utility for nuclear power plant risk (e.g., WASH-1400, NUREG-1150), chemical industry risk, and aerospace industry risk
  - Address large risk space
- Leverages best available data, subject matter expert (SME) judgments, and technically defensible models to provide a quantitative and reproducible assessment of risk
- PRA Methodology
  - Define the set of scenarios that captures the risk(s) of concern
  - Estimate the probability and consequences of each scenario
  - Calculate risk as Risk = Probability x Consequence



Homeland Security
Science and Technology

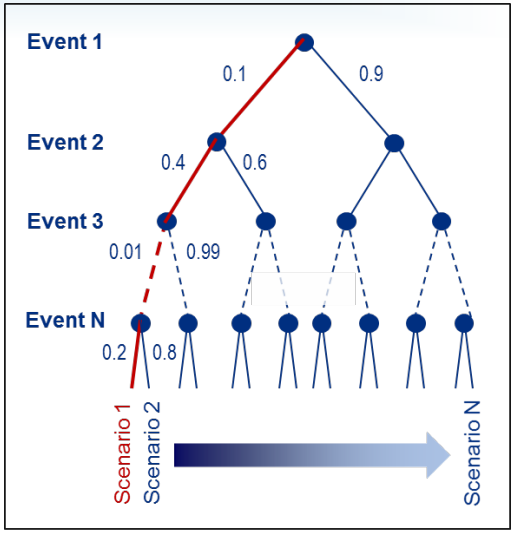
PRA Implementation in the BTRA

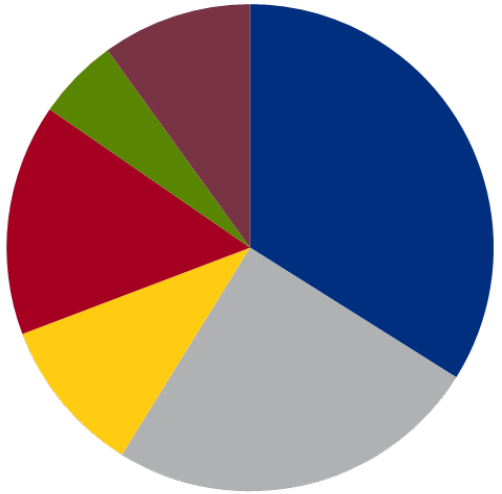
- BTRA Scope
  - 3 terrorist organization categories, 37 biological hazards, 2 routes of exposure, 20 targets, 7 modes of dissemination, etc.
  - Total scenarios = >5 billion; scenarios with consequences >600,000
- Scenarios are defined using an event tree; the event tree is used to calculate scenario probabilities
- Scenario consequences are calculated using computational models; consequence metrics are illnesses, fatalities, economic costs
- Variability is captured in both the probability and consequence estimates; consequences for each scenario estimated 10,000 times



Scenario Probabilities

- Defined with an event tree
- Updated to include adversary models
  - Attack decision model (target, agent, attack mode, quantity)
  - Interdiction during transportation; “pathway model”
  - Agent acquisition
  - Agent production
- Informed by the Intelligence community (IC)
  - Survey of IC members
  - Formal surveys when possible; informal when necessary

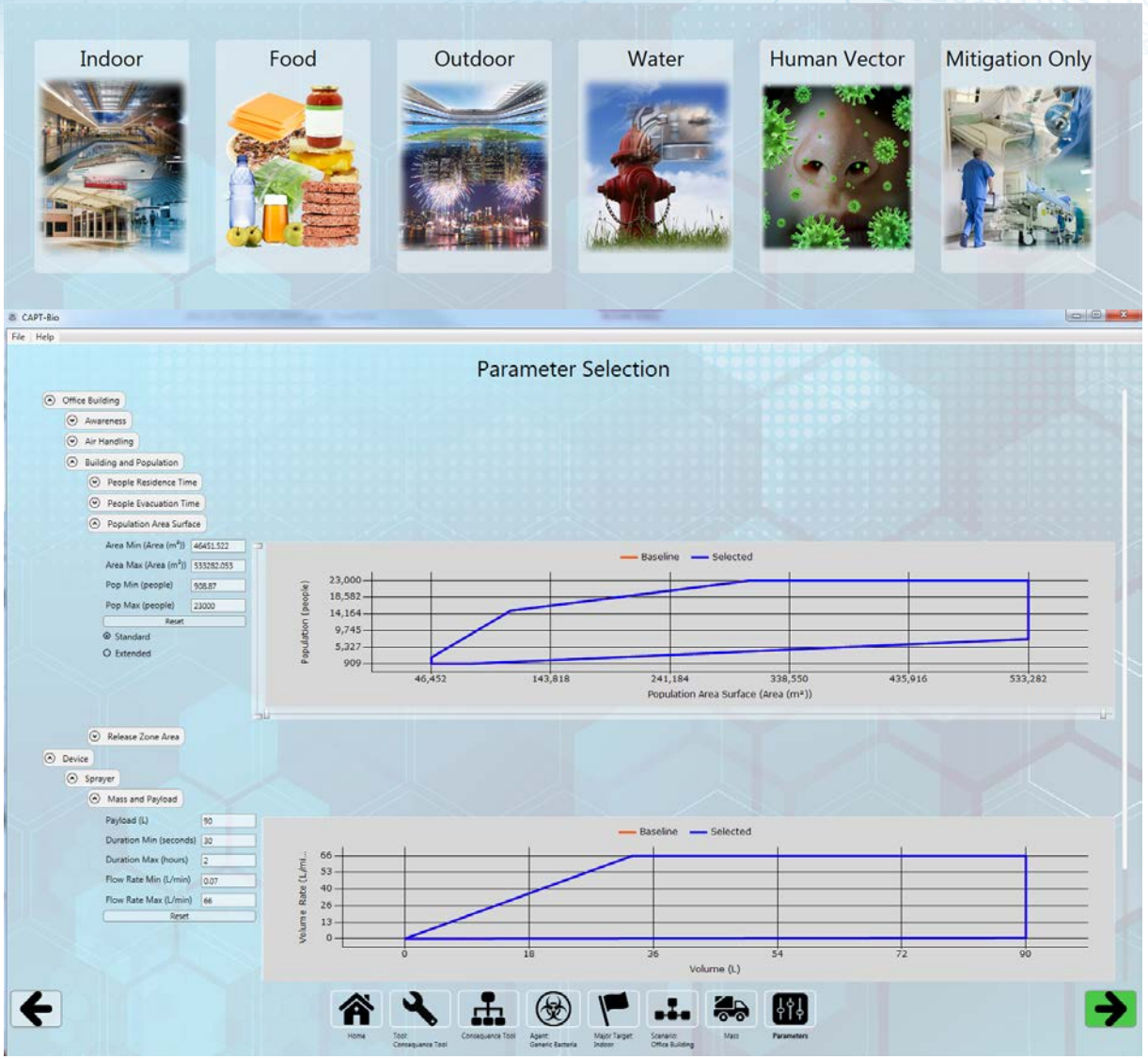




Homeland Security
Science and Technology

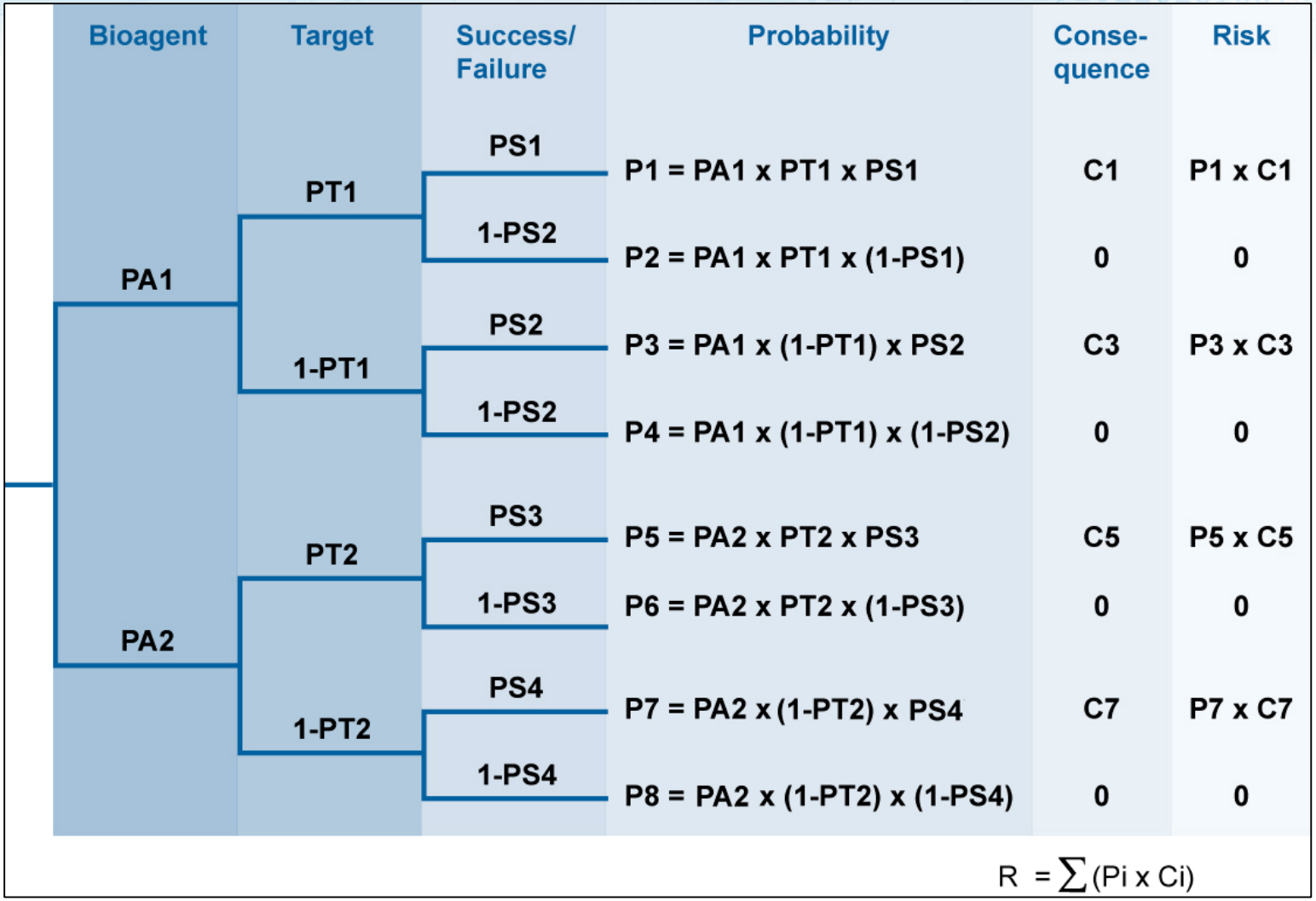
Scenario Consequences

- Estimated using computational models
- Highly parameterized



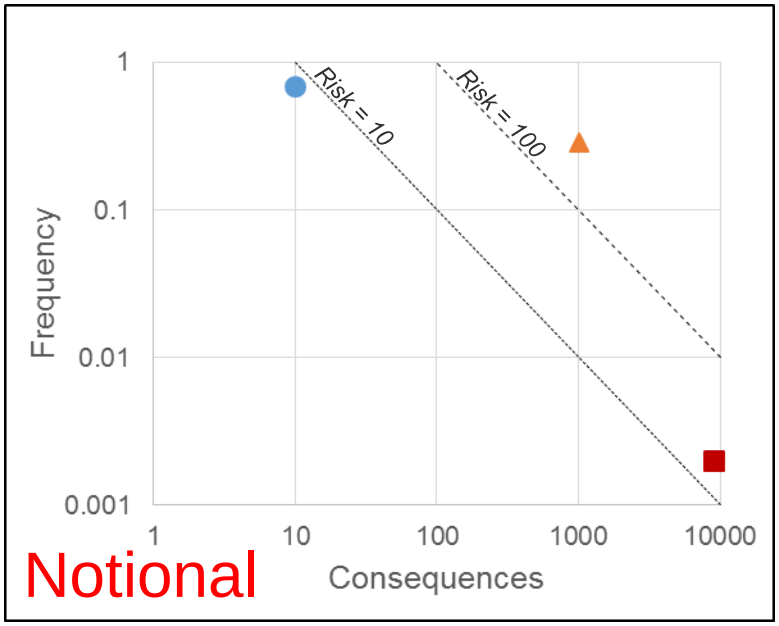
Homeland Security
Science and Technology

Scenario Risk

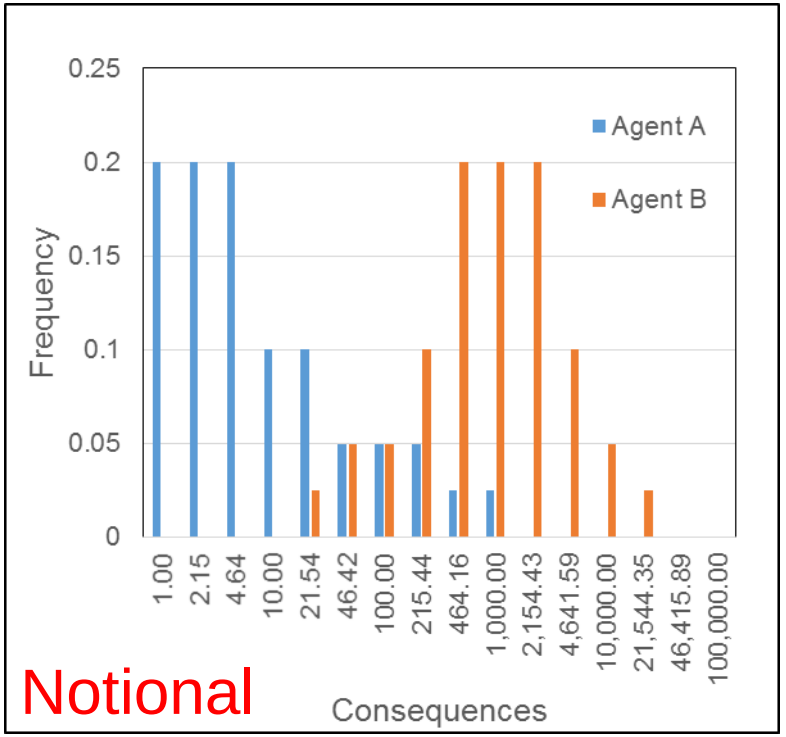


Visualizing Results

Risk square for fatalities



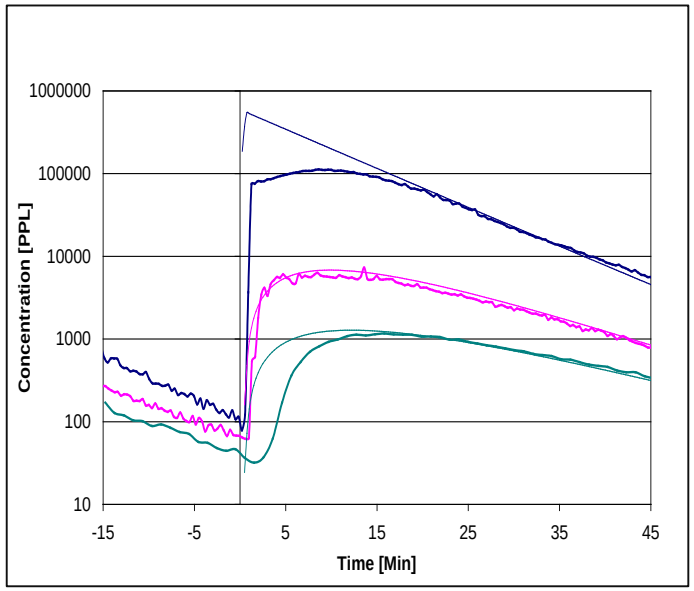
A risk histogram for two agents



Homeland Security
Science and Technology

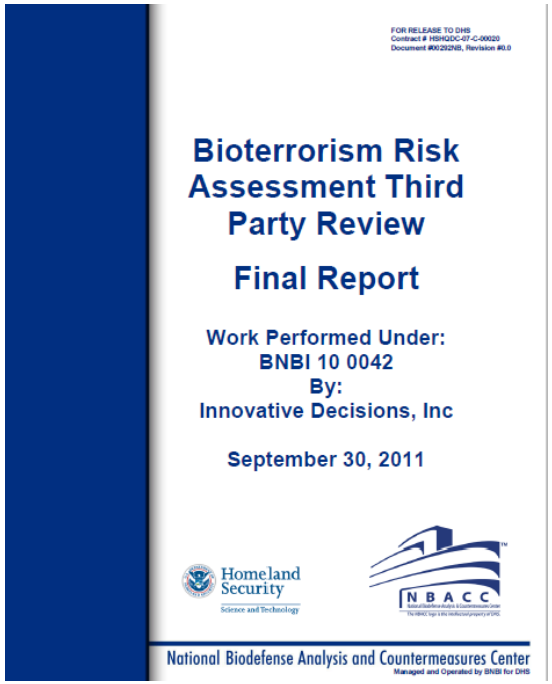
Verified and Vetted

Validated against experiment when possible



- Experimental Zone of Release
- Experimental Zone of Interest
- Experimental Rest of Building
- Theoretical Zone of Release
- Theoretical Zone of Interest
- Theoretical Rest of Building

Verification by Innovative Decisions Inc.



"…the IDI Team came to one overall conclusion: The BTRA model and the BTRA model team comprise an important and valuable national security asset for conducting both broad and tailored bioterrorism risk assessments…While there is a wide range of models for analyzing various aspects of bioterrorism attacks, we know of no other model that is as comprehensive as the BTRA and that provides direct, quantitative, agent-by-agent comparisons."

Verification by Lawrence Livermore National Lab (LLNL)

The LLNL ITRA verification team performed a thorough evaluation of the software code and associated documentation for the 2011 ITRA code 2012 CTRA code provided by Battelle. We confirmed that sound software quality practices were used to ensure the results returned were those expected by the subject matter experts. The algorithms correctly solved the mathematical equations specified in the requirements documentation and code modules worked as specified. We conclude that the codes were thoroughly verified and met sponsor requirements.