Communicating Health Risks under Pressure: Homeland Security Applications

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ABSTRACT

The U.S. Environmental Protection Agency’s (EPA) Office of Research and Development (ORD) Threat and Consequence Assessment Division (TCAD) within the National Homeland Security Research Center (NHSRC) has developed a tool for rapid communication of health risks and likelihood of exposure in preparation for terrorist incidents. The Emergency Consequence Assessment Tool (ECAT) is a secure web-based tool designed to make risk assessment and consequence management faster and easier for high priority terrorist threat scenarios. ECAT has been designed to function as “defensive playbook” for health advisors, first responders, and decision-makers by presenting a series of evaluation templates for priority scenarios that can be modified for site-specific applications. Perhaps most importantly, the risk communication aspect is considered prior to an actual release event, so that management or legal advisors can concur on general risk communication content in preparation for press releases that can be anticipated in case of an actual emergency. ECAT serves as a one-stop source of information for retrieving toxicological properties for agents of concern, estimating exposure to these agents, characterizing health risks, and determining what actions need to be undertaken to mitigate the risks. ECAT has the capability to be used at a command post where inputs can be checked and communicated while the response continues in real time. This front-end planning is intended to fill the gap most commonly identified during tabletop exercises: a need for concise, timely, and informative risk communication to all parties. Training and customization of existing chemical and biological release scenarios with modeling of exposure to air and water, along with custom risk communication “messages” intended for public, press, shareholders, and other partners enable more effective communication during times of crisis. For DOE, the ECAT could serve as a prototype that would be amenable to customization to include radioactive waste management or responses to catastrophic releases of radioactive material due to terrorist actions.

INTRODUCTION

Since September 11, 2001 an increased awareness of the potential for chemical/biological/radiological (CBR) terrorist attacks in civilian settings has emphasized the need for preparedness. This paper and presentation address the needs for CBR civilian attack scenarios that go beyond physical and logistical readiness and the actual response capability itself. We will also explore differences in planning for a civilian CBR incident response (as opposed to military CBR training), provide an overview of a rapid CBR scenario tool, and discuss findings in this year's efforts to expand and update that tool.

The impetus for increased CBR preparedness comes via the perspective of the Threat and Consequence Assessment Division (TCAD) mission within EPA's National Homeland Security Research Center (NHSRC). Before funding and organization of the Department of Homeland Security (DHS), the U.S. Environmental Protection Agency (EPA) formed the NHSRC in September 2002. In November 2004 the (former) EPA NHSRC Rapid Risk Team was reorganized into TCAD. In July 2004, NHSRC contracted for development of a rapid risk assessment tool to assess CBR civilian attack scenarios. The momentum for this initiative continues today, expanding upon lessons learned since 2001, including controversy surrounding the 9/11 investigation into health hazards. With the subsequent organization of the DHS per the requirements of the Homeland Security Act of 2002, more resources are available, but are not necessarily far into the preparation process for assessing a CBR attack.

USER NEEDS FOR CBR SCENARIOS IDENTIFIED BY RAPID RISK TOOL

Beyond preparedness and training for the physical response after an attack itself, EPA NHSRC noted the need to provide accurate scientific bases for all decisions; rapid, transparent assessment; and consistent, easily shared messages regarding risks and steps to take to avoid health consequences. To provide for these needs, EPA NHSRC created the ECAT, or the Emergency Consequence Assessment Tool. Relevant features to address these needs are outlined below.

Accurate Scientific Bases for Decisions

The ECAT does not make the ultimate risk management decisions relevant to a CBR attack such as whether to evacuate, how to clean it up, or how to confirm it is safe. Instead, all relevant science to make these decisions is compiled in the tool, including exposure modeling, toxicity and infectivity data, detection abilities, decontamination methods, "lessons learned" and previous EPA policy decisions.

Rapid, Transparent Assessment

Having all the information in one software tool enables much more rapid assessment of health risks. Instead of the weeks-long assessment of the past, initial decisions may be made on the order of hours, with all inputs to the decision available for quality control checks and management approval. All scientific data is entered into the system for each CBR agent and reviewed for accuracy in non-stressful situations prior to an actual attack. All models are used and validated by potential users serving as beta testers during normal operations. User inputs are logged and available for modification pending scientific agreement of the expert decision makers. This enables the spirit of EPA's desire to have reasonable peer review of scientific calculations and approach while enabling rapid response in a threat situation.

Consistent, Easily Shared Messages

The evolution of the ECAT raised many of the technical and policy issues that have thwarted forward progress in the realm of chronic health risk assessment (for which toxicity consensus alone takes 2 to 5 years to achieve). Differing scientific opinions are the hallmark of thorough peer review: however, in a time of crisis, mixed messages from scientists do not help the public understand what to do. Risk communication elements, including concise press release and press conference preparation, is easily accomplished ahead of a CB attack when all the scientific facts are assembled. Multiple tiers of management review can be conducted ahead of time so that the public is rapidly and consistently informed of the recommendations to protect their health. The tenets of concise communication were applied by Mayor Rudy Giuliani in the wake of 9/11, because he prepared for disaster management press conferences.

INTRODUCTION TO ECAT: PURPOSE, SCOPE, AND GOALS

ECAT's primary purpose is to enable pre-emergency planning for rapid and consistent response and risk assessment. In so doing, the ECAT is engineered to be pre-programmed or customized at the regional or local level to assess exposure specifics, as it is not intended to be prescriptive. The tool enables users to customize models, calculations, and specifications before a threat or actual CB attack occurs.

In 2004-2005, ECAT was designed as a pilot program to address 10 scenarios in a secure web-based platform for ease of access, flexibility, and utility. Through present, due to the sensitive nature of ECAT content, access is provided to approved EPA users only, due to the pilot nature of the program, but collaboration with other government entities such as DOD and DOE is under consideration.

Important goals for the design of ECAT were to allow the tool to be scaled up without investment in reprogramming and to exceed functional specifications. As most software designers will find, the functional specifications evolve over time responsive to user feedback. Iterations of design and testing molded the ECAT into what it is today. Potential users who had input to ECAT's functionality included OSCs, responders, and science advisors; emergency planners and trainers; decision makers, administration, and management. The ECAT design and testing team incorporated a multidisciplinary approach. First responders and technical experts (such as for toxicology, exposure modeling components) designed the content of ECAT. 37 EPA personnel including scientists and OSCs beta tested Version 1.0 in May 2005, and 8 additional testers commented on Version 2.0 in September 2005.

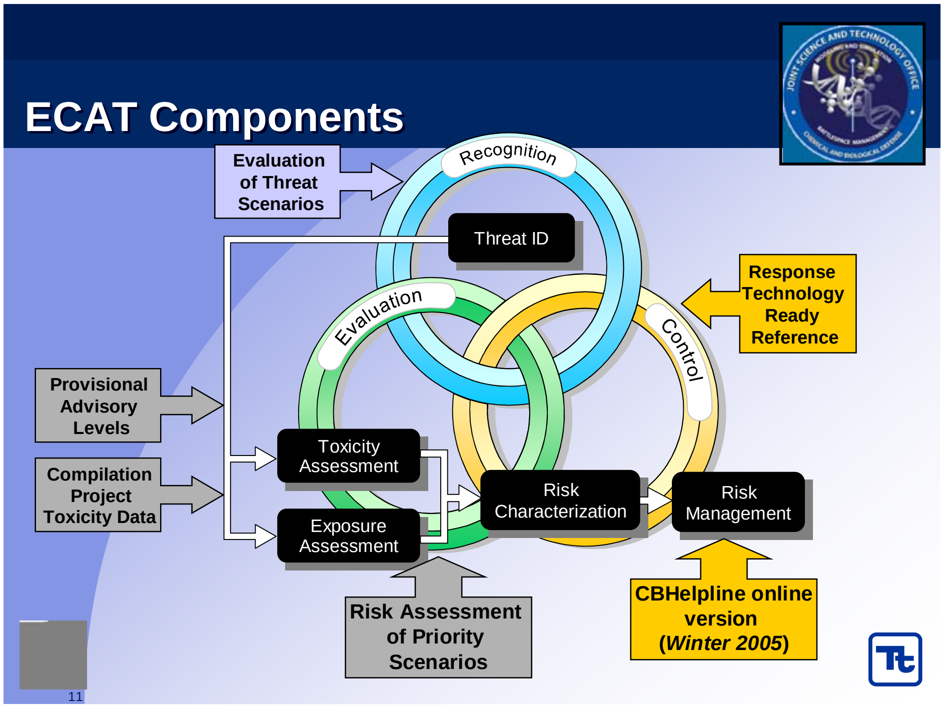


Fig. 1. ECAT components and conceptual response and assessment paradigm linkage

RISK COMMUNICATION USING ECAT

ECAT is designed to communicate health risks to two main target audiences: health advisors and the general public. Even with two disparate audiences, the same underlying principles of crisis communications can be applied.

Guiding Principles for Crisis Communication with the Public

Risk Communication in ECAT is built upon the principles developed by Dr. Vincent Covello, founder and Director of the Center for Risk Communication located in New York City. Summarized below are the guiding principles or central concepts espoused by Dr. Covello for effectively communication during crises.

- **27/9/3:** You should aim to have only **3 main points** which take no longer than **27 words** to explain so that you convey the message in **9 seconds**. This is approximately the length of a newspaper quote and 3 items are the most an audience can remember in a high-stress environment, such as immediately after a C/B emergency. Three supporting pieces of information should be used to back up the 3 main points, and each may go into more detail than the main message. Use the "tell them what you are going to tell them" approach to introduce the 3 main points, give them the backup, and then summarize the 3 main points you were making. Don't be afraid to number the points; in fact, this is recommended for clarity and so the audience can follow you.

- **<u>Primacy/Recency:</u>** Under stress, people remember the **first point and last point** best, so be sure to put the least important point in the middle of a three-point list.

- **<u>AGL-4:</u>** During a time of crisis, the human mind cannot comprehend at its usual functional "average grade level" (assumed to be 11 or 12 across the US, may vary with location). Thus, common electronic grammar/reading level tools can be used to check to ensure that the message you are delivering contains few three-syllable words or jargon, and is aimed at the 7^{th} or 8^{th} grade reading level. Your supporting facts (3 for each main point) may be above this reading level if you need to deliver more scientific information, but still avoid jargon.

- **<u>CCO:</u>** When presented with an emotionally charged question, it is important to show Compassion, Conviction, and Optimism (CCO) in the message. The middle point should be something genuine ("I believe…" or "We shall…) and the last point should be optimistic.

- **<u>1N = 3P (or 4P or 5P):</u>** When answering a negative question or having to present a negative data point, counter with at least 3 positives. Under stress, we tend to remember only the negative so you have to counteract this tendency by making positive statements. Avoid absolutes (never, always) and avoid negative terms (no, none, cannot).

- **<u>Message Maps:</u>** About 95% of media questions can be anticipated and hence preparation is critical. Evaluation of the most likely questions ahead of time, rather than in the heat of a crisis, allows risk managers to agree on wording and content prior to an emergency. The output from each evaluation on how best to answer each of the most common questions is in the form of a "message map." The message map is essentially a reply to an anticipated question in the form of a template showing three key messages and three supporting facts for each key message.

Dr. Covello's method has been used by Gen. Norman Schwartzkopf, British Prime Minister Tony Blair, the World Health Organization, and perhaps most significantly, by Mayor Rudy Giuliani in the wake of 9/11. Each of these leaders planned risk communication answers and practiced their message delivery as part of their governmental duty to be prepared and serve as an effective leader during a time of crisis.

ECAT has been designed to include several features that facilitate communication with the public during an emergency. These features include the previously described guiding principles for risk communication developed by Dr. Vincent Covello, a collection of seven completed message maps, a list of the 75 most commonly asked questions that one can expect from the public, concise fact sheets, widespread use of graphics, and direct electronic links to other valuable sources of information and tools. Example "message mapped" responses suitable for responding to CBR attacks on water supplies or urban centers are included for the ECAT scenarios, as demonstrated in Fig. 2. To serve multiple user groups, references for facts or answers to frequently asked questions are included whenever possible (see Fig. 3.) to ensure transparency.

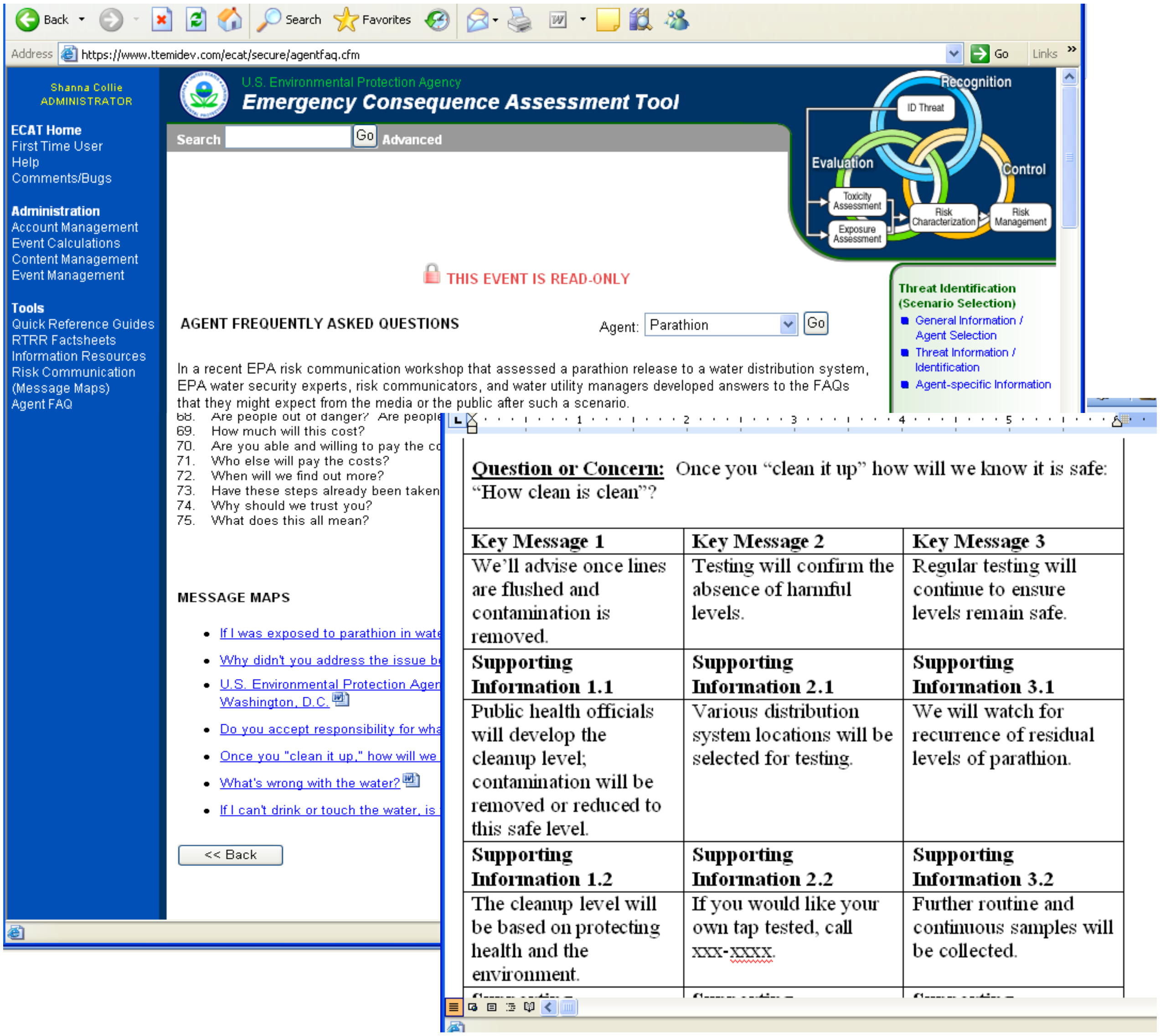


Fig. 2. Example ECAT message maps relating to a scenario where an organophosphate has been introduced to the water distribution system. Clicking on any of the message maps icons (see left screen) brings up a message map template (see inset at right) ready to insert location-specific details. The pre-planning for risk communication enables rapid preparation for press conferences and coordination meetings.

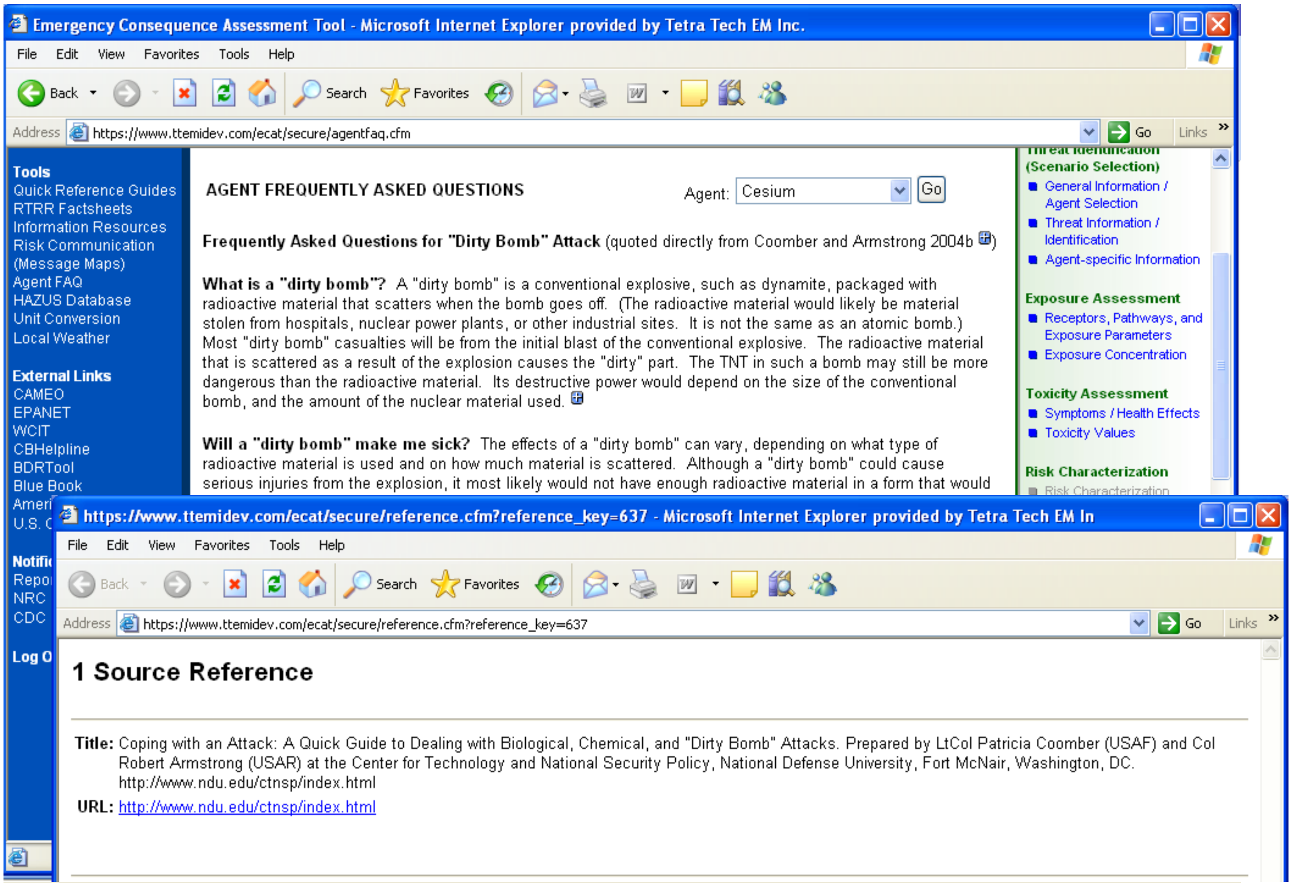


Fig. 3**.** Frequently asked questions for a "dirty bomb" attack scenario are answered with referenced information. Clicking on any of the reference (blue cross) icons brings up the full reference citation (see inset at right) and, if available, an electronic version of the source document. This enables rapid updates and changes to the recommendations as needed on a case-by-case basis.

Risk Communication with Health Advisors

ECAT has been designed to facilitate effective communication among the many types of health advisors – toxicologists, epidemiologists, exposure assessors, environmental modelers, and health care providers. As mentioned earlier, these users have the need for information that is (1) scientifically accurate, (2) rapid and transparent, and (3) consistent and easily shared. One of the major challenges in designing ECAT was to determine how best to organize the voluminous amounts of complex health data in a manner that made intuitive sense. The designers of ECAT judged that the best vehicle for accomplishing this was to organize the complex data in ECAT utilizing the risk assessment - risk management paradigm. The risk assessment – risk management paradigm was defined by the National Academy of Science in 1983. ECAT utilizes a version of that paradigm that is very similar to one used by the EPA's Superfund waste site cleanup program, except that ECAT begins with a threat scenario instead of data collection and evaluation.

The risk assessment – risk management paradigm adapted for ECAT consists of five main elements: Threat Identification, Exposure Assessment, Toxicity Assessment, Risk Characterization, and Risk Management. Threat Identification consists of the selection of several pre-identified hazards, a tool that can identify threat agents based on health symptoms and physical characteristics, and information on specific threat agents. Fig. 4. through Fig. 6. show screen shots of the options within ECAT to select an agent and scenario directly (Fig. 4.), to match symptoms (Fig. 5.), or to evaluate physical characteristics (Fig. 6.).

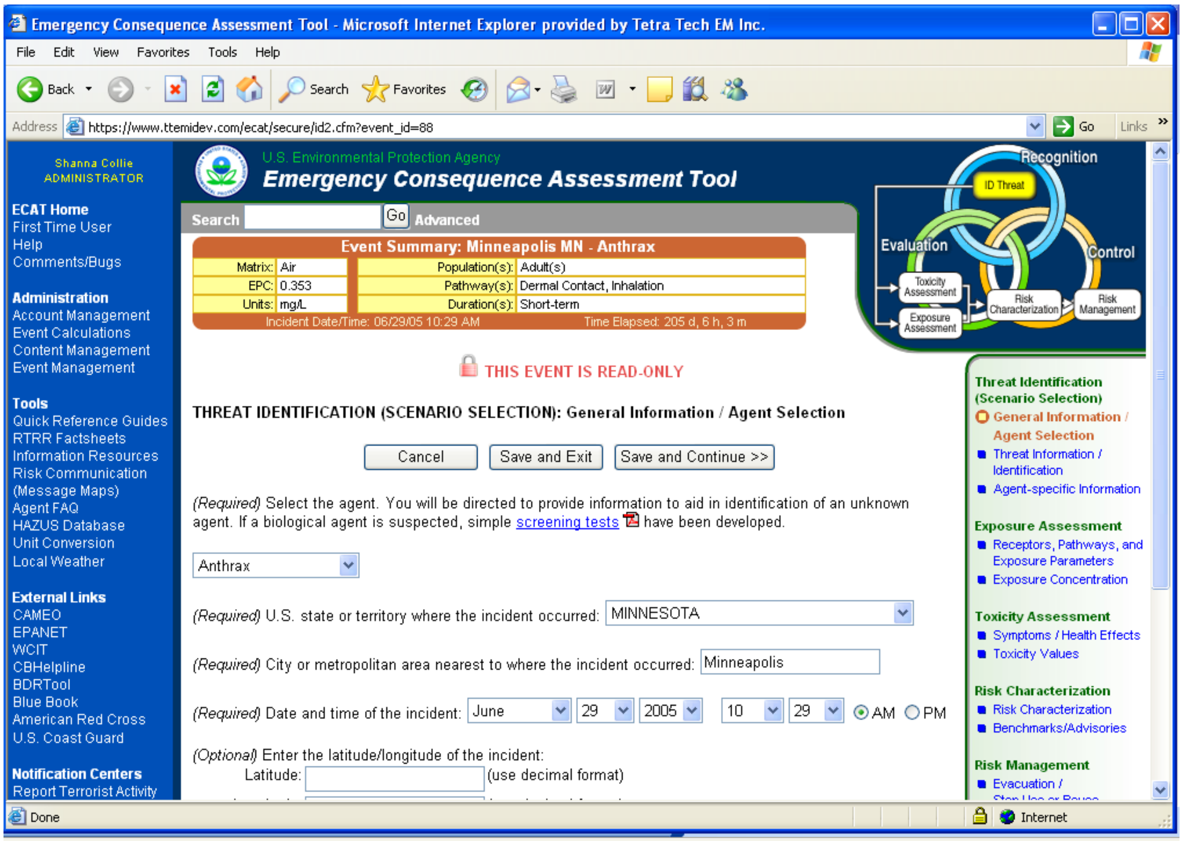


Fig. 4. Threat identification can begin either with selection of an agent with a drop-down menu or by comparing symptoms and physical characteristics for identification of an unknown.

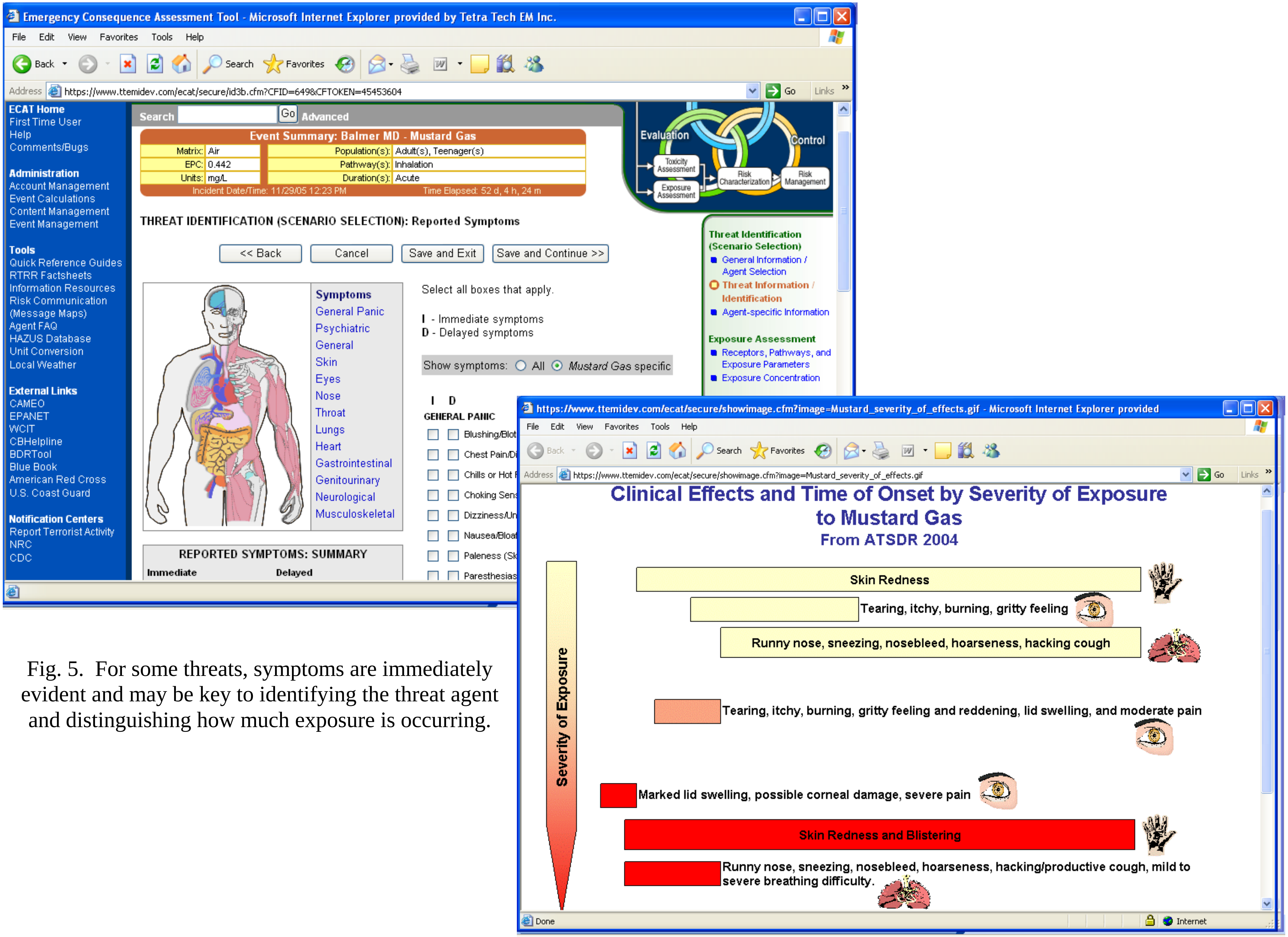


Fig. 5. For some threats, symptoms are immediately evident and may be key to identifying the threat agent and distinguishing how much exposure is occurring.

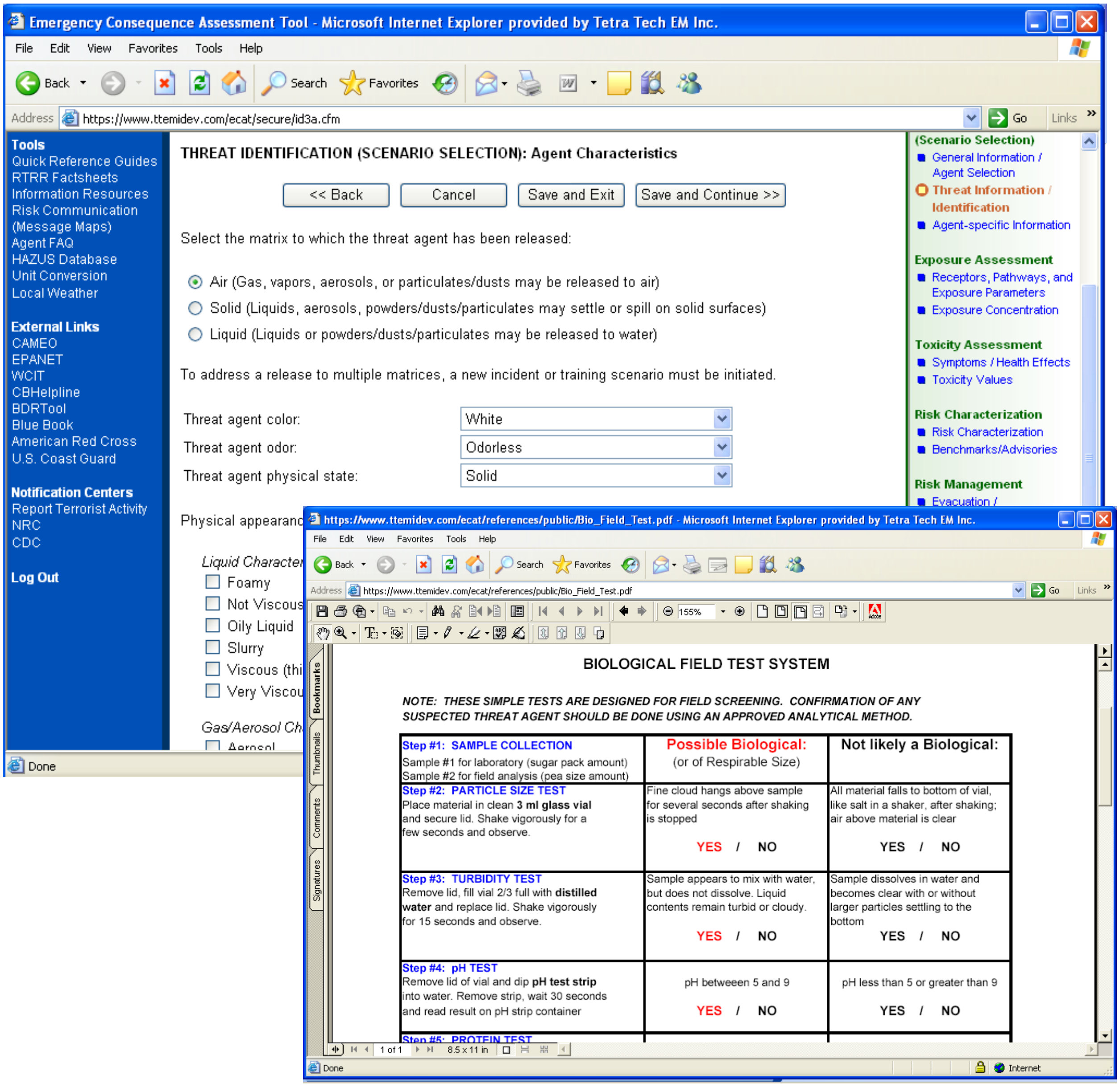


Fig. 6. Evaluating physical characteristics for identification of an unknown (particularly in a training scenario) can be beneficial. Links to additional identification aids are included (see inset at right).

The Exposure Assessment element includes information on how a particular threat agent may come into contact with human receptors. It allows users to predict or track threat agents from their source to possible human receptors along various exposure pathways. ECAT has modeling capabilities that allow users to estimate the fate and transport of agents and to also develop numeric estimates of exposure.

Fig. 7. and Fig. 8. demonstrate the exposure pathway assessment and modeling inputs for air.

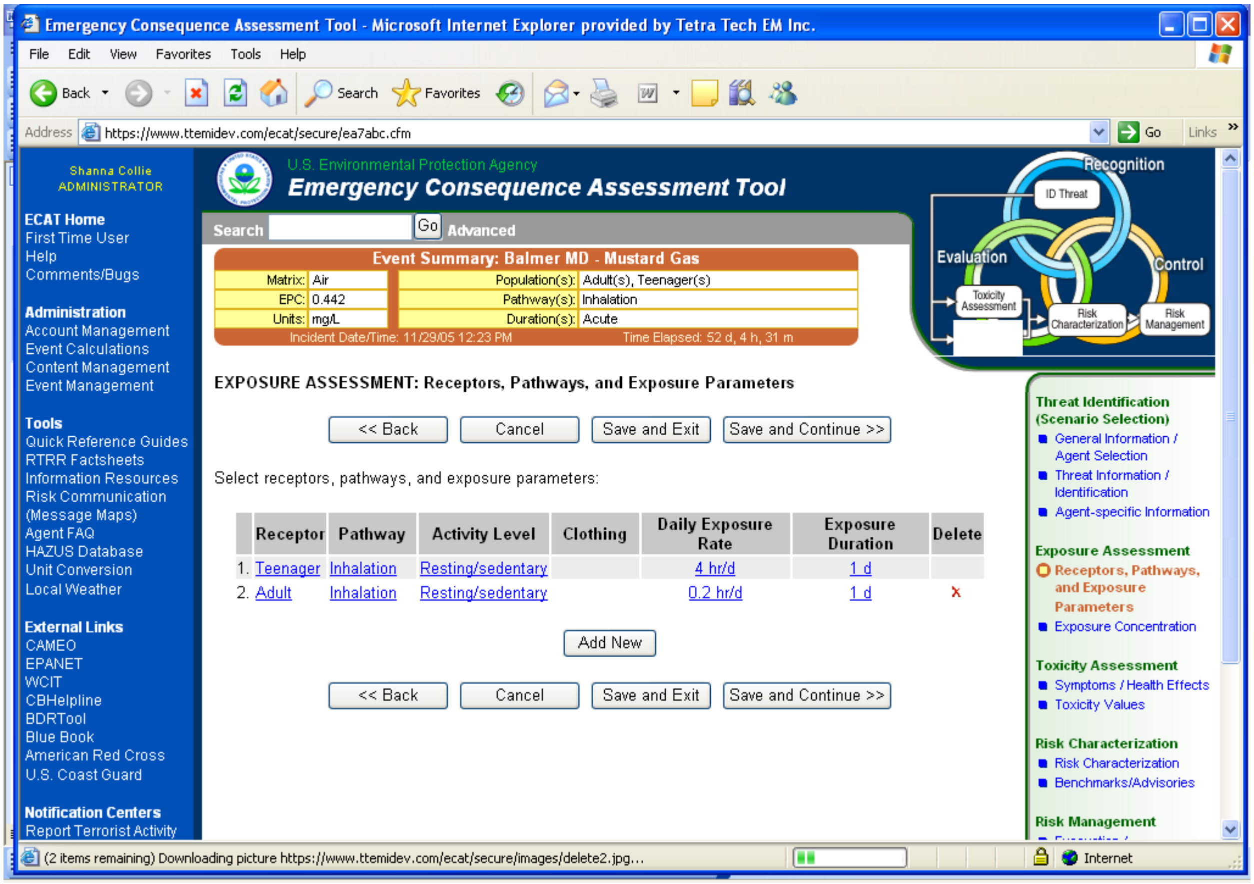


Fig. 7. User inputs to the pathways (inhalation, ingestion, or dermal contact) to be evaluated as well as exposure modeling inputs (i.e., activity rate) are needed to determine the health risk.

Since the ECAT captures a range of scenarios that involve different models and inputs (dependent on the medium or media that are attacked, and depending on the nature of the environment, whether it be indoors or outdoors), multiple models are needed. For air releases, a location-specific model that incorporates physical characteristics (i.e., sinking gas, powder in a "burst" fully mixed model assumption) and local attributes may be used. For water releases, a breach of security in a water distribution line or an attack on the untreated water supply can be modeled. Fig. 8. shows an example of modeling inputs for air; equivalent models and inputs are needed for indoor air and water modeling.

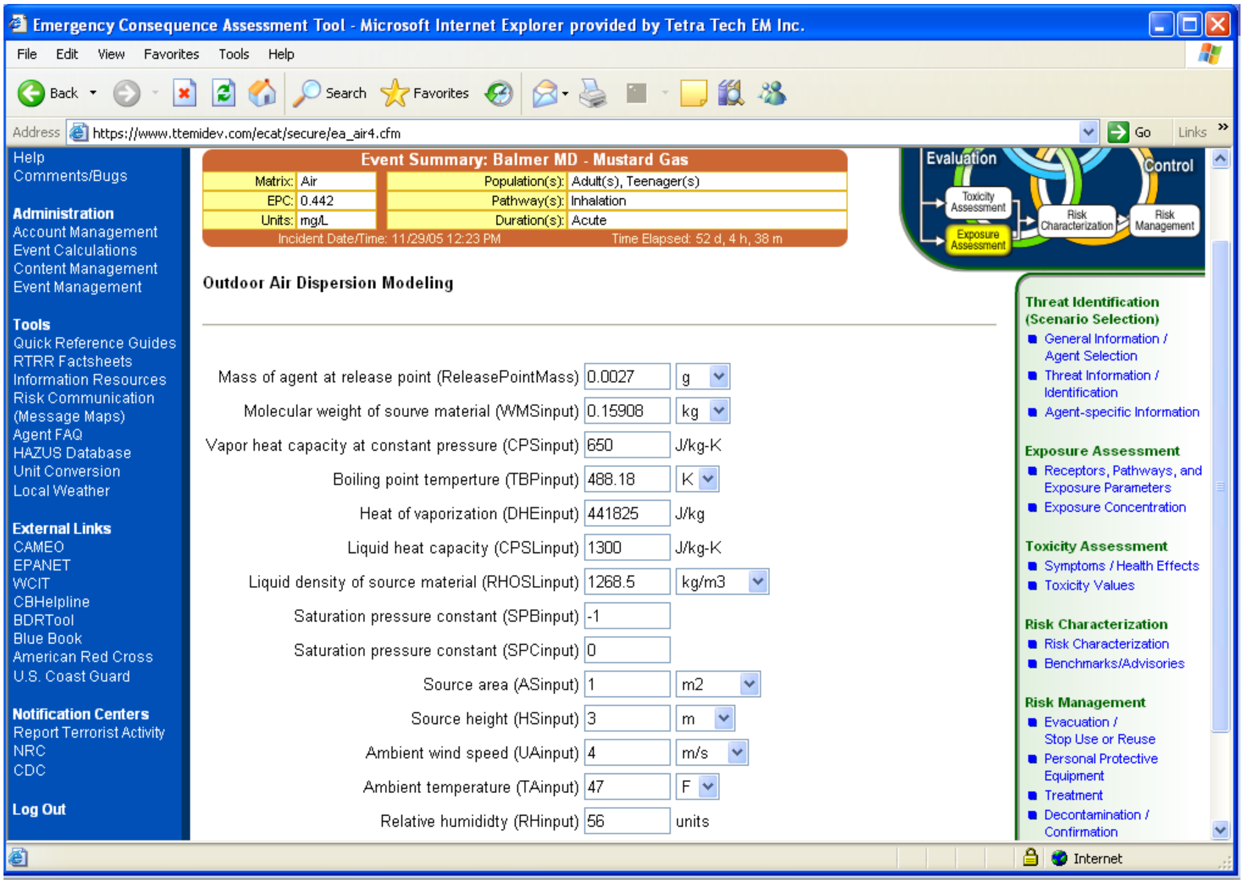


Fig 8. User inputs to the appropriate air model can be complex. The online User's Manual gives basic overviews of the models in ECAT and present a range of default values.

Toxicity Assessment describes two critical characteristics of the threat agents. Firstly, it qualitatively describes the symptoms and health effects that have been associated with the threat agent. Secondly, the toxicity assessment will provide and describe any available toxicity benchmarks that can be used to quantify how much of a threat agent does it take to elicit any harmful effects or symptoms.

Fig. 9. through Fig. 11. show data in ECAT for assessing how toxic a threat agent may be, providing detail for science advisors who wish to review the underlying science.

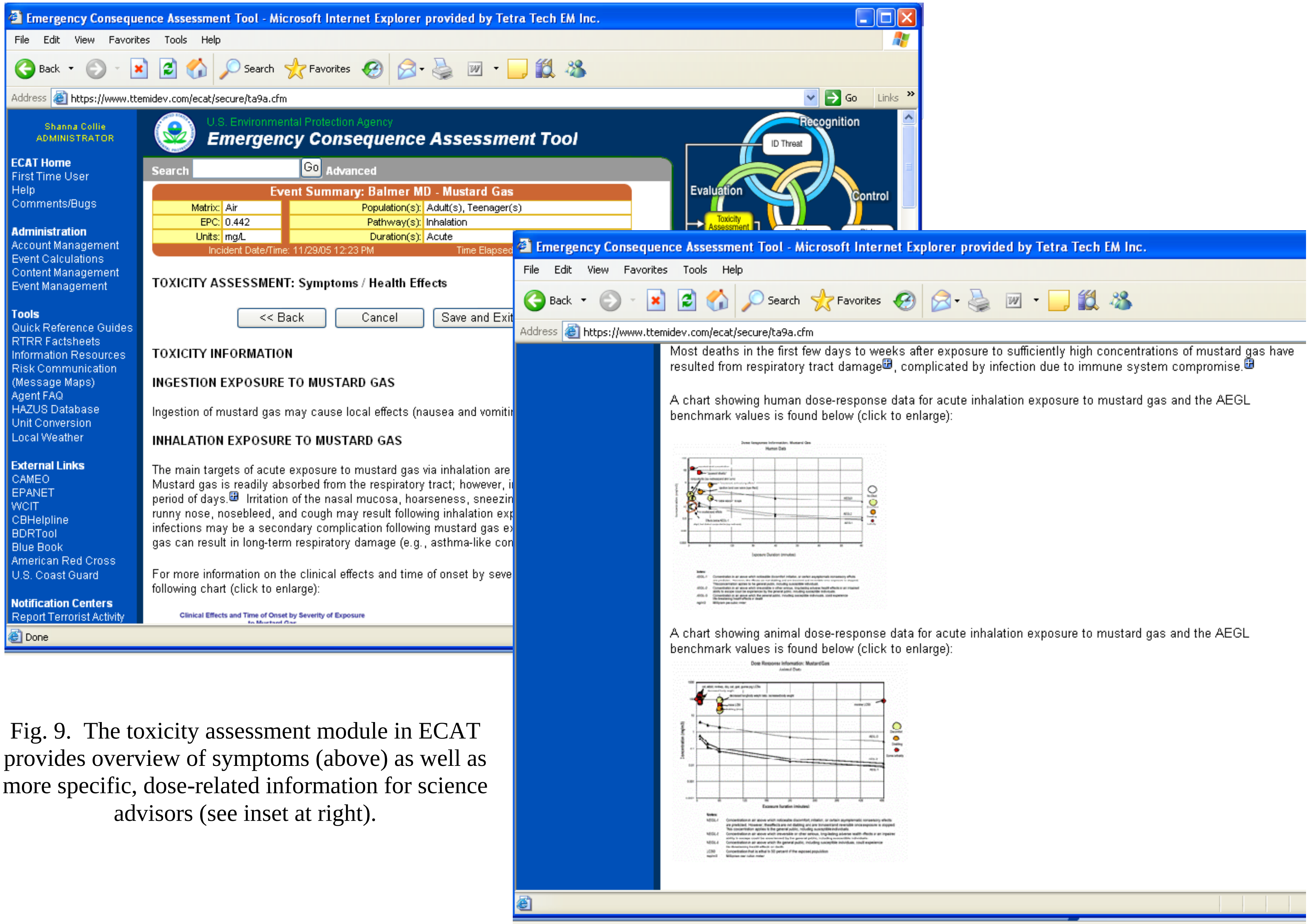


Fig. 9. The toxicity assessment module in ECAT provides overview of symptoms (above) as well as more specific, dose-related information for science advisors (see inset at right).

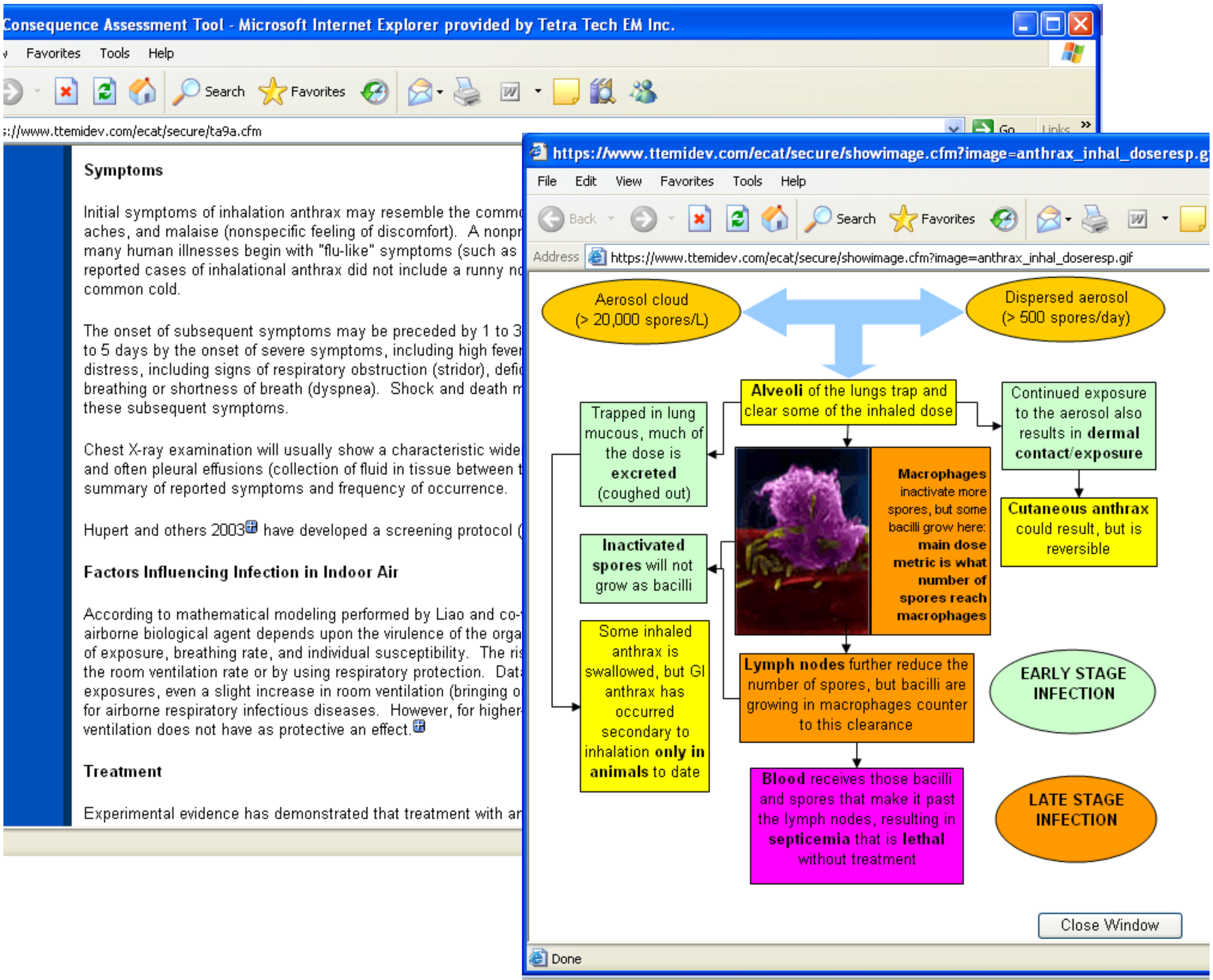
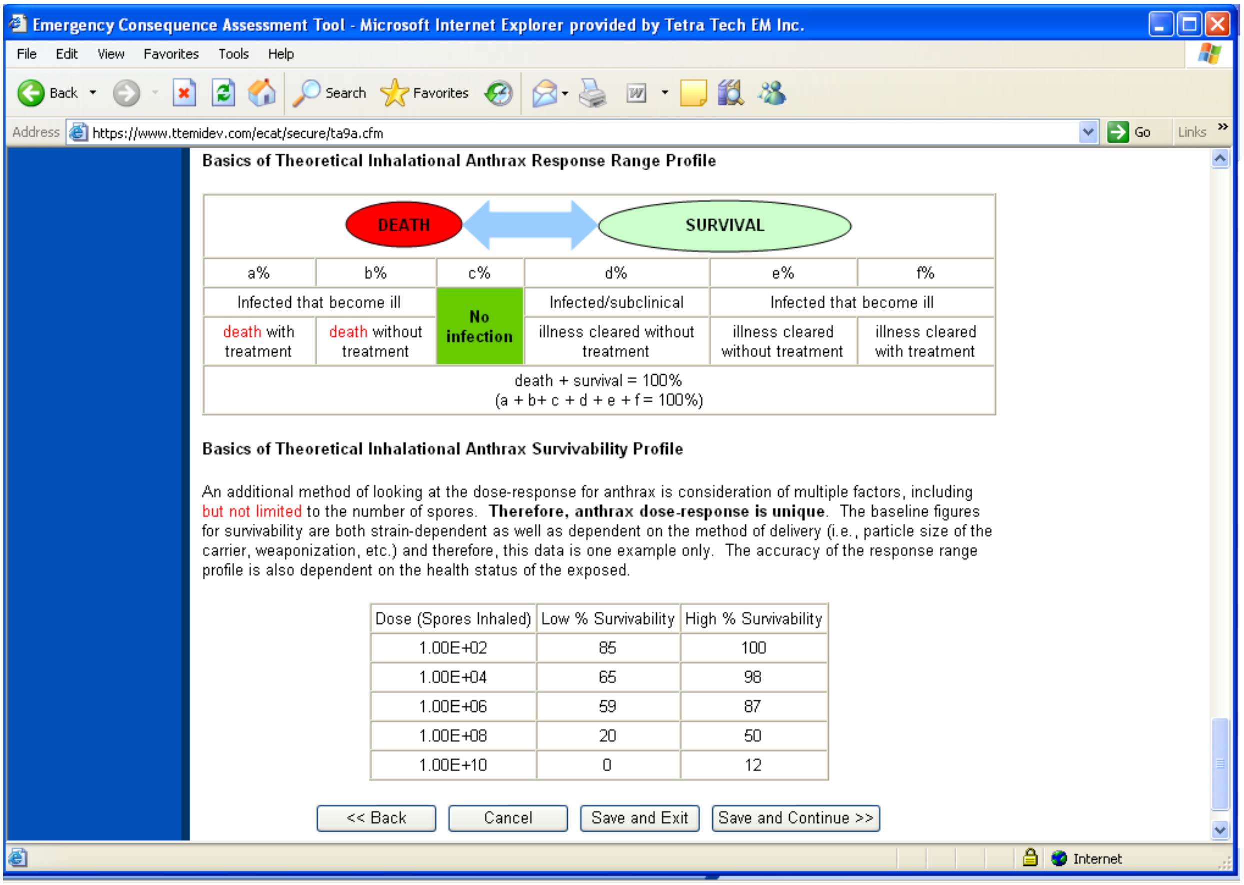


Fig. 10. For biological threat agents, a basic review of the agent's symptoms, clinical course, and biokinetic characteristics as a primer for those less familiar with the agent is included, with references to appropriate sources. As quantitative microbial risk assessment methods and state of the science evolve, the ECAT information will be updated to reflect the latest approaches.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Basics of Theoretical Inhalational Anthrax Response Range Profile

DEATH ⟷ SURVIVAL

a%	b%	c%	d%	e%	f%
Infected that become ill		**No infection**	Infected/subclinical	Infected that become ill	
death with treatment	death without treatment		illness cleared without treatment	illness cleared without treatment	illness cleared with treatment
death + survival = 100% (a + b+ c + d + e + f = 100%)					

Basics of Theoretical Inhalational Anthrax Survivability Profile

An additional method of looking at the dose-response for anthrax is consideration of multiple factors, including but not limited to the number of spores. **Therefore, anthrax dose-response is unique.** The baseline figures for survivability are both strain-dependent as well as dependent on the method of delivery (i.e., particle size of the carrier, weaponization, etc.) and therefore, this data is one example only. The accuracy of the response range profile is also dependent on the health status of the exposed.

Dose (Spores Inhaled)	Low % Survivability	High % Survivability
1.00E+02	85	100
1.00E+04	65	98
1.00E+06	59	87
1.00E+08	20	50
1.00E+10	0	12

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Fig. 11. For biological threat agents, the "toxicity assessment" includes not only a review of symptoms (see Fig. 10.) but also as an assessment of the virulence or infectivity data on a given agent.

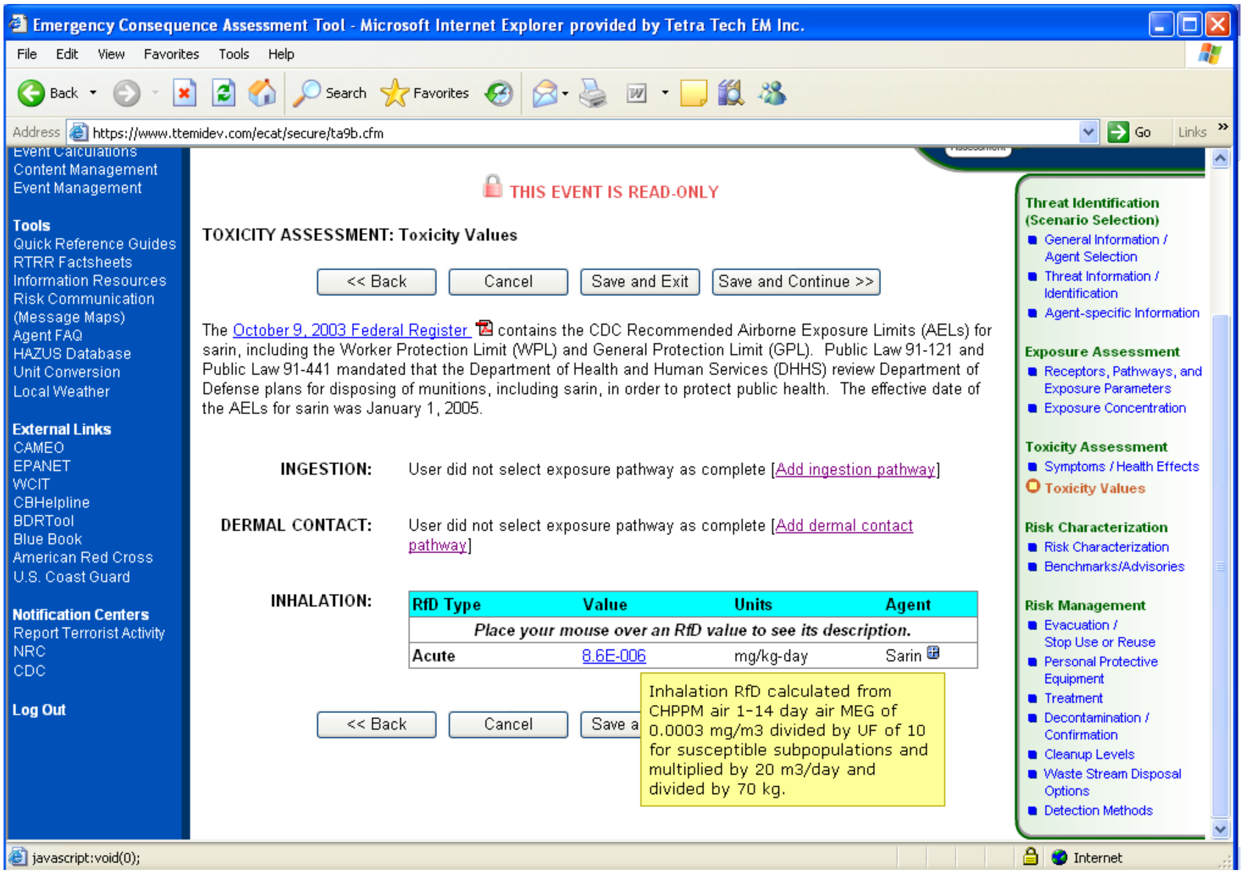

Fig. 12. Toxicology experts may delve into the underlying study that presents a human health hazard. References are accessed by clicking the reference (blue cross) icon, and for some agents (particularly chemical agents), where multiple studies are available, a custom reference dose can be calculated.

Risk Characterization is the step where information from toxicity and exposure are integrated to formulate an estimate of the likelihood of harm. It can be conducted by either of two general ways – by comparing to available health standards (e.g., drinking water standards), or in the case where health standards are not available, then by comparing estimates of exposure with existing health benchmarks in light of the uncertainties and limitations with the data.

Fig. 13 shows an example of risk characterization benchmarks presented.

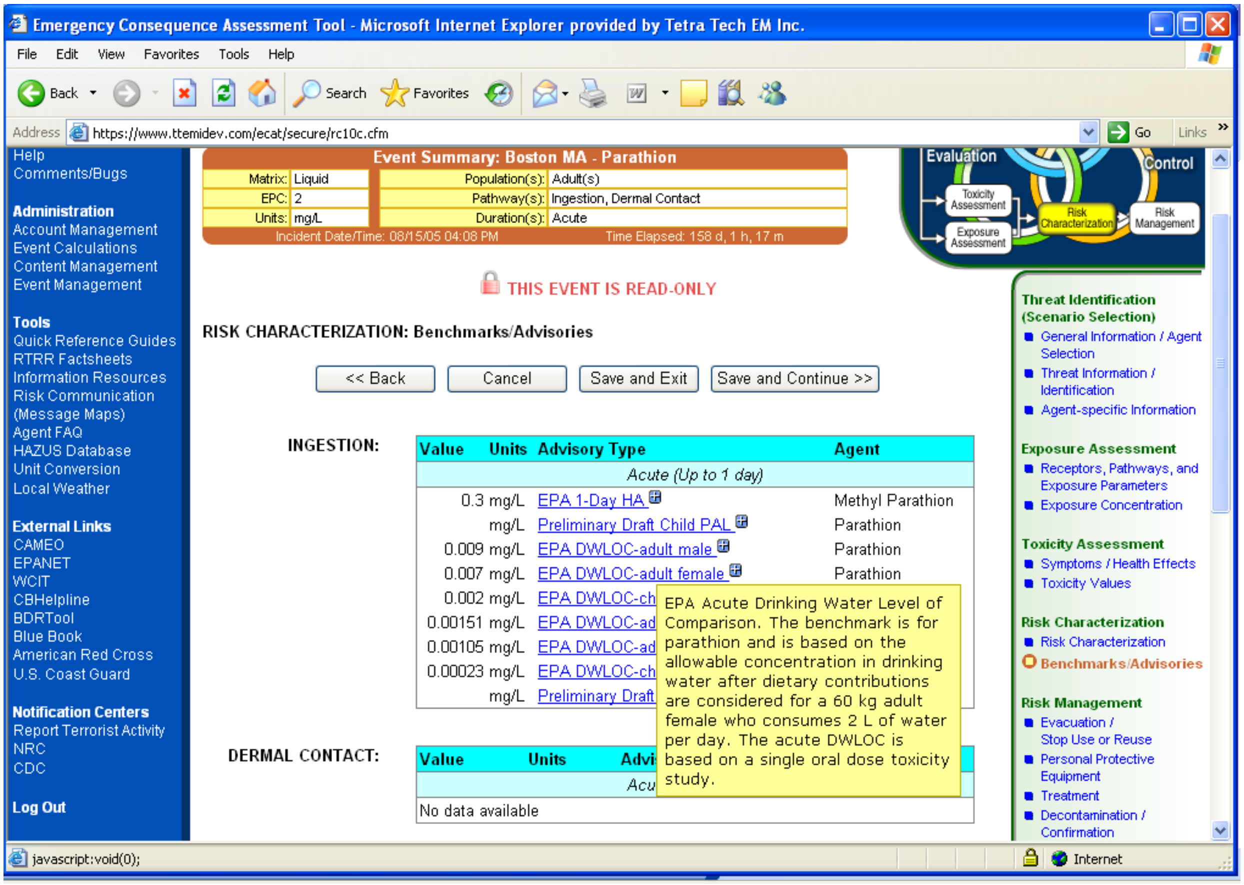

Fig. 13. Risk characterization information is useful when set alongside benchmarks. Clicking on the benchmarks gives details of their derivation.

Finally, the Risk Management element provides information on what actions might need to be taken in responding to various threat scenarios. This includes information about what sampling protocols and personal protective equipment are needed, whether potentially affected persons should shelter-in-place or quickly evacuate, what medical treatments are appropriate, what information is known about cleanup levels, and where contaminated materials should be properly disposed of.

Fig. 14. gives example information relevant to stop use (for water contamination) directives. The Risk Management module also provides advice regarding evacuation (for air releases) and ultimate reuse (for buildings and water supplies) after the incident.

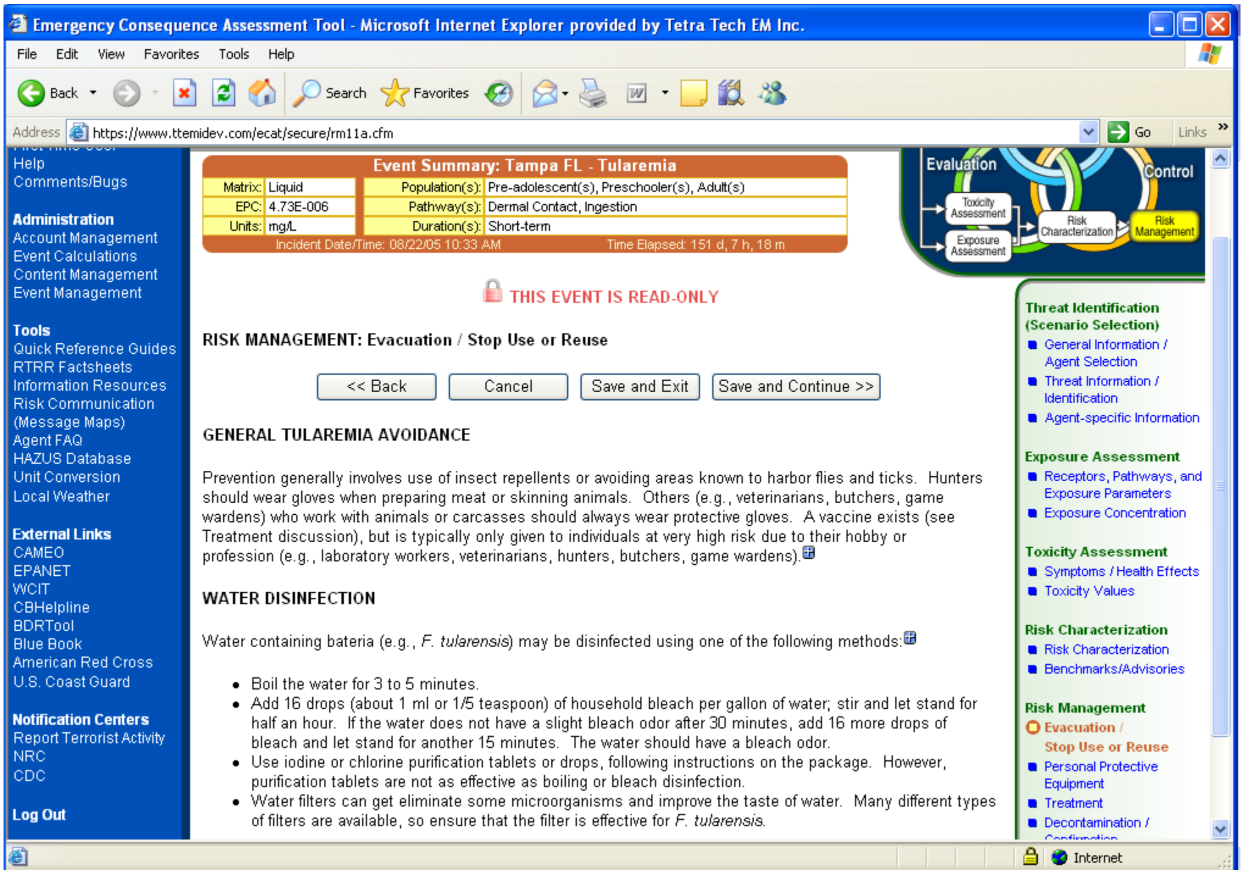

Fig. 14. Risk management includes effective communication of the actions the public can take to avoid health effects. Biological threats (such as highly infectious tularemia) as well as natural disaster-generated threats (such as cholera, shigella, and other infections) can be controlled if the public is directed on how to avoid infection.

CONCLUSIONS

The pilot scenarios contained in the EPA NHSRC Emergency Consequence Assessment Tool provide valuable insights into the specific information needed to plan an effective and successful CBR release response in civilian environments. The ECAT combines two traditional EPA strengths—emergency response and health risk assessment—into a rapidly employed scientific platform that will enhance training and preparedness. Opportunities for expansion of ECAT to region- or DOE-specific landscapes and populations are readily accomplished, and possibilities for EPA-DOE collaboration are open.

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