Information Overload: Dealing with CBRNE and HazMat Incidents

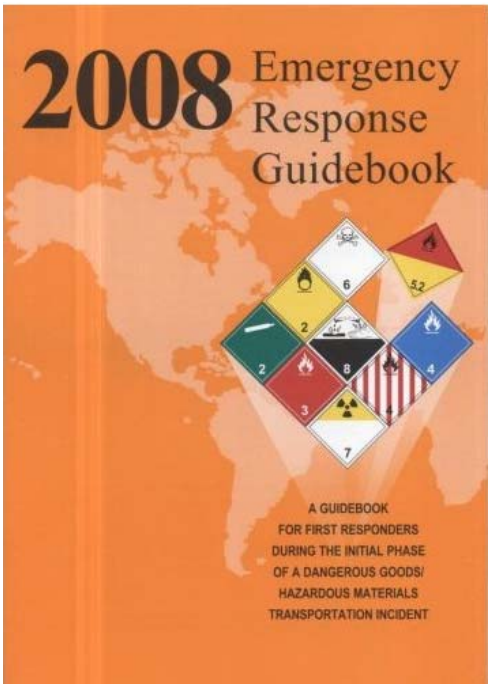
What is CBRNE and HazMat?

We live in a dangerous world. A terrorist may seek to inflict harm on society by releasing or attempting to release a dangerous chemical, biological, or radiological material, or detonate an explosive or nuclear device (CBRNE). There are also many toxic industrial chemicals (TICs) and toxic industrial materials (TIMs) used by industry and in governmental operations which can inflict serious harm if accidentally released or if deliberately released as the result of a terrorist incident. There may be a clandestine operation manufacturing explosives or illegal drugs or a "storehouse" containing unknown chemicals.

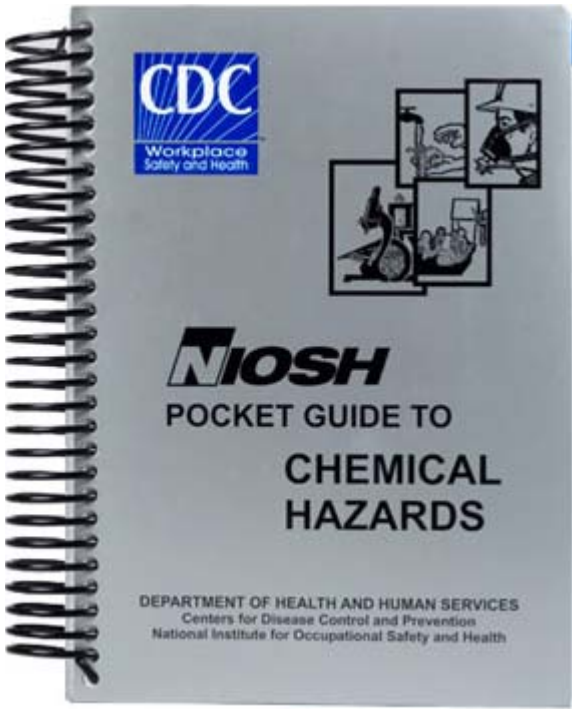
HazMat refers to incidents involving dangerous chemicals and other materials. CBRNE refers to chemical, biological, radiological, nuclear, and explosives. The explosives may include improvised explosive devices (IED) and commercial and military explosives. The lessons learned from TICs and TIMs incidents due to transportation and industrial accidents are valuable in how to protect civilians from CBRNE incidents.

Reference Sources

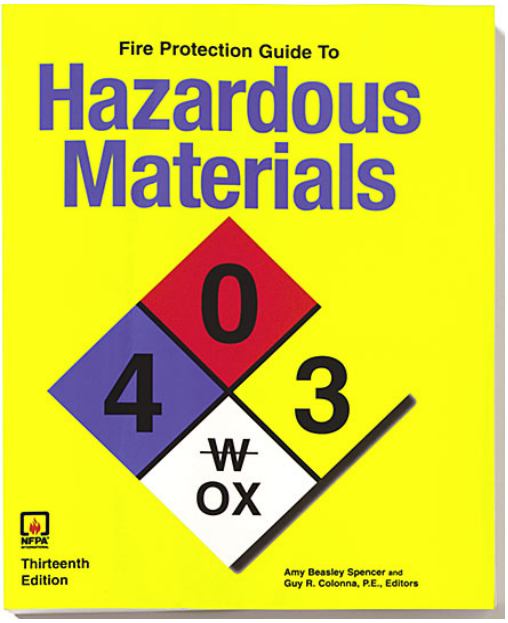
Many reference sources are available for finding information about CBRNE materials and TICs and TIMs. Most are available in the public domain and are listed below:



2008 Emergency Response Guidebook (updated every four years) - electronic version also available

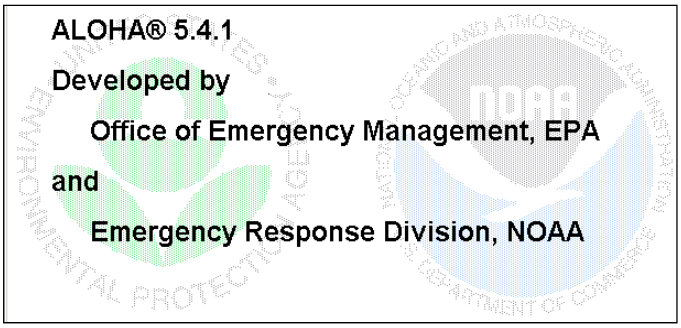


NIOSH Pocket Guide to Chemical Hazards electronic version also available

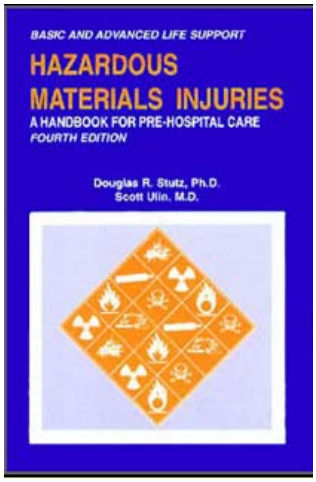


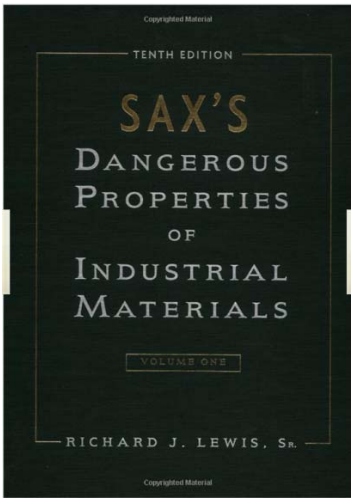
ACGIH Guidelines for Selection of Chemical Clothing, details at http://global.ihs.com/news/temp/standards/ACGIH.html.

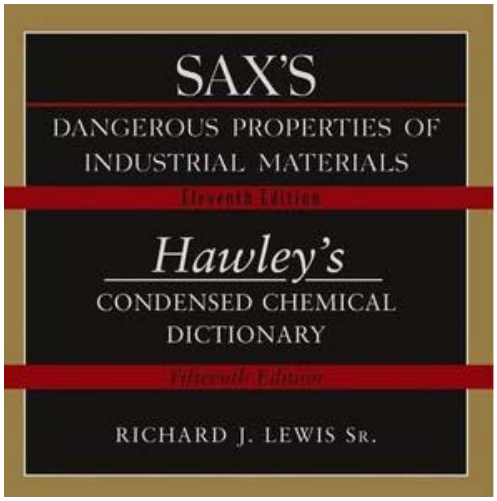
NFPA Fire Protection Guide to Hazardous Materials



EPA's ALOHA Gas Dispersion Model, can be downloaded by visiting http://www.epa.gov/OEM/content/cameo/aloha.htm.







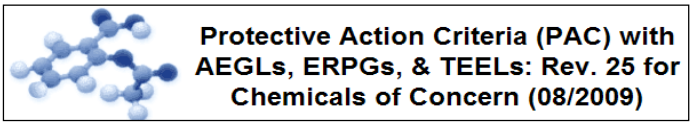
Basic and Advanced Life Support for Hazardous Material Injuries

Sax's Dangerous Properties of Industrial Materials, available in book (left) or CD versions (right)

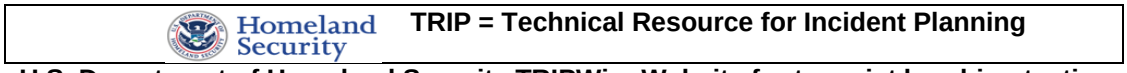
U.S. Government database on toxic chemicals including health effects
http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

U.S. Government database on HazMat involving release of toxic chemicals
http://webwiser.nlm.nih.gov/getHomeData.do.

U.S. EPA database on Acute Exposure Guideline Levels
http://www.epa.gov/oppt/aegl/



U.S. Department of Energy website for toxic levels of concern for chemicals
http://www.atlintl.com/DOE/teels/teel.html.



U.S. Department of Homeland Security TRIPWire Website for terrorist bombing tactics and IED design and placement (*restricted access*)
https://www.tripwire-dhs.net/IED/appmanager/IEDPortal/IEDDesktop?_nfpb=true&_pageLabel=LOGIN

Lawrence Livermore National Laboratories model for radioactive isotope releases, including releases from dispersive devices (dirty bombs) or from fires (latest version 2.07)
https://www-gs.llnl.gov/hotspot/

Nuclear weapons (government document, available in libraries and from Internet sources): S. Glasstone (ed.). 1962; 3rd ed 1977. The Effect of Nuclear Weapons. Prepared by the U.S. Department of Defense and published by the U.S. Atomic Energy Commission, Washington, D.C.

There are many other reference sources and military documents. Some are compilations of parts of the references already cited.

How many different chemicals are out there in the real world? To date, the American Chemical Society has assigned about 34 million CAS (Chemical Abstract Service) numbers to different chemicals. The problem is compounded by the fact that many of the chemicals are known by different names. Add to this the fact that the many mixtures and product formulations are made up of different chemicals. Fortunately, only a few thousand chemicals are likely to be of concern to responders.

Do responders including the military use these reference sources in case of a CBRNE or HazMat incident in case of a TIC or TIM release? The answer is "No", or if any are used it is in a limited way. Responders are too busy with priorities such as protecting the public and saving lives. **If responders can't get answers right away at the time of the incident, they are not going to mess with these reference sources.**

How Responders Make Decisions

Responders to CBRNE and HazMat incidents are under stress and must make decisions quickly. They do not have the luxury of time to weigh alternative courses of action in an organized or deliberate way and then select an action based on pros and cons. Usually they have only skimpy information about the incident and must focus on priorities such as saving lives and protecting the public. An incident commander generally selects one course of action based on experience and training, and mentally runs through it quickly to look for flaws. If the incident commander does not find flaws, he/she takes the course of action, and if flaws are found, the action is adjusted accordingly. The incident commander is also effective in communicating intent, e.g., what is it that we want to do, and what are the hazards/obstacles along the way? The incident commander may not be able to describe the decision-making process calling it a "gut feeling", but what he/she is doing is processing raw information about the situation at hand and making a decision based on training and prior experience. This is done rapidly in the person's mind. The person is not even aware of the process. The psychologist, Dr. Gary A. Klein, who consults with the military on how to make rapid-fire decisions, used the term, "Recognition Primed Decision" model for this process; the person quickly and often subconsciously compares the situation at hand with a master file (in the person's mind) of previous situations and trainings and initiates a course of action. The methodology for making decisions is applicable to both civilian incident commanders and to military training. The training emphasizes goals and objectives, bringing people up to speed and imparting experience, examining real incidents and the decisions made, drills, and simulations. The successful commander making the decision is also not afraid to change course along the way if circumstances change or as new information becomes available.

Suggested Reading: Gary Klein, "Sources of Power: How People Make Decisions", the MIT Press, Cambridge MA, 1998.

How to Package Information on CBRNE and TICs and TIMs

Prior experience and training are very important to responders in making decisions. But there is a problem. CBRNE and TIC and TIM incidents are too varied. There are too many different dangerous materials, and too many different ways these dangerous materials can be deployed or accidentally released to harm the public. To attempt to try to train responders on the many hazards and how to deal

with them would result in information overload. And responders do not have time to wade through many references, even if the references are at a person's fingertips and organized in a simple way. The problem is each reference is specialized, maybe one such as the 2008 Emergency Response Guidebook (ERG) deals only with transportation accidents, although some limited information on protective action distances for chemical warfare agent spills is in the ERG. Another source deals only with chemicals. Another source deals with plume modeling in case of a toxic release of the chemical to the air. Another models "dirty bomb" releases. It takes time to learn and find the information.

What is the answer? Suppose the technical information is packaged in a small computer tool, which may be a stand-alone hand-held product or accessed through the Internet or run on a laptop. Add to that map overlays and Google-earth topographic features to examine consequences if there is a chemical release to the air, a radiological or nuclear incident, or explosion. This is the concept when AristaTek developed the PEAC tool. Training and experience are important, but technical information is also important when making the right decisions. There is too much technical information for a responder to remember; the PEAC tool is designed to retrieve the essential information quickly.

Development of the PEAC Tool.

The concept for the PEAC tool developed as the result of University of Wyoming Research Corporation (a not-for-profit entity, a.k.a Western Research Institute) contracts in the 1990's with the U.S. Department of Energy (DOE) on public safety. A major part of this work had as its objective of gathering information on toxic industrial chemical spills and releases to the atmosphere. These contracts involved spilling hazardous chemicals or spilling surrogate chemicals at the DOE HazMat Spill Center near Mercury Nevada, and examining their behavior including dense gas distribution in the atmosphere under stable nighttime and sunset conditions. The work was also funded in part by private industry (a consortium of 10 petroleum and chemical companies) and by the U.S. Environmental Protection Agency (EPA). Some additional tests were done measuring the evaporation rate of spilled anhydrous ammonia and chlorine liquids. Additionally, 123 real-world industrial accidents were surveyed which involved public evacuations due to possible or actual release of toxic chemicals to the air. The survey showed for not one of the incidents were toxic gas dispersion models run to determine public evacuations, even though the computer software was sometimes available. Under the stress of the situation where rapid decisions were to be made, no one was at hand to run the model predicting ambient toxic concentrations, although sometimes models were run long after the incident. There was one incident in West Virginia where the EPA ran a model for a "what-if" situation which turned out to be overly conservative resulting in an evacuation that some later thought "unnecessary". The incident commanders did what they always did, making their decisions based on a reservoir of past training and experience. The study also noted situations where incident commanders did not have adequate information on the chemical behavior and toxicity resulting in decision mistakes, and there were also mistakes made in communicating evacuations to the public. These events that were outside their realm of training and experience.

The U.S. Department of Energy requested that chemical information on public safety be shared with the public. Initially, for several years, the University of Wyoming Research Corporation maintained a website where anyone could access raw data taken at the DOE HazMat Spill Center for tests funded by public funds. These test results have been used for gas dispersion model development notably by Steve Hanna and others.

In the late 1990's, the group at the University of Wyoming Research Corporation who completed the HazMat Spill Center tests elected to develop a self-contained, hand-held computer tool where chemical information including toxic gas dispersion modeling could be easily accessed. This is part of the "public safety" mission. In 1999, the researchers put in some capital and elected to form a for-profit company AristaTek to market the computer tool, which was called the PEAC tool, which at that time contained a gas dispersion model, the information in the Emergency Response Guidebook, the information in the NIOSH pocket guide, information on chemical protective clothing and respirators from manufacturers, and other chemical information from various sources. The earliest version offered to the public used the Apple Newton as the software platform. Following the 9/11 event, the computer tool was expanded to include information on weapons of mass destruction, including chemical, biological, radiological, and nuclear. AristaTek linked up with other companies offering software packages and on-site analytical capabilities to provide additional capability for emergency response. Lab-top versions are available in addition to a hand-held version.

AristaTek continues to review actual incidents gathering information from news stories and government accident investigations. Experience is the best teacher. Summaries of selected HazMat incidents are posted in the AristaTek Newsletter, with links to websites and government reports to obtain additional information.

Response to TICs and TIMs Releases Important

One of the worst industrial accidents in recent history occurred at a chemical plant near Bhopal, India, during the night of December 2-3, 1984. Water was added to a very large storage tank containing methyl isocyanate during a pipe flushing operation; the resulting heat generated when water and methyl isocyanate mixed caused the methyl isocyanate to boil and vent from the tank. The vapor cloud of methyl isocyanate drifted over nearby Bhopal killing thousands of people. The official count of the dead certified by the local government in 1991 court trials was 3928, which was later revised in 1994 to over 6000 deaths. Approximately 100,000 to 200,000 people were estimated to have to have permanent injuries of varying degrees. There is some controversy as to whether sabotage was a contributing factor to the release. This accident was reviewed in the AristaTek Newsletter, http://www.aristatek.com/Newsletter/NOV09/NOV09newsletter.aspx.

U.S. government regulations have done a lot to improve workplace safety. Community-right-to-know regulations and placarding of transportation vehicles have done a lot to inform responders what chemicals they are dealing with in case of a HazMat incident. Companies which store or use large quantities of certain dangerous chemicals must comply with Environmental Protection Agency regulations (40 CFR Part 68) must inform local officials of worst-case and possible chemical release scenarios in addition to what chemicals are stored or used at the facility. But all the regulations in the world do not protect against acts outside the law, for example terrorist activities and clandestine manufacture of illegal drugs and explosives or theft of dangerous materials, or transportation accidents resulting from sabotage.

Even when responsible companies have accidents, later investigations often reveal gaps in communication including failures to communicate hazards. There have been cases where companies thought themselves to be exempt from community-right-to-Know reporting requirements, and because firemen did not know what chemicals were present responding to a fire, they doused water on water-reactive chemicals creating a worse situation. There were also situations where responders drove through a vapor cloud of a toxic chemical thinking it was water fog because it looked like water fog. In another situation, responders fighting a fire at a chemical facility not wearing respiratory protection (SCBA) had to be treated for inhalation of toxic chemicals; the responders had accepted an initial

statement by the company that no toxic chemicals were released, and company employees at the scene were not wearing respiratory protection. There are also situations where it is best to let a building containing chemicals burn and use fire-fighting resources to protect adjoining buildings or property, if water runoff from the chemicals create a severe environmental problem (e.g. contamination of water supplies, fish kills).

Who Needs the PEAC TOOL?

First responders, Incident Commanders, inspectors, City Planners, the military, in fact anyone dealing with emergency response to incidents involving hazardous materials, chemical radiological, biological, or nuclear incidents, or explosives can use the PEAC Tool. There could be an accidental release of a toxic industrial chemical (TIC) or toxic industrial material (TIM) or the release may be deliberate as in the case of terrorist activity. Responders may encounter a clandestine laboratory manufacturing explosives or illegal drugs, or an "abandoned" storehouse containing unknown chemicals or other possibly dangerous materials.

The PEAC tool is also important in training responders to these incidents in mock drills. Hypothetical scenarios can be posed. The internal clock and date and location (a latitude and longitude or a City) can be reset in the PEAC tool for different drills. The user can work either in English or metric units.

A trainer, assuming the role of an incident commander, might request information for a chemical release such as (1) NFPA diagram and personal protective clothing, (2) Level 2 Emergency Response Guideline level based on a 1-hour exposure, (3) clear nighttime, low-wind, Protection Action Distances overlaid on a map, to be used for public evacuations or shelter-in-place, and (4) emergency basic life support to persons overcome by the chemical. With training, the PEAC tool can provide the answers in less than a minute in printout form or a file that can be stored internally. Explosion damage, fireball stand-off distances, radioactive isotope information, and nuclear weapon information can also be accessed.

The bottom line is that first responders and the incident commander must take all precautions in protecting the public and emergency response personnel. They can't always assume based on past training and experience that the particular situation at hand is similar to other situations that they have encountered before. Nor can they assume the "community right-to-know" paperwork for chemicals stored or used at a site is up to date and accurate, or reflects the hazards.