Let's Take a PEEK at the PEAC Software

by S. Bruce King

PEAC Example – Ethylene Dibromide

This month our example is Ethylene Dibromide, which has a chemical formula of $C_2H_4Br_2$. Ethylene Dibromide is only slightly soluble in water (0.43% [4.3 grams/liter] at 86 °F) and soluble in most organic solvents. Ethylene Dibromide is listed under the UN # (United Nations Number) by the US Department of Transportation: UN 1605 and has a CAS # of 106-93-4.

Description Ethylene Dibromide is a nonflammable colorless, heavy liquid with a sweet chloroform-like odor at room temperature above 50°F (10°C). Its odor is not detectable at a low enough concentration to be considered a warning of excessive exposure. A liquid at room temperature, ethylene dibromide readily penetrates skin, cloth, and other protective materials such as rubber and leather. It is nonflammable. Persons whose clothing or skin is contaminated with liquid Ethylene Dibromide (above 50 °F) can secondarily contaminate others by direct contact or through off gassing vapor. The liquid is heavier than water. When heated to decomposition, it may release gases and vapors such as hydrogen bromide, bromine, and carbon monoxide. Ethylene Dibromide should be stored in a dry place at ambient temperature.

Sources/Uses Ethylene Dibromide is produced by liquid-phase bromination of ethylene at 35-85°C. This is followed by neutralization to free acid and purification by distillation. Ethylene Dibromide was used extensively as a scavenger for lead in gasoline and as a pesticide and an ingredient of soil, vegetable, fruit, and grain fumigant formulations. However, these uses have almost disappeared in the United States. It is used to some extent as a chemical intermediate, gauge fluid, and as a nonflammable solvent for resins, gums, and waxes.

Synonyms include 1,2-Dibromoethane, Ethylene bromide, Glycol dibromide, sym-dibromoethane

Standards and Guidelines

OSHA 8-hour TWA = 20 ppm; acceptable ceiling concentration = 30 ppm

NIOSH REL-TWA = 0.045 ppm; 15-min ceiling limit = 0.13 ppm

NIOSH IDLH (immediately dangerous to life or health) = 100 ppm
As shown above, the OSHA and NIOSH TWA values are substantially different, and this is most likely because NIOSH has Ethylene Dibromide listed as a carcinogen. The PEAC-WMD tool will typically display the most conservative TWA value if the OSHA and NIOSH values are different.

Incompatibilities Incompatible with strong oxidizers, magnesium, alkali metals, and liquid ammonia.

Acute Exposure Ethylene Dibromide alkylates macromolecules causing cellular disruption and reduced glutathione levels. Cellular disruption in tissues and organs, such as liver and kidneys, results in progressive dysfunction. Manifestation of some of the effects of acute high exposure may be delayed a few days. Children do not always respond to chemicals in the same way that adults do. Different protocols for managing their care may be needed.

Respiratory - Early symptoms of acute exposure include irritation of the nose and throat. Exposures of moderate to severe intensity produce respiratory manifestations ranging from cough, chest pain, and dyspnea to bronchitis, pneumonitis, pulmonary edema, and hemorrhage. Pulmonary edema occurred 3 days after oral poisoning in one fatal human case.

Children may be more vulnerable because of higher breathing rate per kg of weight and failure to evacuate an area promptly when exposed. Hydrocarbon pneumonitis may be a problem in children.

CNS - Ethylene Dibromide is a mild central nervous system depressant. Drowsiness has been reported following ingestion and inhalation. Inhalation of vapors in a confined oxygen-deficient space has caused rapid loss of consciousness, coma, and death.

Dermal - Liquid Ethylene Dibromide is a skin irritant. Brief skin contact or contact with contaminated clothing causes erythema and discomfort. Splashing of the liquid on the skin causes a sensation of cooling because the liquid evaporates quickly. Prolonged skin contact may cause blistering and skin ulcers (may be delayed 24–48 hours). Ethylene Dibromide can be absorbed through the skin to produce systemic effects. Exposure to certain chemicals can lead to Reactive Airway Dysfunction Syndrome (RADS), a chemically- or irritant-induced type of asthma. Because of their larger relatively surface area:body weight ratio, children are more vulnerable to toxins absorbed through the skin.

Ocular/Ophthalmic - Conjunctivitis has been reported after exposure to Ethylene Dibromide. Eye contact with the compound may cause temporary loss of vision because of destruction of tissues in the eye.

Hepatic - Ethylene Dibromide poisoning often affects the liver. Significant liver damage has resulted from inhalation and ingestion of Ethylene Dibromide. Necrosis of the liver was a chief finding in a fatal case of acute oral poisoning. In two fatal cases of inhalation/dermal exposure, serum aspartate aminotransferase and lactic dehydrogenase were elevated before death.

Renal - The kidney is often affected in Ethylene Dibromide poisoning. Severe renal lesions were reported in fatal cases of acute oral poisoning and also inhalation poisoning. Lesions included necrosis of the tubular epithelium, cytoplasmic vacuolization of the proximal convoluted tubules, and tubular protein casts.

Gastrointestinal - Abdominal pain, nausea, vomiting, and diarrhea have been reported after Ethylene Dibromide ingestion.

Metabolic - Metabolic acidosis can occur after high exposure to Ethylene Dibromide.

Potential Sequelae - Patients who develop severe acute neurologic injury but survive may have both central and peripheral neurologic effects that persist indefinitely.

Chronic Exposure No reliable reports exist of adverse health effects in humans exposed chronically to Ethylene Dibromide.

Chronic exposure may be more serious for children because of their potential for a longer latency period.

Carcinogenicity - The Department of Health and Human Services (DHHS) has determined that Ethylene Dibromide can reasonably be anticipated to be a human carcinogen, based on Ethylene Dibromide-induced tumors in multiple sites and by various routes of exposure in animals. Results from epidemiological studies have been inconclusive.

Reproductive and Developmental Effects - There is inconclusive but suggestive evidence that Ethylene Dibromide may reduce fertility in men. Antispermatogenic effects have been demonstrated in various animal species. Ethylene Dibromide is included in *Reproductive and Developmental Toxicants,* a 1991 report published by the U.S. General Accounting Office (GAO) that lists 30 chemicals of concern because of widely acknowledged reproductive and developmental consequences.

Special consideration regarding the exposure of pregnant women is warranted, since Ethylene Dibromide has been shown to be a genotoxin; thus, medical counseling is recommended for pregnant women.

In using the PEAC application we access information for the chemical by first locating Ethylene Dibromide in the database. The following figures show the screens displayed for chemical properties, Figure 1 for the *PEAC-WMD for Windows* application and Figure 2-5 for the *PEAC-WMD for the Pocket PC* application.

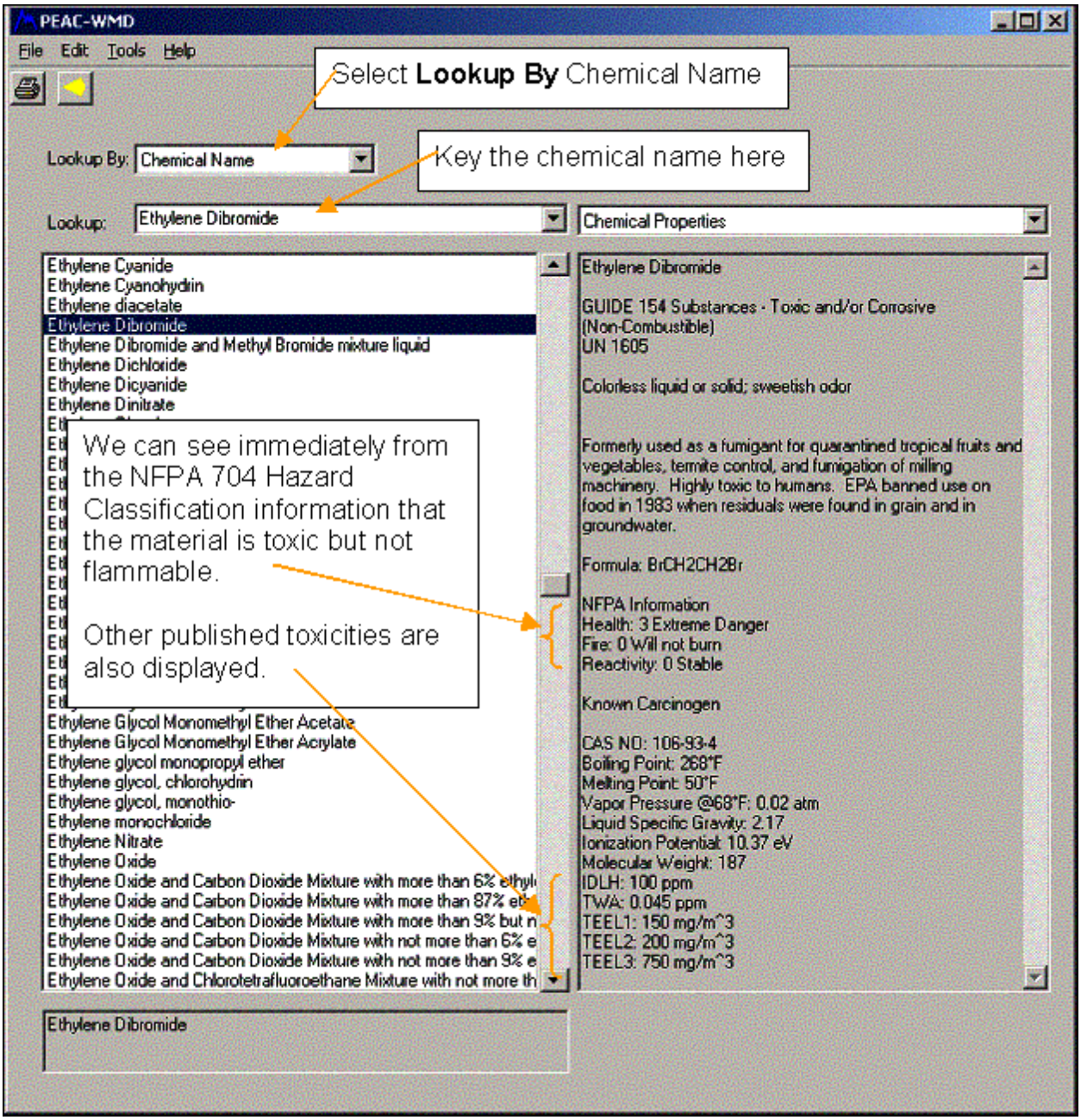

Figure 1 - Using the Lookup By: Name for Ethylene Dibromide using the PEAC-WMD for Windows application

Review of the information displayed in the chemical properties screen whether in Figure 1 (above) or Figures 2-4 (below), show chemical properties values discussed earlier at the top of this discussion. As you can see, the published toxicity values, e.g., IDLH and the TEELs (Temporary Emergency Exposure Limits) published by Department of Energy are provided. We will use the IDLH as the Level of Concern when we develop the PAD a little later.

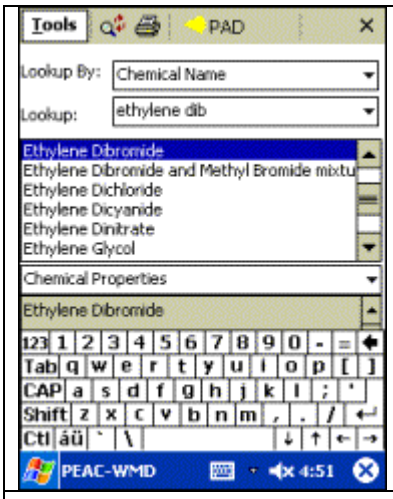

Figure 2 – Selecting Ethylene Dibromide using the PEAC-WMD for Pocket PC application

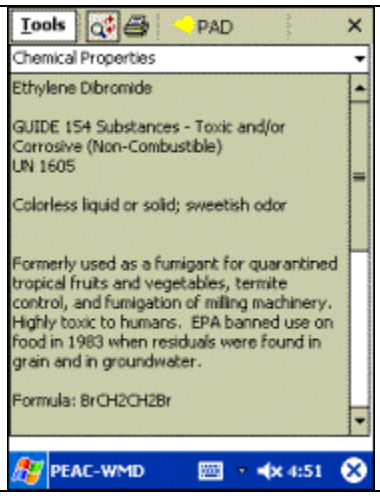

Figure 3 – The top portion of the Chemical Properties Data Display Screen

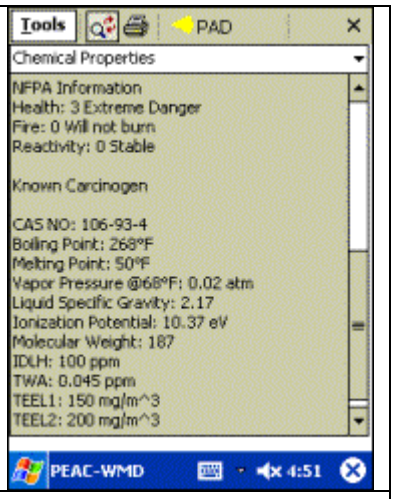

Figure 4– The bottom portion of the Chemical Properties Data Display Screen

The PEAC-WMD application provides more than just the **Chemical Properties** for the identified material, the **Chemical Properties** are just the default information screen displayed, by clicking (if running the Windows version, see Figure 5) or tapping (if running the Pocket PC version, see Figure 6) on the drop-down box where **Chemical Properties** is displayed on the screen, the user is provided with a list of other databases that provide information for the selected chemical (Ethylene Dibromide in our current example). So the search is done once, and the user is indexed into the different databases easily and quickly.

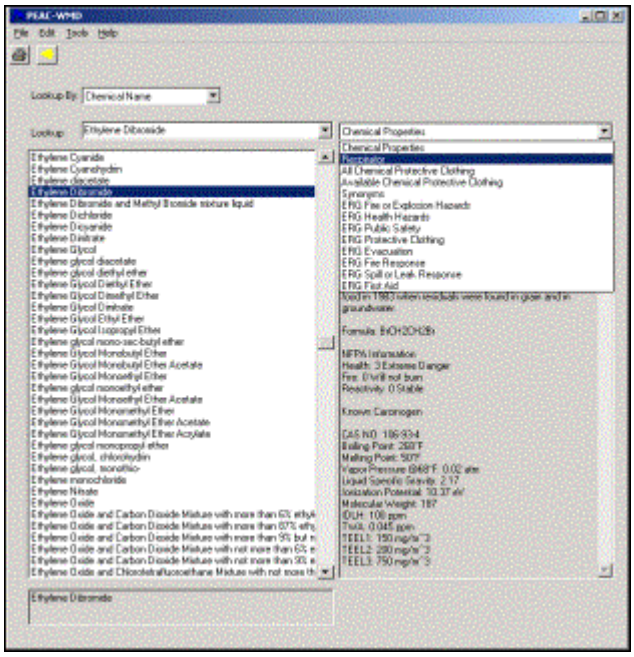

Figure 5 – Accessing other databases from the PEAC-WMD for Windows application

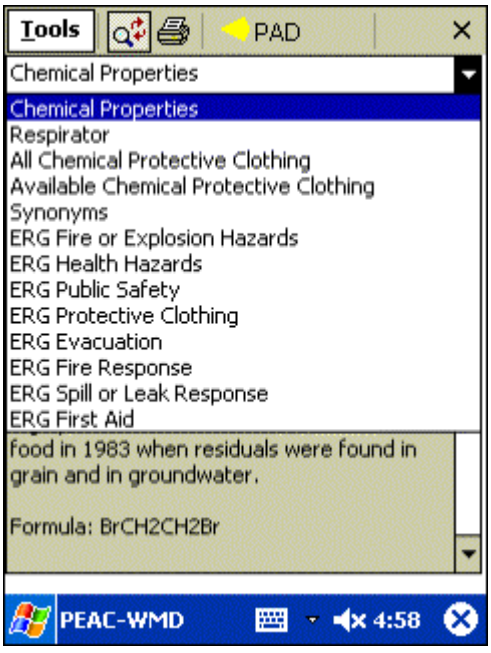

Figure 6 – Accessing other databases from the PEAC-WMD for Pocket PC application

A quick review or sampling of the type of information available in each of these screens is now provided. First is access to **Respirators Recommendations**, these are primarily taken from the NIOSH Pocket Guide and provide the user with different types of respirators for increasing concentrations. A sample of the information is provided in Figure 7. Likewise the **Chemical Protective Clothing (CPC)** database can be accessed by clicking on either the **All Chemical Protective Clothing** or the **Available Chemical Protective Clothing** selection as shown in Figure 8. The **All Chemical Protective Clothing** displays all the CPC entries in the PEAC-WMD database for the selected chemical vs. the **Available Chemical Protective Clothing** displays just those CPC entries that match the manufacturers the user has previously identified as the products the response organization typically keeps in inventory.

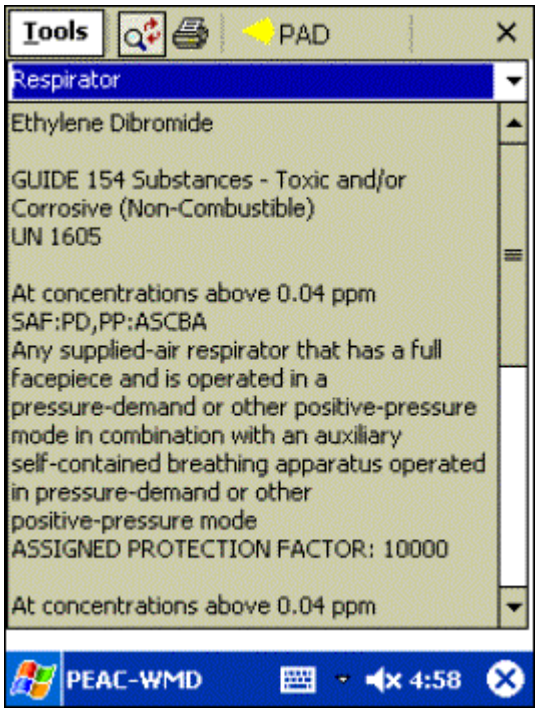

Figure 7 – Respirator Recommendations for Ethylene Dibromide

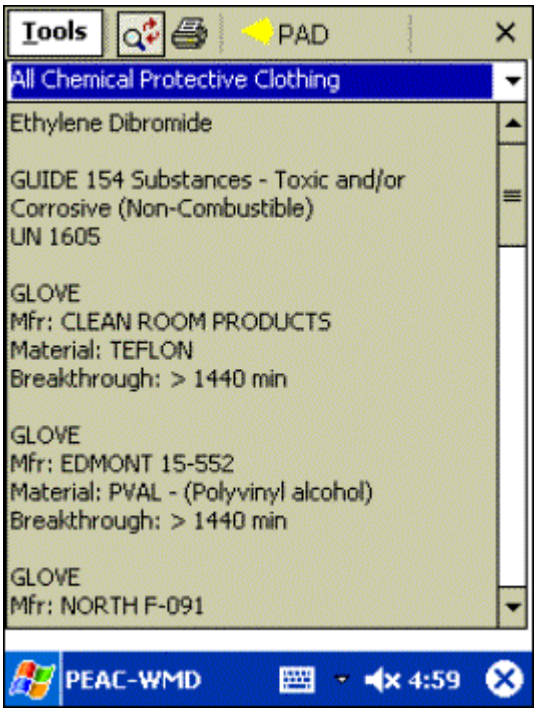

Figure 8 – Chemical Protective Clothing for Ethylene Dibromide

The IC (Incident Commander) will typically utilize more than a single resource for developing a response plan but sometimes the information in other resources will use a different name for the same substance. Clicking on the **Synonyms** selection will provide a quick list of other names the substance may be referenced by in other resources as shown in Figure 9. To further assist the responder in initiating the best response plan, PEAC-WMD also provides the generic guidelines found in the 'orange pages' of the DOT Emergency Response Guidebook (ERG). These are categorized into different types of procedures depending on the incident and the problem to be mitigated. An example for **Spill or Leak Response** is shown in Figure 10.

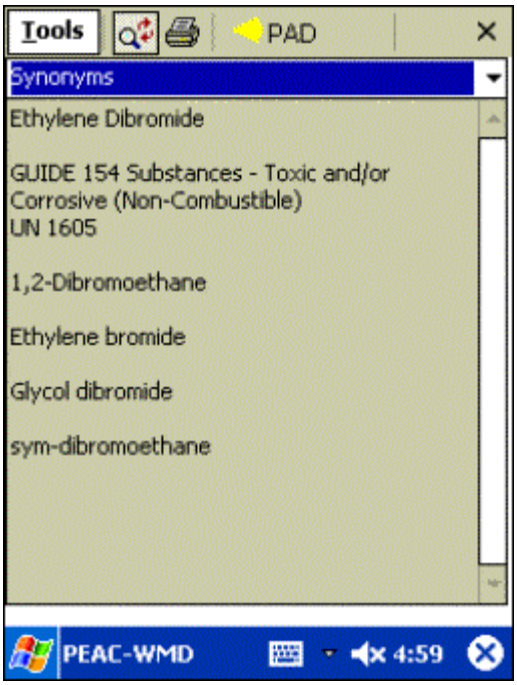

Figure 9 – Synonyms

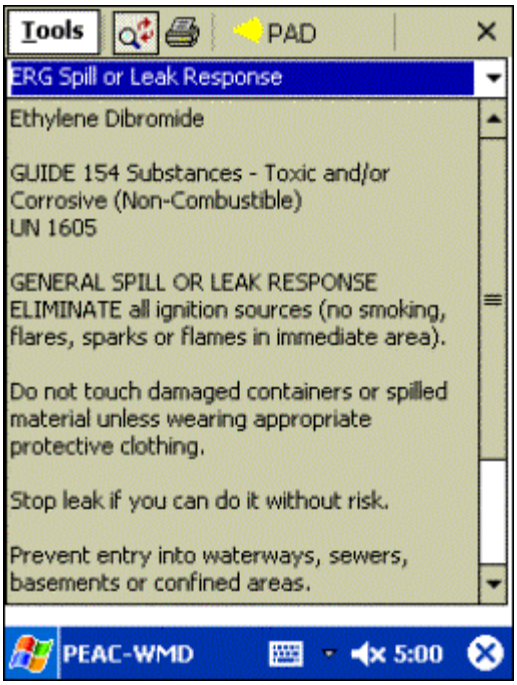

Figure 10 – ERG Spill or Leak Response

A benefit of using the PEAC tool is assistance in the development of an evacuation zone for those chemicals that produce a toxic vapor cloud. Because of its boiling point Ethylene Dibromide will be released from a container as a liquid. As with all of our examples, AristaTek creates a scenario for a spill or release of the specific chemical, and then we work through the development of a PAD (Protective Action Distance) to demonstrate how the PEAC system works.

For our hypothetical scenario using Ethylene Dibromide as the involved chemical we'll set the location to be a manufacturing facility on the North Side of Miami, FL. There is a fire in a warehouse adjacent to an outside storage area containing drums of Ethylene Dibromide. The time is 2:00 AM on July 11th, the temperature is 90°F with clear skies and very light winds of maybe 2 mph. The drums have not been breached but the fire is difficult to extinguish because of the flammable chemicals involved and there is a concern that the Ethylene Dibromide may get too hot and BLEVE. There are residential and commercial areas nearby and light traffic on a nearby highway downwind. The IC has a monitor positioned to cool the drums with water, and the question is asked if there is a reasonable standoff distance that can be provided with regard to toxic vapor if one or more of the drums should BLEVE? There are 20+ drums in the storage area and perhaps 10 are really closest to the fire and posing a danger.

With a BLEVE there are multiple concerns, fragmentation of the container that can be thrown outwards and cause injuries, the possible toxic vapor clouds that could be formed and possible ignition of the liquid and vapors when released from the container. The last concern is not a problem with Ethylene Dibromide since it is non-combustible. The PEAC tool does not currently try to predict how far fragmentation would be a problem. But the PEAC tool can provide some guidance with regards to toxic vapor clouds that a BLEVE would release. Our only problem is to decide how many drums would be involved and would they all be released at one time.

For this scenario, we'll assume ten drums are involved. As seen at the top of the data display screens, there is a yellow icon displayed; this is the PEAC icon for notifying the user that a Protective Action Distance can be calculated. Clicking or tapping on the PAD icon will display a screen as shown in Figure 11. Following through the screens, we provide information on the Meteorology, Container Size, and Type of Release (Source). As shown in Figure 11, we have modified the Container Size by increasing the length of the container by a factor of 10 to give us an approximate volume for 10 drums if they were all to BLEVE. If you decide to follow along on this example, remember to change the location to Miami and the time to 2:00 AM, July 11th.

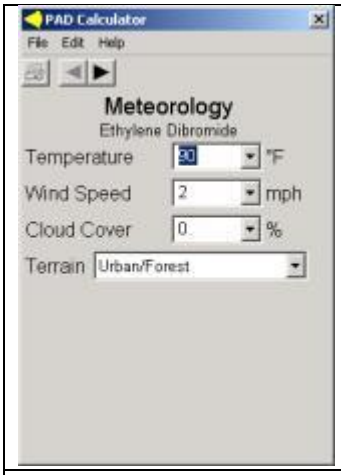	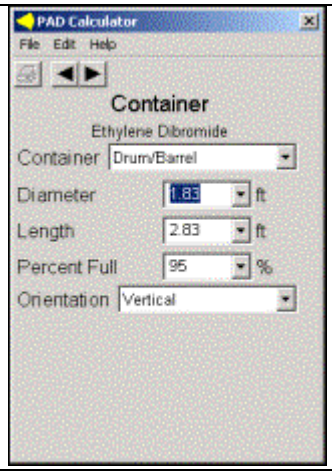	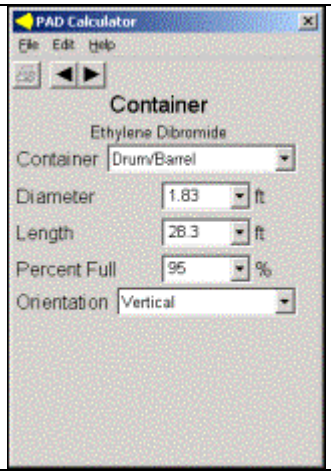	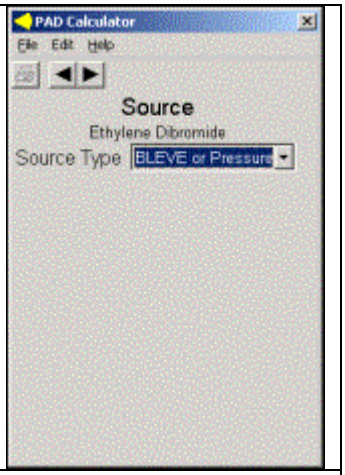
Meteorology It's Miami in July and the temperature about 90°, light wind is set for 2 mph, clear sky so we'll set cloud cover to 0%, and the terrain is Urban/Forest since it's an urban setting.	**Container** We have selected from our list of container sizes the **Drum/Barrel** selection. This provides us with a default size that should get us pretty close to the actual size, but for only **<u>one</u>** drum.	**Container** To quickly get the approximate volume for ten drums, we'll just increase the length of the container by a factor of 10 or to a value of 28.3 feet.	**Source** As the scenario calls for, we've selected **BLEVE or Pressure Explosion** as the **Source** type of release.

Figure 11 – Calculating a PAD using the PEAC-WMD System

By pressing the right arrow at the top of the screen, the PEAC system will display a screen as shown in Figure 12. This calculates a **PAD** (Protective Action Distance) based on the default **Level of Concern** the IDLH of 100 ppm. This evacuation or standoff distance is based on the toxicity of Ethylene Dibromide, it is not based on what fragmentation of the containers might occur and be thrown outward from the storage area.

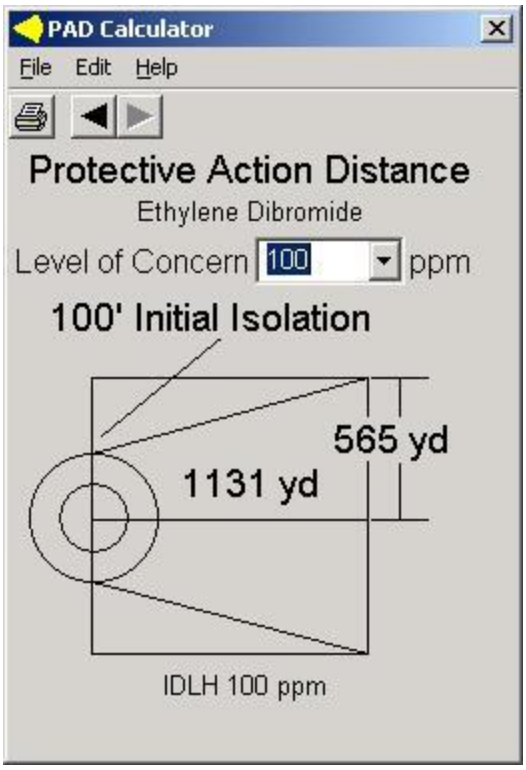

Figure 12 – Default PAD for Ethylene Dibromide-Using the IDLH of 100 ppm

Now we can provide the IC with some guidance as to how far downwind people might be at risk if the drums were to BELVE.

Portions of this discussion were adapted from the Agency for Toxic Substances and Disease Registry (ATSDR) Web site for Medical Management Guidelines at: http://www.atsdr.cdc.gov/.