Let's Take a PEEK at the PEAC Software

An example using the PEAC tool

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The example of PEAC for this month is Bromine, the chemical formula Br_2. Bromine is a dark reddish-brown, volatile, diatomic liquid with a suffocating odor at room temperature. Because the vapor pressure is so high, the dark red vapors are immediately detectable when a container is opened. The corrosive property of bromine is considered a major hazard by the United States Department of Transportation. Bromine is capable of dissolving metals and non-metals and spontaneously combines with aluminum, titanium copper, phosphorus, arsenic, gold and antimony. It will not corrode platinum, lead or nickel. The corrosive reaction results in a non-hazardous bromide.

As an oxidizer, bromine will react with organic matter, such as wood or sawdust; tremendous heat is produced increasing the risk of combustion following bromine spills. Bromine spills should be neutralized with a 5 to 10% solution of sodium thiosulphate. Sawdust should never be used to absorb bromine. Explosions are also possible if ammonium hydroxide is used in an attempt to neutralize a spill.

Bromine is slightly soluble in water, producing hydrogen bromide. Hydrogen bromide is a corrosive colorless gas with a pungent odor that is extremely soluble in water. In the presence of sunlight and humid air or hot water, it forms hydrobromic acid with concentrations up to about 60%. Although less toxic than bromine, it has all the irritant qualities of bromine.

Bromine should be stored in its original container, separated from combustible, organic or other readily oxidizable materials and protected against physical damage and sunlight. Bromine should be kept above 20°F (- 6.6°C) to prevent freezing but heating above atmospheric temperatures should be avoided as raised vapor pressure could rupture the container.

When handling bromine in significant quantities, full body protection (constructed of resistant material) should be worn. Bromine will readily dissolve in alcohol, ether and other organic solvents.

<u>In the event of a fire:</u> Bromine is non-combustible.

<u>Uses:</u>

Pure bromine is used in the synthesis of a variety of bromine-containing substances. In the early 1970s, about 75% of the production of bromine went into the making of ethylene dibromide (EDB) as an antiknock agent in leaded gasoline but not today.

Fumigant production in the form of methyl bromide and ethylene dibromide account for about 10% of the total bromine marketed, while high-density bromine fluids account for

about 25%. The high-density bromine fluids (calcium bromide and zinc bromide) are used around the world as completion fluids in oil wells.

The remaining market for bromine is in the manufacture of various organic compounds including tetrabromobisphenol A, decarbromodiphenyl oxide, hexabromocyclododecane and pentabromocholorocyclohexane which are blended with various polymeric materials to modify the finished products.

Other uses for bromine include flame retardants, cleaning agents, dyestuffs, photography, water sanitation, pharmaceuticals, bleaching fibers and silk, and chemical warfare gas.

Exposure Symptoms: Inhalation of the irritant bromine vapors and/or direct contact (liquid or vapor) with skin and mucous membranes will produce direct tissue injury. Injury may occur at various levels of the respiratory tract depending on the concentration of bromine and duration of exposure. Target organs include the upper and lower respiratory tract, skin, and eyes.

Acute Exposure

Dermal: Pure bromine (liquid or vapor) is extremely irritating to the skin. Unlike most other chemical agents, there is no immediate visible skin reaction after contact. The delay before initial signs of injury become apparent often results in more extensive damage. The most common local effects are blister formation, brownish discoloration of the skin and slow-healing ulcers.

Mucous Membranes: Exposure to low concentrations produces lacrimation, rhinorrhoea, eye irritation with mucous secretions from the oropharyngeal and upper airways, coughing, dyspnoea, choking, wheezing, epistaxis, and headache. A brownish discoloration of the tongue and buccal mucosa may occur and be accompanied by a characteristic breath odor.

Central nervous system: The bromide ion is a central nervous system depressant producing ataxia, slurred speech, tremor, nausea, vomiting, lethargy, dizziness, visual disturbances, unsteadiness, headaches, impaired memory and concentration, disorientation and hallucinations.

Respiratory: There are few reports about the chronic complications of an acute exposure to bromine. However, the literature has described the chronic manifestations of chlorine inhalation. Bromine is potentially capable of extensive damage to the lower respiratory tract. Limited studies have reported diffuse interstitial pulmonary fibrosis, emphysema and/or airway hyperreactivity secondary to acute exposure to bromine.

General principles of management: Acute contact with bromine liquid or vapor requires removal from the source of the bromine contamination.

Eye: The eye(s) should be irrigated with copious amounts of tepid water for at least 15 minutes. If irritation, pain, swelling, lacrimation or photophobia persist, further medical evaluation is recommended.

Dermal: Remove of contaminated clothing and thoroughly wash the affected area with copious volumes of water for 20 minutes. Since the effects may be delayed, close observation for blistering and discoloration of the skin is required for the next 24 hours.

Inhalation: Respiratory support in accordance with symptomatology, including: maintenance of an adequate airway, oxygen, antibronchospasm therapy (inhaled beta adrenergic agonist, aminophylline and/or short course of corticosteriods) and antibiotics if there is evidence of infection. Assisted or supported ventilation with tracheal intubation and positive pressure ventilation may be needed.

Professions that would be potentially at risk of exposure include:

- Drug Makers
- Dye Makers
- Gold Extractors
- Gasoline Additive Makers
- Organic Chemical Synthesizers
- Petroleum Refinery Workers
- Photographic Chemical Makers
- Silk and Fiber Bleachers

The following discussion provides screen captures from ***PEAC-WMD 2002 for Windows*** and the ***PEAC-WMD 2002 for the Pocket PC*** application while viewing some of the information available for bromine.

The first step is to find the chemical in the PEAC database; we chose to find the chemical by entering the name. The first information screen or default screen to be displayed is from the *Chemical Properties* database. As shown in the figures 1-3 below, the information for *Chemical Properties* are the same whether displayed on the Pocket PC version of the software (Figure 1 and 2) or the Windows version of the software (Figure 3). The NFPA 704 Hazard Classification information immediately gives the user the information that this material is a health hazard and it is non-combustible.

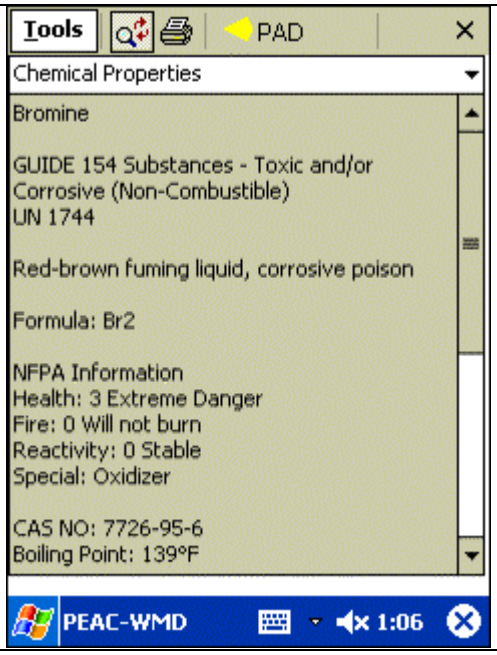


Figure 1 - Chemical Properties on the Pocket PC version of PEAC-WMD (top)

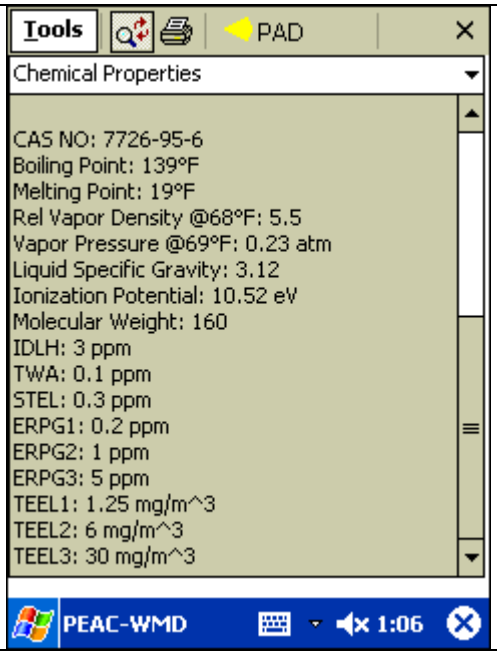


Figure 2 - Chemical Properties on the Pocket PC version of PEAC-WMD (bottom)

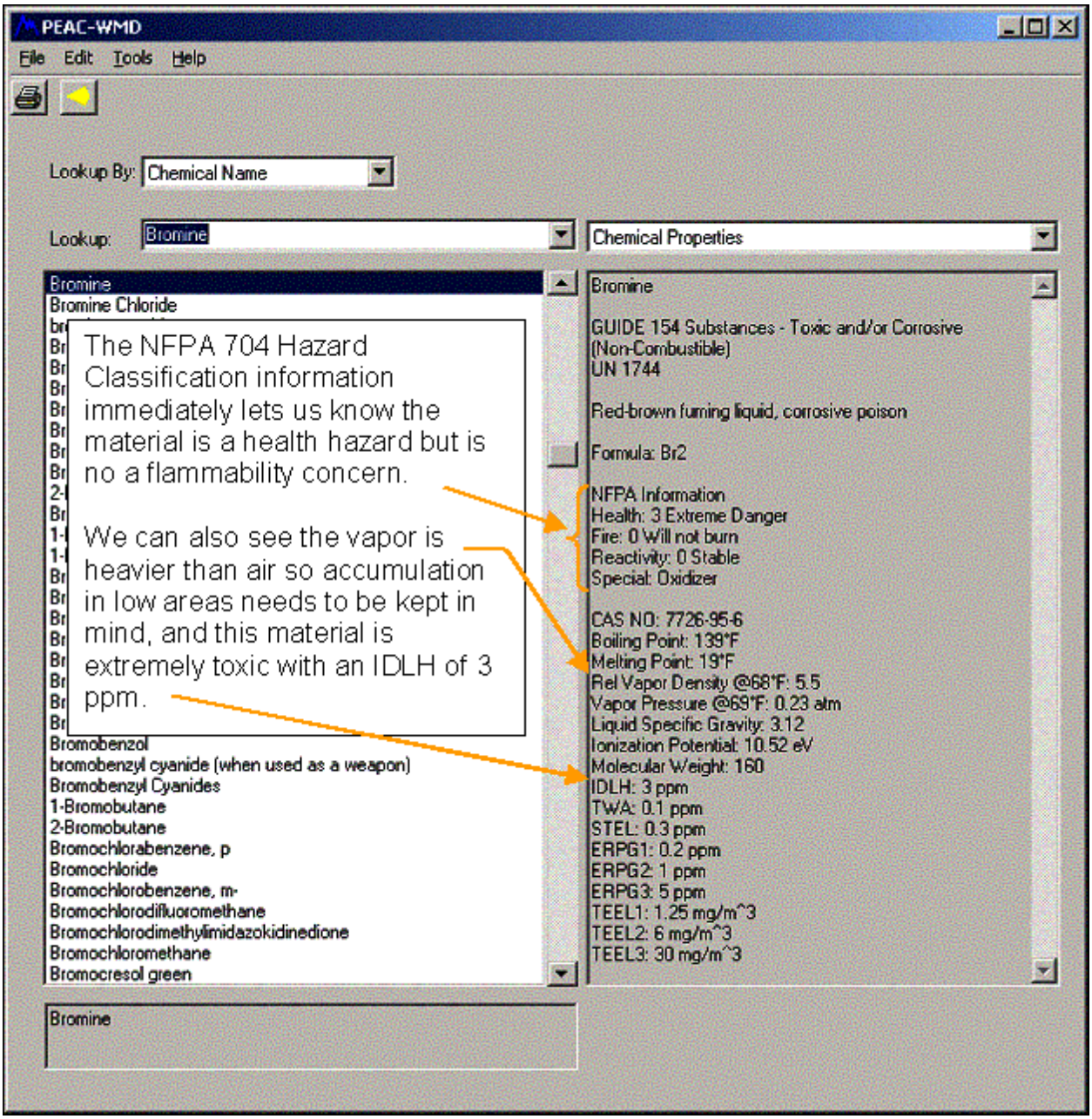
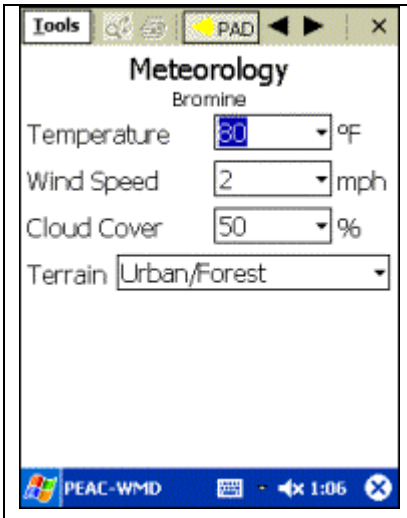


Figure 3 - Chemical Properties for Bromine (Windows version of PEAC-WMD)

Obviously, one of the primary concerns when dealing with a response involving Bromine is how far to evacuate personnel and the public to prevent exposure. The following screens demonstrate the PAD Calculator input screens to determine a PAD or Protective Action Distance based on a hypothetical incident.

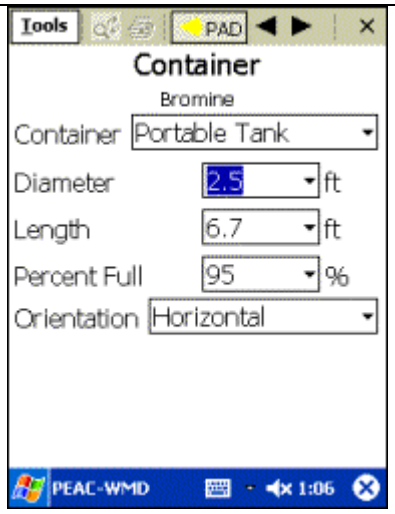
At a manufacturing facility for photographic chemicals outside of Philadelphia just after lunch break, a one-ton container of bromine has been off loaded with a forklift. As the container is being moved to a production area, the container is accidentally run into steel pedestal breaching the tank sufficiently such that most of the contents have spilled into a pool on the ground outside the production facility. The temperature is ~80°F, very light

winds, it is partly cloudy, and the shallow pool that formed is about 30' in diameter. What would be a reasonable downwind evacuation distance? (The figures below are from the Pocket PC version of PEAC-WMD but similar images could be seen from the Windows version.)



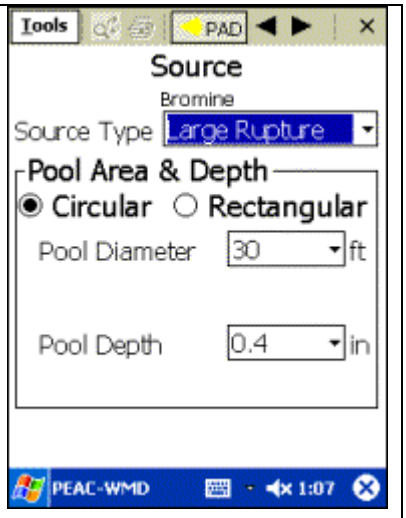
Meteorology

It's Philadelphia (or nearby) in September and we said the temperature about 80, light wind is set for 2 mph, partly cloudy we'll set 50%, and the terrain is Urban/Forest since it's an industrial facility.



Container

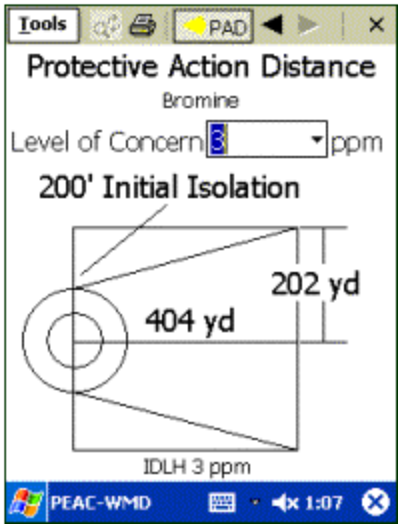
We select **Portable Tank** from our list of containers and it fills in the size of the container. We can leave the percent full at 95%. We have set the tank orientation as horizontal, although in this case in doesn't really matter.



Source

Since we have lost most of the contents we select L**arge Rupture.** Since Bromine boils above the ambient temperature (see Figure 3, C**hemical Properties** lists the boiling point as 139°F)

A pool will be formed and we enter in the approximate size and depth.



The PEAC built-in dispersion model makes a calculation using the IDLH of 3 ppm as the **Level of Concern** as a default value.* This results in a downwind distance of ~400 yards. The initial isolation zone in all directions is 200' as displayed in the ERG2000 "green pages". The responder has the option to use a value other than the IDLH as the end-point for the dispersion model calculation. A different value can be entered for the **Level of Concern** or a value from the list of toxicity levels in the PEAC database can be selected. The PAD calculator will recompute a distance and display a new screen.

Portions of this discussion were adapted from the ***International Programme on Chemical Safety (IPCS)*** located on the Internet at www.inchem.org/.

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* Since the IDLH is a recommended concentration that allows for 30 minutes to vacate an area, the responder may elect to utilize a lower concentration for the **Level of Concern** to provide a safety margin when dealing with public evacuations.