Let's Take A PEEK at the PEAC software

PEAC Example –Methyl Bromide

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This month our example is Methyl Bromide, which has a chemical formula of CH_3Br. Methyl Bromide is listed under the UN # (United Nations Number) by the US Department of Transportation: UN 1062 and has a CAS # of 74-83-9.

Persons exposed only to methyl bromide gas do not pose substantial risks of secondary contamination; however, some methyl bromide may permeate clothing. Persons whose clothing or skin is contaminated with liquid methyl bromide (temperatures less than 38.5°F) can secondarily contaminate others by direct contact or through off gassing vapor.

A gas at room temperature, methyl bromide readily penetrates skin, cloth, and other protective materials such as rubber and leather. It is nonflammable and toxic at low concentrations.

Methyl bromide is odorless and odor provides no warning of hazardous concentrations. However, because methyl bromide is odorless and nonirritating, a lacrimator (an agent that irritates the eyes and causes tearing), most commonly chloropicrin at 2%, is often added as a warning agent.

Methyl bromide is absorbed well by the lungs and to some degree through intact skin. Oral exposure is rare because methyl bromide is a gas at room temperature, but it may be absorbed by the gastrointestinal tract. Exposure by any route can cause systemic effects.

Description: Methyl bromide is a colorless gas at room temperature and a liquid below 38.5°F (3.6°C) or when compressed. It is usually shipped as a liquefied, compressed gas. It is odorless and nonirritating at low concentrations and has a musty or fruity odor at high concentrations (greater than 1,000 ppm).

Sources/Uses: Methyl bromide is produced by adding sulfuric acid to a mixture of sodium bromide and methyl alcohol. Methyl bromide is used primarily as a pesticide to fumigate soil, spaces, structures, and commodities. It is also used as a methylating agent, low-boiling solvent, and oil extractant in chemical syntheses. Less toxic chemicals have replaced it as a refrigerant and fire-extinguisher constituent.

Physical Properties:

Description: Colorless; gas at room temperature and liquid below 38.5°F (3.6°C)

Warning properties: **Inadequate**; musty or fruity odor at greater than 1,000 ppm; eye and throat irritation at greater than 500 ppm.

Molecular weight: 95.0 daltons

Boiling point (760 mm Hg): 38.5°F (3.6°C)

Freezing point: -137°F (-94°C)

Vapor pressure: 1420 mm Hg at 68°F (20°C)

Gas density: 3.4 (air = 1)

Water solubility: Water soluble (0.09% at 68°F) (20°C)

Flammability: Flammable, but only in the presence of a high energy ignition source.

Synonyms: bromomethane, monobromomethane, isobrome, and methyl fume.

Standards and Guidelines : OSHA ceiling limit = 20 ppm (skin)

NIOSH IDLH (immediately dangerous to life or health) = 250 ppm

AIHA ERPG-2 (the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action) = 50 ppm

Incompatibilities: Methyl bromide reacts with strong oxidizers, magnesium, aluminum, tin, zinc, and alloys. It attacks aluminum to form aluminum trimethyl, which is spontaneously flammable.

Routes of Exposure:

Inhalation Most exposures occur by inhalation and by absorption through the skin. **Odor is not an adequate indicator of the presence of pure methyl bromide and does not provide reliable warning of hazardous concentrations**. Because pure methyl bromide lacks adequate warning properties, significant exposure can occur before symptoms are evident.

Methyl bromide is 3 times heavier than air and can accumulate in poorly ventilated or low-lying areas. Under adverse conditions, it can remain in the air for days after application as a fumigant. Fatalities have occurred among pesticide appliers and building occupants who were exposed during the application process or who prematurely reentered fumigated buildings.

Children exposed to the same levels of methyl bromide as adults may receive larger doses because they have greater lung surface area:body weight ratios and increased minute volumes:weight ratios. In addition, they may be exposed to higher levels than adults in the same location because of their short stature and the higher levels of methyl bromide found nearer to the ground.

Skin/Eye Contact Methyl bromide gas easily penetrates most protective clothing (e.g., cloth, rubber, and leather) and skin. Prolonged retention in clothing and rubber boots may lead to chemical dermatitis and severe burns. Skin absorption may contribute to systemic toxicity. Children are more vulnerable to toxicants absorbed through the skin because of their relatively larger surface area:body weight ratio.

Ingestion Ingestion of methyl bromide is unlikely because it is a gas at room temperature.

Health Effects

Methyl bromide is a neurotoxic gas that can cause convulsions, coma, and long-term neuromuscular and cognitive deficits.

Exposure to high concentrations of pure methyl bromide may cause inflammation of the bronchi or lungs, an accumulation of fluid in the lung, and irritation of the eyes and nose. Tearing agents added to methyl bromide to provide warning of its presence can also cause these symptoms, even at very low concentrations.

Skin contact with high vapor concentrations or with liquid methyl bromide can cause systemic toxicity and may cause stinging pain and blisters.

Acute Exposure Methyl bromide methylates the sulfhydryl groups of enzymes, causing cellular disruption and reduced glutathione levels. Cellular disruption, primarily in the CNS, results in progressive dysfunction. In sublethal poisoning, a latency period of 2 to 48 hours can occur between exposure and onset of symptoms. Methanol, a metabolite of methyl bromide, may also contribute to the neurologic and visual effects, but this is only likely to be significant at high levels of exposure.

Children do not always respond to chemicals in the same way that adults do. Different protocols for managing their care may be needed.

CNS The most serious effects of acute inhalation exposure involve the CNS. Depending on the concentration and duration of exposure, initial neurologic effects may be delayed for 2 or more hours after exposure and may include headache, nausea, vomiting, dizziness, malaise, and visual disturbances. Examination may reveal involuntary movements of the eyes, dilated pupils, slurred speech, trembling of the extremities during movement, impaired gait, impaired sensation of touch, brain damage (i.e., cerebellar abnormalities), motor deficits, and decreased reflexes. Neuropsychiatric abnormalities often occur after acute exposure, although onset may be delayed for days to weeks. In some cases, mental disturbances may predominate with only mild neurologic signs and no seizures; in others, severe and prolonged seizures may occur. Motor and cognitive deficits may persist indefinitely.

Peripheral Neurologic Peripheral neuropathy may develop after acute exposure to methyl bromide and may persist indefinitely.

Respiratory Respiratory symptoms are the most likely nonneurologic effects of acute methyl bromide inhalation. Throat irritation, chest pain, and shortness of breath are common. Severe exposures may cause inflammation of the bronchi or lungs and an accumulation of fluid in the lungs, which may be delayed 24 hours or longer after exposure. Death may result from respiratory or cardiovascular failure.

Exposure to certain chemicals can lead to Reactive Airway Dysfunction Syndrome (RADS), a chemically- or irritant induced type of asthma.

Children may be more vulnerable because of relatively increased minute ventilation per kg and failure to evacuate an area promptly when exposed.

Cardiovascular Acute inhalation of high concentrations can cause rapid, ineffective beating of the heart.

Renal Protein and blood in the urine, scant urine production, absence of urine production, and accumulation of urea and other nitrogen wastes in the blood due to death of kidney cells have been described. Complete recovery is usual.

Hepatic Elevated liver enzymes in serum and jaundice occur occasionally after acute exposure.

Ocular Eye exposure to liquid methyl bromide or to high concentrations of vapor may cause corneal irritation and burns.

Dermal Contact with either liquid or high vapor concentrations can cause stinging pain, redness of the skin, and blisters characteristic of second-degree burns. Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants absorbed through the skin.

Potential Sequelae Peripheral nerve damage, speech difficulty, and neuropsychiatric sequelae such as impaired gait, involuntary movements of the eyes, tremors, involuntary muscle jerks, seizures, decline in mental abilities, and severe mental disorders (i.e., psychoses) may develop weeks after exposure.

Chronic Exposure Repeated exposures have been associated with peripheral neuropathies, especially sensory neuropathy, impaired gait, behavioral changes, and mild liver and kidney dysfunction. Visual impairment secondary to atrophy of the optic nerve has been reported. Chronic exposure may be more serious for children because of their potential longer latency period.

Carcinogenicity The International Agency for Research on Cancer has determined that methyl bromide is not classifiable as to its carcinogenicity to humans.

Reproductive and Developmental Effects Methyl bromide is not considered a reproductive or developmental toxicant. No human data are available; one study of experimental animals (rats and rabbits) did not find teratogenic effects at levels below those causing maternal death. Methyl bromide is not 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.

In using the PEAC application we access information for the chemical by first locating Methyl Bromide 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.

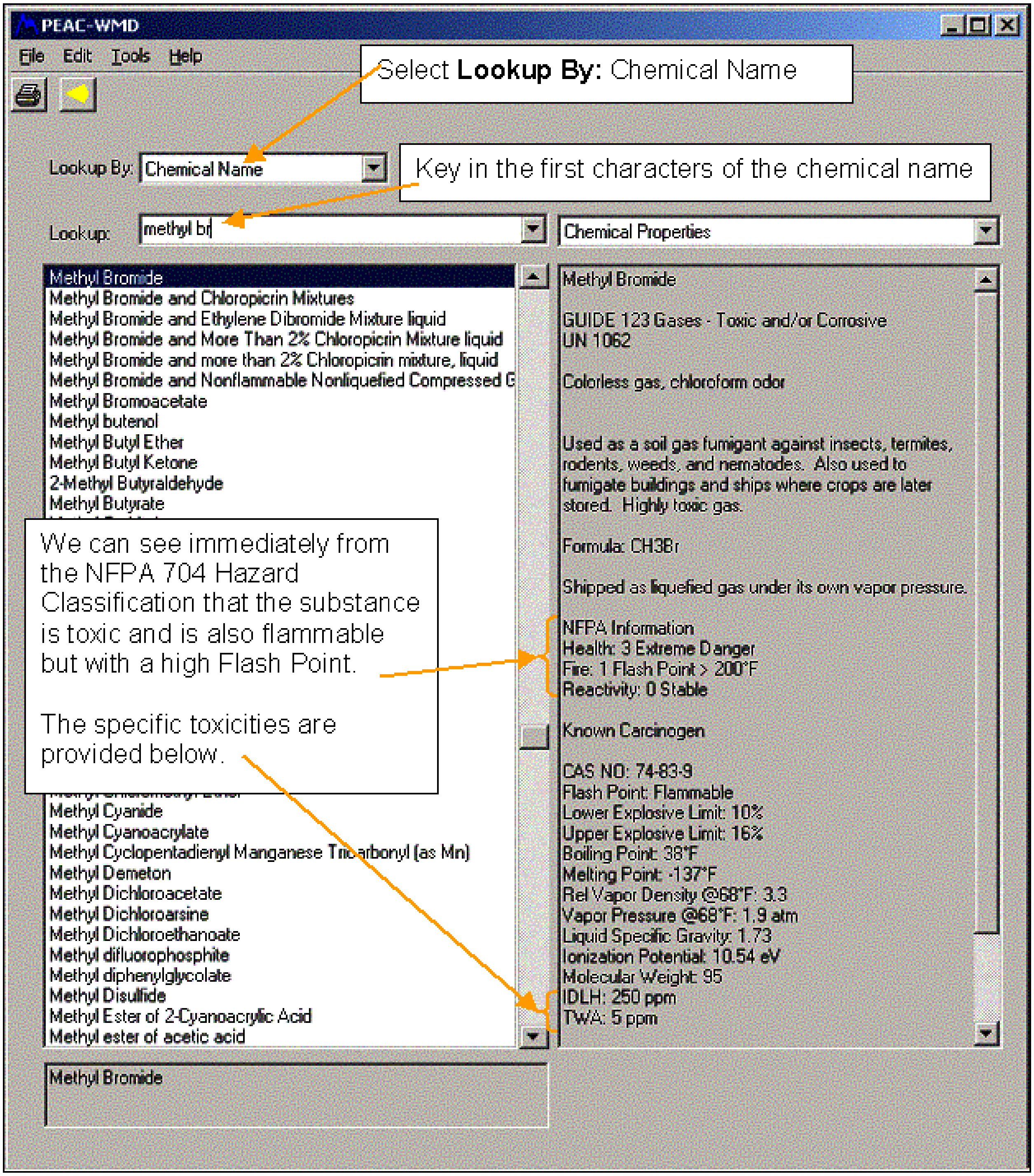

Figure 1 - Using the Lookup By: Name for Methyl Bromide using the PEAC-WMD for Windows application

Review of the information displayed in the chemical properties screen whether in Figure 1 (above) or Figures 2-5 (below), show chemical properties values discussed earlier at the top of this discussion. As you can see below, the published toxicity values, e.g., IDLH, ERPGs, 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.

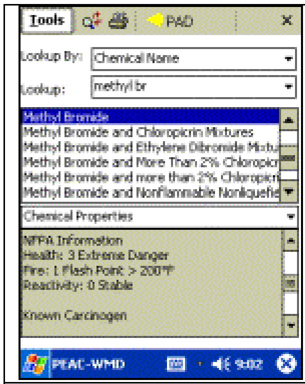

Figure 2 – Selecting Methyl Bromide using the PEAC-WMD for Pocket PC application

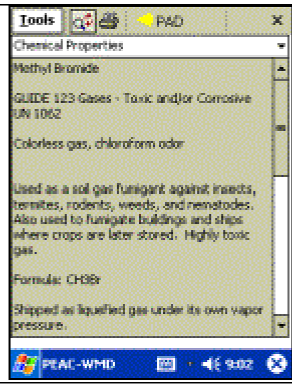

Figure 3 – The top portion of the Chemical Properties Data Display Screen

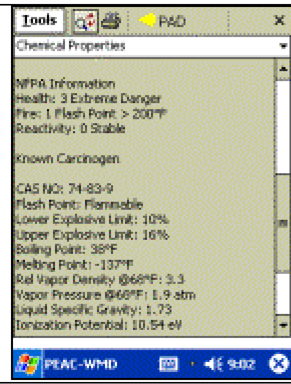

Figure 4– The middle portion of the Chemical Properties Data Display Screen

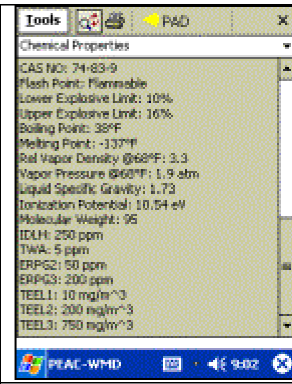

Figure 5– The bottom portion of the Chemical Properties Data Display Screen

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. If transported as a compressed liquefied vapor it will be released from a container as a vapor or aerosol or a liquid that will rapidly vaporize. As with most 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 Methyl Bromide as the involved chemical we'll set the location to be a chemical manufacturing facility located in Baton Rouge, LA. The date is November 11, 2003, about 9:30 AM with a temperature of 75°F, a wind speed of 10 mph with a partly cloudy sky. The release involves a portable tank that has a 1" transfer valve knocked off by a forklift. The PEAC tool can provide guidance with regards to toxic vapor cloud that is released. If you decide to follow along as we proceed through these examples, remember to set the location to Baton Rouge and set the date and time to the proper values, otherwise you'll compute different values. Also it should be understood that the examples shown below assume that no fire is involved, otherwise the Methyl Bromide might ignite.

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 6. Following through the screens, we provide information on the Meteorology, Container Size, and Type of Release (Source). The following figures demonstrate how we would work through our scenario to see what our Protective Action Distance should be.

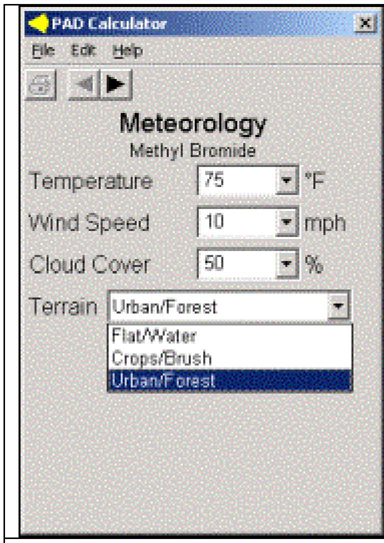	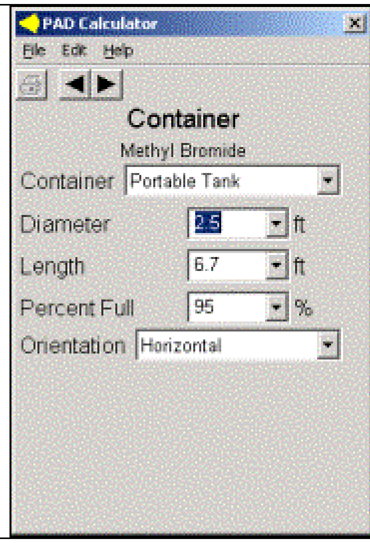	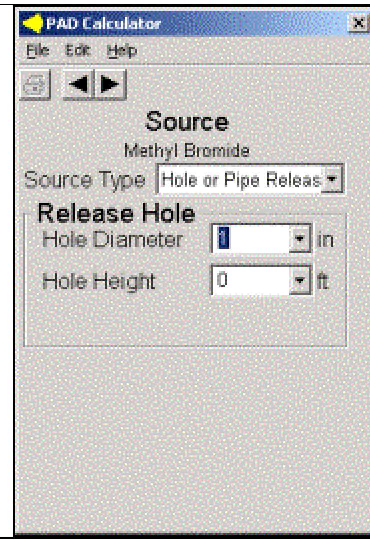
Meteorology It's Baton Rouge in November and the temperature about 75°, wind is set for 10 mph, partly cloudy skies and the terrain is **Urban/Forest** since it's an industrial setting.	**Container** We have selected from our list of container sizes the **Portable Tank** selection; this gives some quick dimensions that should get us close to the right size.	**Source** We have selected a **Hole or Pipe Release** for the type of release with a **1" Hole Diameter**.

Figure 6 – Calculating a PAD using the PEAC-WMD System for November 11th

By pressing the right arrow at the top of the screen, the PEAC system will display a screen as shown in Figure 7. This calculates a **PAD** (Protective Action Distance) based on the default **Level of Concern** the IDLH of 250 ppm. This evacuation or standoff distance is based on the toxicity of Methyl Bromide.

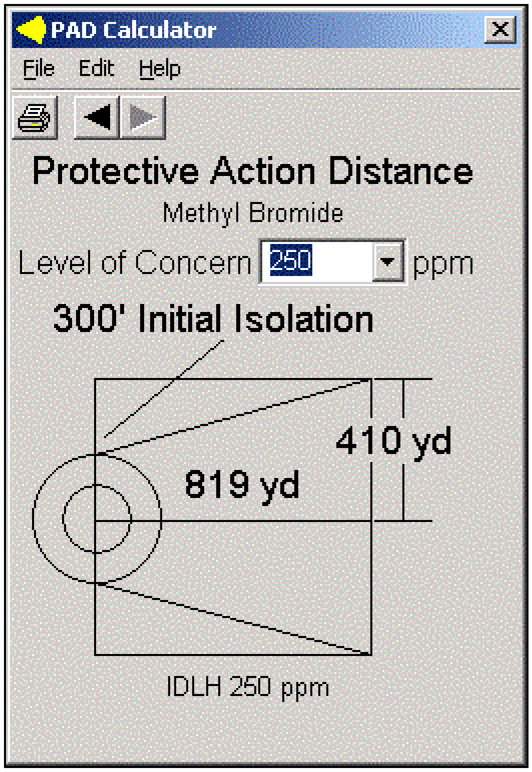

Figure 7 – Default PAD for Methyl Bromide using the IDLH of 250 ppm

If we felt that the IDLH was not a conservative enough concentration to provide adequate protection to the public, we can quickly compute another PAD using another Level of Concern concentration. For instance, we could select the ERPG-2 value from the pop-up list as shown in Figure 8. The results of the new calculations are shown in Figure 9.

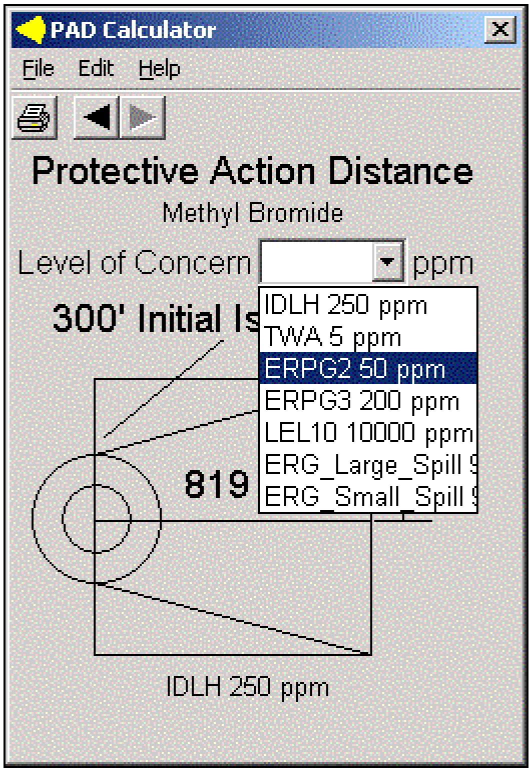

Figure 8 – Selecting another Level of Concern from the pop-up list

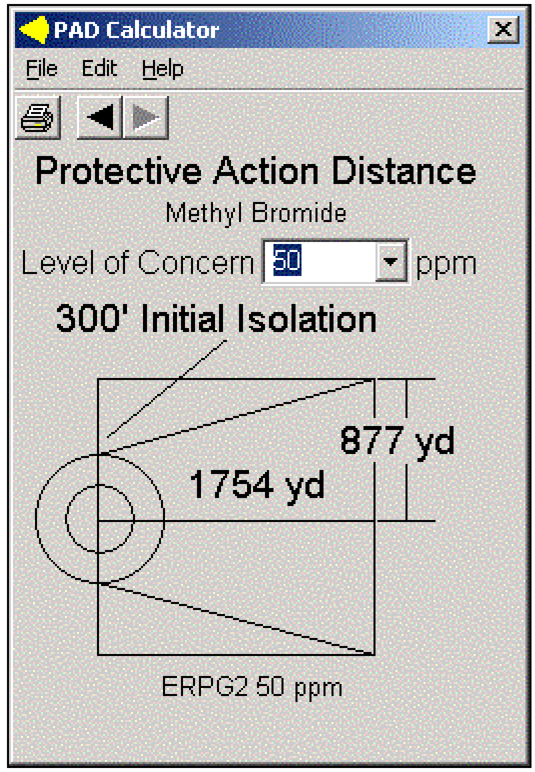

Figure 9 – The PAD calculated based on the ERPG-2 LOC of 50 ppm.

Substantial 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/.