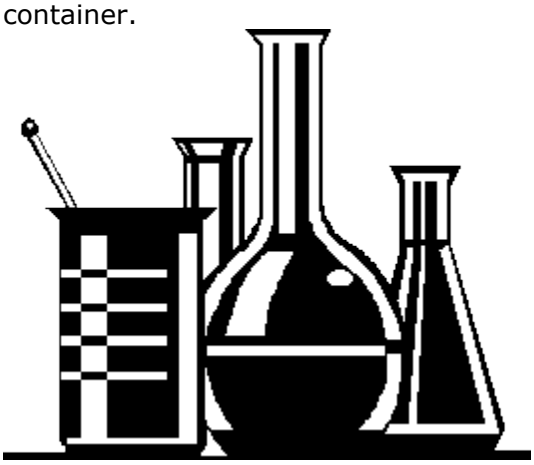
Let's Take a PEAK at PEAC

An example using the PEAC tool

Hydrogen Cyanide (chemical formula HCN) is a colorless, volatile, and extremely poisonous chemical compound whose vapors have a bitter almond odor. It melts at 7.9˚F and boils at 78˚F. It is miscible in all proportions with water or ethanol and is soluble in ether. Its water solution is a weak acid commonly known as hydrocyanic acid or prussic acid. It is slightly lighter than air and therefore less likely to accumulate in low spots when released from its container.



Hydrogen cyanide is readily absorbed from the lungs; symptoms of poisoning begin within seconds to minutes. The odor of hydrogen cyanide is detectable at 2-10 ppm (OSHA PEL =10 ppm), but **does not provide adequate warning of hazardous concentrations**. Perception of the odor is a genetic trait (20% to 40% of the general population cannot detect hydrogen cyanide); also, rapid olfactory fatigue can occur, i.e., the nose becomes desensitized to the odor very rapidly.

Children exposed to the same levels of hydrogen cyanide as adults may receive larger doses because they have greater lung surface area:body weight ratios and increased minute volumes:weight ratios.

Exposure to hydrogen cyanide can cause skin and eye irritation. More importantly, skin or eye absorption is rapid and contributes to systemic poisoning. After skin exposure, onset of symptoms may be immediate or delayed for 30 to 60 minutes. Most cases of toxicity from dermal exposure have been from industrial accidents involving partial immersion in liquid cyanide or cyanide solutions or from contact with molten cyanide salts, resulting in large surface-area burns.

Children are more vulnerable to toxicants absorbed through the skin because of their relatively larger surface area:body weight ratio. Ingestion of hydrogen cyanide solutions or cyanide salts (e.g., sodium cyanide) can be rapidly fatal.

The principal use of hydrogen cyanide is in the manufacture of organic chemicals, e.g., acrylonitrile, methyl methacrylate, and adiponitrile that are used in producing synthetic fibers and plastics. It is also used in electroplating; mining; chemical laboratory; and is sometimes used in agriculture as a fumigant.

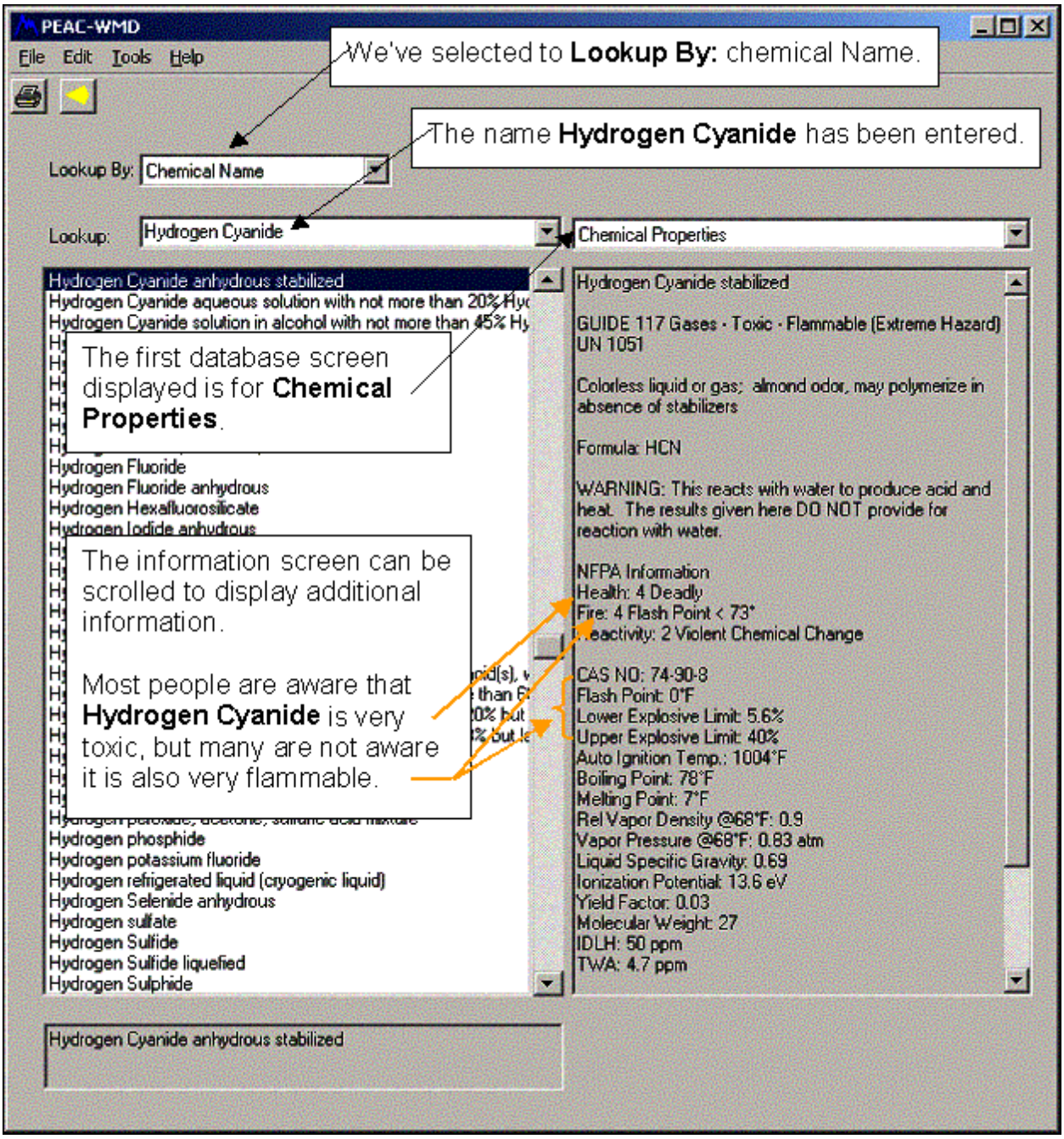
Hydrogen cyanide is highly toxic by all routes of exposure and may cause abrupt onset of profound CNS, cardiovascular, and respiratory effects, leading to death within minutes. Exposure to lower concentrations of hydrogen cyanide may produce eye irritation, headache, confusion, nausea, and vomiting followed in some cases by coma and death. Hydrogen cyanide acts as a cellular asphyxiant. By binding to mitochondrial cytochrome oxidase, it prevents the utilization of oxygen in cellular metabolism. The CNS and myocardium are particularly sensitive to the toxic effects of cyanide.

Incompatibilities - Hydrogen cyanide reacts with amines, oxidizers, acids, sodium hydroxide, calcium hydroxide, sodium carbonate, caustic substances, and ammonia.

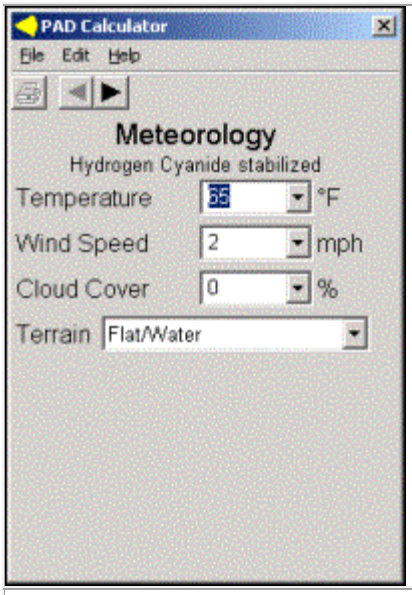
Hydrogen cyanide may polymerize at 122 ˚F to 140 ˚F.

The following discussion provides screen captures from ***PEAC-WMD 2002 for Windows*** application while viewing some of the information available for Hydrogen Cyanide.

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 to be displayed is from the Chemical Properties database. As shown in the figure below, there are some interesting facts about Hydrogen Cyanide. First as most people are aware, it is a very toxic chemical with an IDLH of 50 ppm. In addition, it is very flammable with a rather wide flammability range as indicated from the LEL of 5.6% and the UEL of 40%. As indicated earlier, it is slightly lighter than air and therefore will not accumulate in low areas for which many toxic chemical vapors have a tendency.

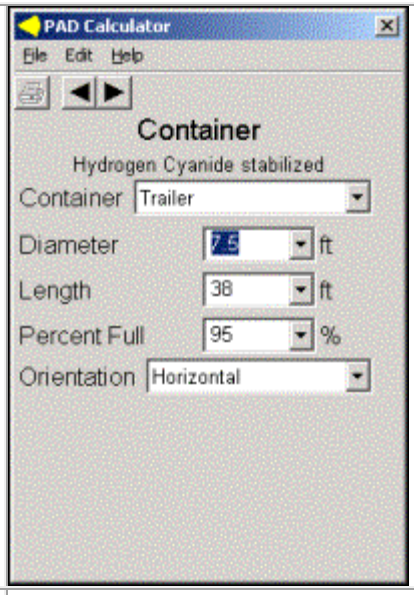


Obviously, one of the primary concerns when dealing with a response involving Hydrogen Cyanide is how far to evacuate personnel and the public to prevent exposure. The following screens demonstrate the PAD Calculator input screens to determine a PAD or Protective Action Distance based on a hypothetical incident. The incident involves a railcar that has derailed and struck a bridge creating a hole in the car. The hole can't be seen but liquid is coming out the hole and forming a liquid pool about 120' across. The surrounding area is mostly pasture with a residential area about 2 miles downwind. The time is about 2:00 AM, the wind is light, outside temperature is in the mid 60's, and no cloud cover.



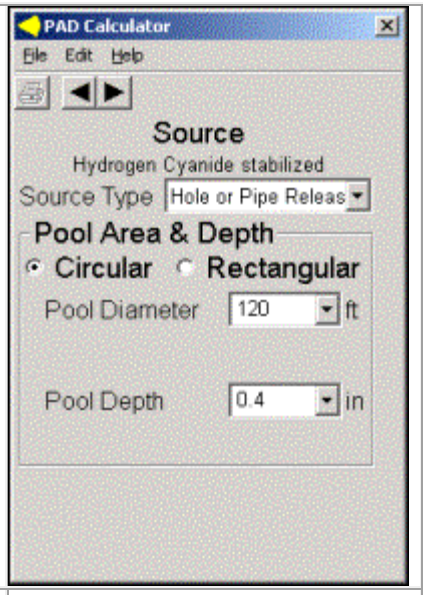
Meteorology

The temperature is mid-60's or about 65, light wind is set for 2 mph, no cloud cover is 0%, and the terrain is pasture or basically flat (no substantial surface obstacles).



Container

We select a railcar from our list of containers and it fills in a default size of the container. 95% full assumes worst-case unless we know it is less, this also allows for headspace. We have assumed the tank is horizontal.



Source

The exact size of the hole is not known but we know it has formed a pool about 120' across. We don't know the depth of the pool but use a shallow depth (0.4") as a default.

The PEAC built-in dispersion model makes a calculation using the IDLH of 50 ppm as the Level of Concern. This results in a downwind distance of 4.9 miles. The initial isolation zone in all directions is 1,300' as displayed in the ERG2000. With a residential area about two miles away from the incident, the call for evacuation is probably in order. 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 of Hydrogen Cyanide were adapted from the ATSDR's Medical Management Guidelines (MMGs) for Acute Chemical Exposures.