Let's Take a PEEK at PEAC

An example using the PEAC tool

Anhydrous Hydrogen Fluoride (sometimes referred to as AHF, chemical formula HF) is an achromatic and transparent liquid under low temperature. Its boiling point is 19.4°C(66.9°F), the melting point is -83.37°C(-118.07°F) and the specific gravity is 1.008g/cm^3(25°C). It easily volatilizes into the air forming a smog. Owing to its active chemical feature, it can react on alkali, metal, oxide and silicate, etc. It mixes freely with water including air humidity forming hydrofluoric acid, which has a strong irritant odor. It will strongly corrode the eyes, ears, nose and laryngitis mucous membrane. AHF or hydrofluoric acid seriously corrodes human tooth and skeleton and calcificates them, resulting in permanent damage. It is a very dangerous material, which must be handled with great care.

Hydrogen fluoride is generally derived from the reaction of concentrated sulfuric acid on fluorspar (CaF_2).

Uses

- Etching and glass cleaning in the manufacture of glass, semiconductors (computer chips), and ceramics (home and industrial applications)
- Rust removal in commercial and home laundry products
- Milling titanium
- Metallurgy laboratories
- Petroleum exploration, refining (in alkylation units), and in the oil fields
- Dental laboratories (for cleaning porcelain prosthetics)
- Electroplating
- Some janitorial products for cleaning tiles, and ceramic devices
- Aluminum brighteners
- Various chemical industries
- Porcelain painters (at home)

Occupationally exposed populations

- Computer chip manufacturing workers (etch stations and quartz tube cleaners and maintenance personnel)
- Oil field workers (e.g., "roustabouts"), and alkylation refinery workers
- Workers in the synthesis of fluorinated chemicals
- Laundry workers (only when involved with rust removers)
- Glass etchers
- Electroplaters

In the event of a fire: the combustion of carbon-containing materials in the presence of hydrogen fluoride can produce carbonyl fluoride (the fluorine analogue of phosgene).

Environmental: the effects of fluoride ion on bacterial sewage treatment systems, fish and wildlife are potentially disastrous. Spills can be rapidly complexed with calcium (e.g. as lime) or magnesium salts, resulting in inactivation of the fluoride ion and precipitation.

First-aid measures and management principles:

- Any suspected or known skin contact with HF should be aggressively diluted and washed with a flood shower or the nearest available high flow of water. Decontamination should continue for 15 minutes. All contaminated clothing must be removed. Exposed skin surfaces should be soaked in a calcium or magnesium salt solution, gel or paste. Alternatively, quaternary ammonium compounds (e.g., benzalkonium chloride) may be used.

- After possible eye contact, the eyes must be thoroughly irrigated with at least 2 l of saline or other appropriate eye wash solution for 10-15 minutes.

- After oral ingestion, calcium-containing antacids, especially in liquid form, should be given. Nothing else should be given by mouth after ingestion.

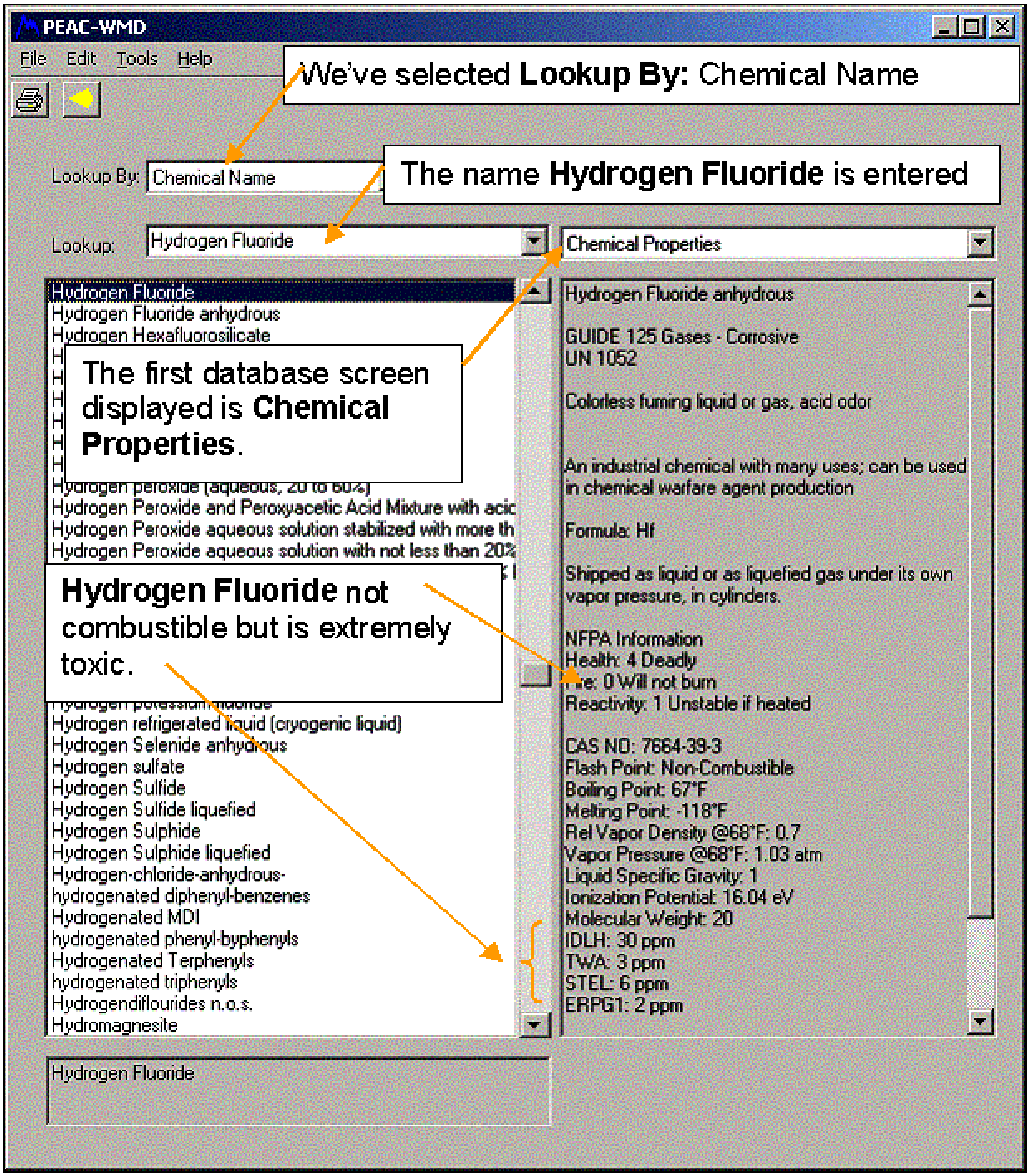
- Calcium supplementation should be given, intravenously or orally, because severe hypocalcaemia may develop rapidly after a delay of minutes to hours following serious exposure (>1% body surface area for a concentrated solution, or >5% body surface area for a dilute solution). Serial determination of blood calcium should be started as soon as possible and repeated every 6 hours for 24 hours or until stable. As soon as possible, patients should be placed on continuous electrocardiographic monitoring for signs of hypocalcaemia or dysrhythmia.

A Safety Alert was published in the April 28, 1997 issue of Chemical & Engineering News (page 6). Elizabeth F. Watson, the Manager of the Chemical Manufacturers Association Hydrogen Fluoride Panel, wrote the alert. The Alert warns that anhydrous Hydrogen Fluoride, stored in carbon steel cylinders, slowly builds up pressure by the reaction of the AHF with the iron to form iron fluoride and hydrogen gas. The hydrogen collects in the cylinder and the pressure slowly increases.

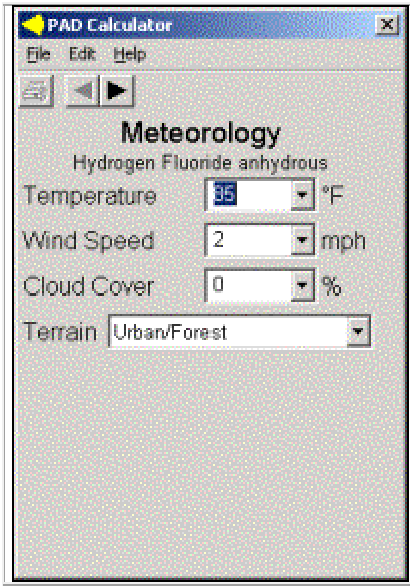
- In the incident reports, the pressure in a lecture bottle that had been in storage for at least 14 years was found to be in excess of 2,400 psig, rather than 5 - 15 psig, as expected for AHF. After venting, the cylinder gas was found to be primarily hydrogen.
- The lesson from this is very applicable to academic environments, where old lecture bottles are frequently found. The corrective action is to locate all old cylinders and remove them. The prevention is to have a good cylinder inventory, and do not allow corrosive gas cylinders to remain in the inventory for more than a designated period.

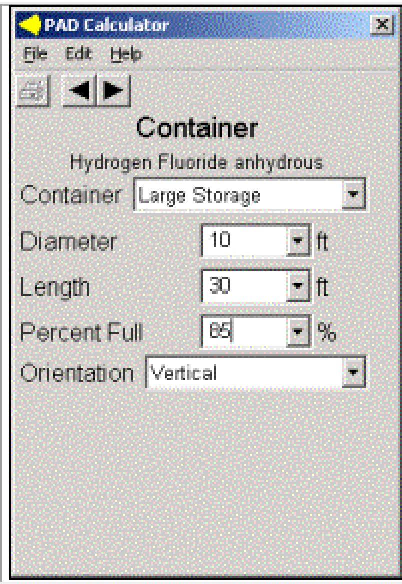
The following discussion provides screen captures from ***PEAC-WMD 2002 for Windows*** application while viewing some of the information available for Anhydrous Hydrogen Fluoride.

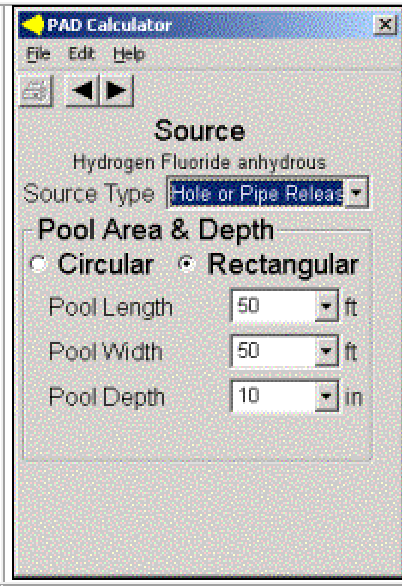
The first step is to find the chemical in the PEAC database; we chose to find the chemical by entering the name. The first information screen to be displayed is from the Chemical Properties database. As shown in the figure below, there are some interesting facts about Hydrogen Fluoride. First as most people are aware, it is a very toxic chemical with an IDLH of 30 ppm. It is not combustible. If the chemical is refrigerated and released, it will accumulate in low-lying areas. As the chemical warms up, it mixes with air and does not remain in low spots.



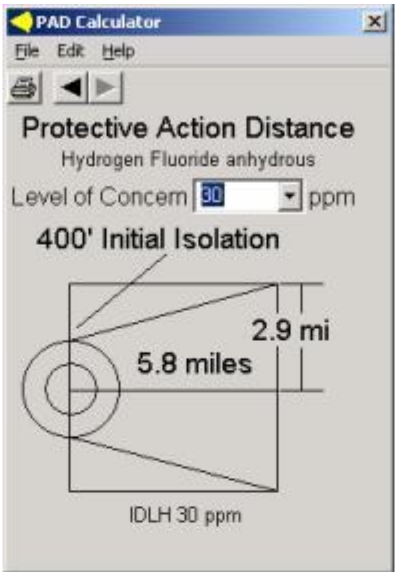
Obviously, one of the primary concerns when dealing with a response involving Hydrogen Fluoride is how far to evacuate personnel and the public to prevent exposure. The following screens demonstrate the PAD Calculator input screens to determine a PAD or Protective Action Distance based on a hypothetical incident. A refinery in Houston has an alkylation unit that uses AHF. The container is an approximate 60-ton container, say approximately 30 feet long and 10 feet in diameter and stands on end. One clear evening about mid-night in mid-August th, when winds are almost calm, a 4" line running from the bottom of the tank is accidentally severed releasing most of the AHF into a bermed 50'x50' area. Since AHF boils at ~67°F some material flashes to vapor but a large portion "auto-cools" forming a pool and starts evaporating and creating a toxic cloud. What would be a reasonable downwind evacuation distance?







Meteorology	Container	Source
It's Houston in August so we'll guess the temperature is about 85, light wind is set for 2 mph, no cloud cover is 0%, and the terrain is Urban/Forest since it's an industrial facility.	We select **Large Storage** from our list of containers and it fills in the size of the container. We can leave the percent full at 95% or calculate that with 60 tons, it is about 85% full. We have set the tank orientation as vertical.	The size of the hole/pipe or orifice was 4" but since the Hydrogen Fluoride dumps as a liquid/vapor mixture, the important concern is the size of the pool. We'll estimate the pool depth to be about 10".



The PEAC built-in dispersion model makes a calculation using the IDLH of 30 ppm as the **Level of Concern**. This results in a downwind distance of 5.8 miles. The initial isolation zone in all directions is 400' as displayed in the ERG2000. 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.

IMPORTANT - It should be noted that the Goldfish experiments conducted in 1986 at the Department of Energy's Liquefied Gaseous Fuels Spills Test Facility (now called the HAZMAT Spill Center) located on the Nevada Test Site released large volumes of AHF to study its behavior. It was anticipated that <20% of the AHF would flash to vapor and the remaining liquid would pool and evaporate over time. Instead, ~17% flashed to vapor and the majority of the remaining AHF formed a ground-hugging cloud of aerosol that started moving downwind. The resulting downwind distances that HF was detected were considerably longer that those predicted by simple evaporation and dispersion modeling. AristaTek's current PEAC model does not account for aerosol formation and the resulting longer downwind distances that toxic materials may be carried. With additional R&D by AristaTek and development of public domain data sets that document aerosol formation and dispersion in field scale experiments, this modeling capability should be made available to the first responder community.

Portions of this discussion of Anhydrous Hydrogen Fluoride were adapted from the ***International Programme on Chemical Safety (IPCS)*** located on the internet at: http://www.inchem.org/.