Let's Take a PEEK at the PEAC software

This month our example is Sarin also called GB or Isopropoxymethylphosphonyl fluoride. This is one of the G series nerve agents, it is a colorless liquid with almost no odor in pure state. It is very soluble in water. Its chemical formula is $C_4H_{10}FO_2P$, which corresponds to a molecular weight of 140.09. Sarin has a vapor density greater than air (4.9), so any vapors are going to seek low spots.

At standard conditions of sea level and 68°F, the chemical has a vapor pressure of 3 mm of Mercury, which is equivalent to 0.0039 atmospheres. With a melting point of -70°F and a boiling point of 316°F, it is typically found as a liquid. As with all the chemical warfare agents, the material is extremely toxic, it has an IDLH of 0.2 mg/m^3, which corresponds to 0.035 ppm. When compared to hazardous substances such as chlorine (IDLH=10 ppm) or Phosgene (IDLH=2 ppm), we can see that Sarin is indeed a very dangerous material and must be handled with a great deal of respect.

Sarin (GB) is not your everyday typical industrial chemical; it actually has only one purpose: to be used as a chemical warfare agent. The USA has signed the "Convention on the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction" (Chemical Warfare Convention). The treaty lists three different schedules of chemicals, with the "recognized" chemical warfare agents, e.g., Sarin, VX, Soman, Mustard, making up the Schedule 1 list. It is **illegal** to possess Sarin and/or manufacture the chemical. It would therefore be expected that Sarin would be encountered in one of two instances: (1) as a munitions device stolen from the United States Military (highly improbable since these materials and their associated devices are under strict security whether in storage or transport for destruction), or (2) in the possession of a terrorist group that has smuggled the chemical into the country or manufactured the material in a clandestine laboratory.

Hazards and protection

Storage - Keep in a cool, dry, dark location in a tightly sealed container or cylinder. Keep away from incompatible materials, ignition sources and untrained individuals. Secure and label area. Protect containers/cylinders from physical damage.

Handling - All chemicals should be considered hazardous. Avoid direct physical contact. Use appropriate, approved safety equipment. Untrained individuals should not handle this chemical or its container. Handling should occur in a chemical fume hood.

Protection - Wear appropriate protective gloves, clothing and goggles.

Respirators - Wear positive pressure self-contained breathing apparatus (SCBA).

Small spills or leaks - Rapidly hydrolyzed by dilute aqueous sodium hydroxide or sodium carbonate forming relatively non-toxic products. Water alone removes the fluorine atom producing a non-toxic acid. Decontaminants include bleach slurry, dilute alkali, hot soapy water, steam and ammonia.

Health related information

Exposure effects - Effects from vapor exposure begin to appear 30 seconds to 2 minutes after exposure. With liquids, there is almost always a latent period with no visible effects between the time of exposure and the onset of symptoms. Effects from liquid exposure begin to appear from several minutes up to 18 hours after exposure. Onset of symptoms from exposure to large amounts of liquid agent may appear as rapidly as 1 minute after exposure. Generally, the more rapid the onset of symptoms, the larger the amount of agent involved in the exposure.

Inhalation – TOXIC: inhalation, ingestion, or skin contact with material may cause severe injury or death. Effects of contact or inhalation may be delayed.

Skin - The symptoms in normal order of appearance are running nose; tightness of chest; dimness of vision and pinpointing of the eye pupils (myosis); difficulty in breathing; drooling and excessive sweating; nausea, vomiting; cramps and involuntary defecation or urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. These symptoms are followed by cessation of breathing and death.

Eyes - Constriction of the pupil, tearing, and blurred or dim vision are common clinical findings. Occasionally prolonged dilation of the pupils may occur in severe poisonings. Excessive salivation commonly occurs.

First Aid

Inhalation - Nerve agent vapors are heavier than air, which means that they will sink into low terrain and basements. Monitor ECG and adequacy of respirations and ventilation; supplemental oxygenation, frequent suctioning of secretions, endotracheal intubation, and assisted ventilation may be required.

Skin - Remove and isolate contaminated clothing and shoes. Immediately flush with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin.

Eyes - Immediately flush with running water for at least 20 minutes.

In using the PEAC application we access information for the chemical by first locating Sarin or GB 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.

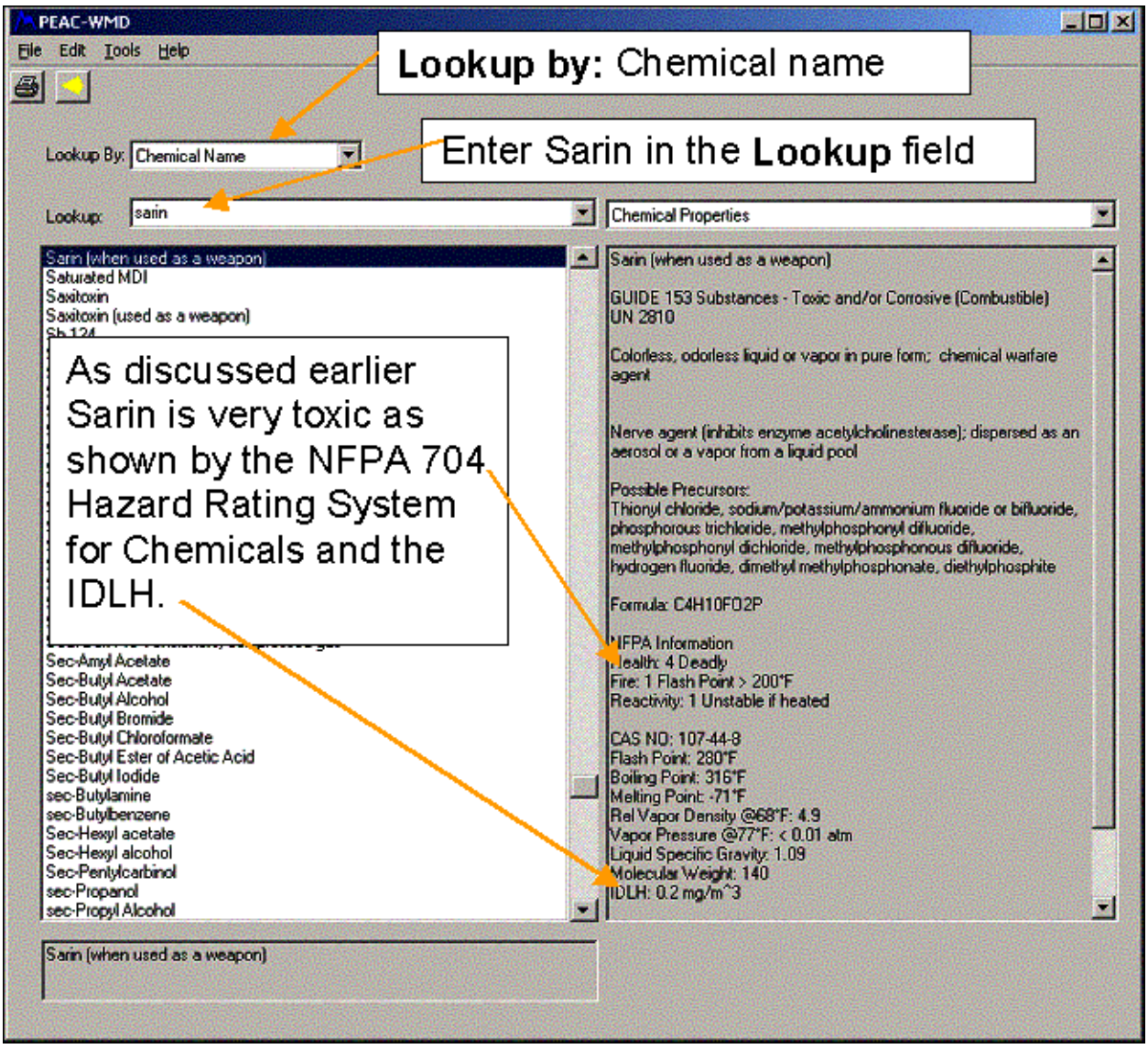


Figure 1 - Using the Lookup By: Name for Sarin using the PEAC-WMD 2002 for Windows application

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. In addition, other values are provided such as the TEELs (Temporary Emergency Exposure Limit) published by Department of Energy.

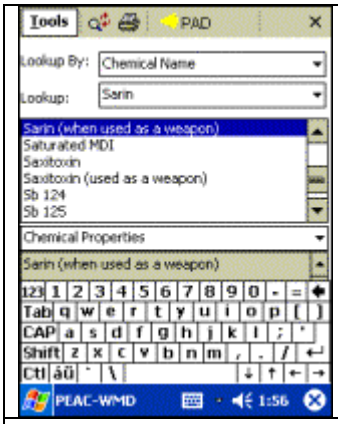


Figure 2 - Selecting Sarin using the PEAC-WMD for Pocket PC application

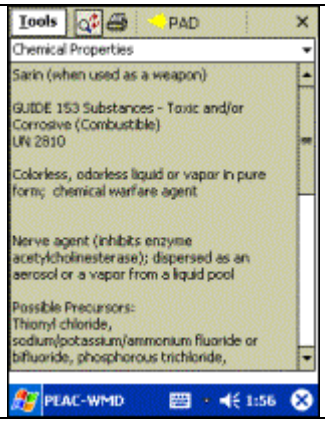


Figure 3 – The top portion of the Chemical Properties Data Display Screen

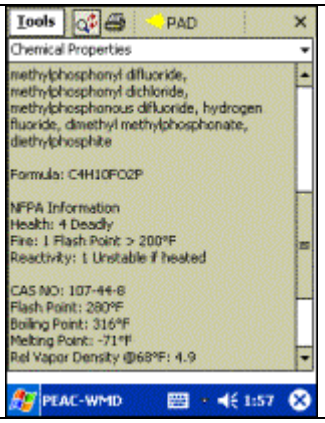


Figure 4 – The middle portion of the Chemical Properties Data Display Screen

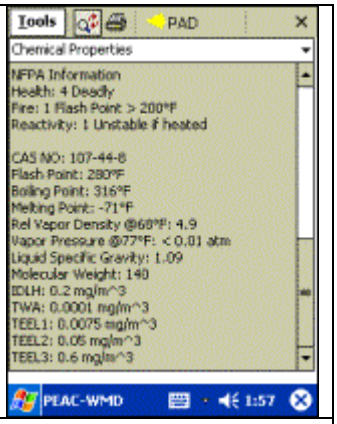


Figure 5 – The bottom portion of the Chemical Properties Data Display Screen

Additional information is available regarding how to prevent skin contact by checking the CPC listing, i.e., **Chemical Protective Clothing**.

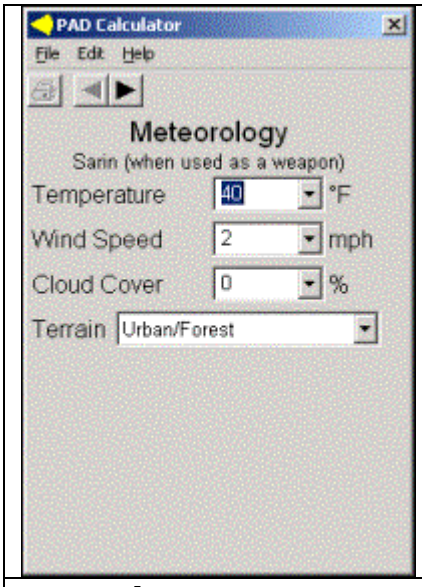
For those unfamiliar with the PEAC database and how CPC garments are displayed, there are two possible display screens for CPC garments. The **All Chemical Protective Clothing** displays all entries in the PEAC database for the specific chemical selected. The **Available Chemical Protective Clothing** selection is based on filtering the **All Chemical Protective Clothing** listing for only those manufacturers that the user has already indicated they have in their inventory. Without a great deal of explanation, there is a simple to use feature where the user indicates what manufacturers' products they have in their inventory so a "short list" can be provided rapidly to the user when on the scene.

Another benefit of using the PEAC tool is assistance in the development of an evacuation zone for those chemicals that produce a toxic vapor cloud. Sarin has a relatively low vapor pressure (3 mm Hg), so if a small amount is spilled and forms a puddle, the amount of vapor released is very minimal. Why then is there so much concern with the chemical warfare agents, e.g., Sarin, Tabun, Soman, VX, Lewisite, and Mustard Gas, all of which have very low vapor pressures at standard conditions? The answer has two parts. First, as already discussed above for Sarin, these hazardous substances are very toxic, on the order of 100 times more toxic than the most deadly industrial chemicals. Secondly, if they are released under conditions where more than just a pool or puddle is created, the effect of their low vapor pressure can be overcome. When released as a weapon, e.g., using an explosive charge or atomizer to create an aerosol or tiny droplets, the effective liquid surface area of the resulting released agent is increased several orders of magnitude. This increase in effective surface area increases not only the resulting vapor content in the air to be inhaled by victims; it also increases the opportunity for skin contact and the resulting exposure by victims.

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 scenario using Sarin as the spilled chemical we'll use Invesco Field at Mile High, the home of the Denver Broncos as the location and the time as 2:30 PM on December 22nd. A small container (estimated at 2-3

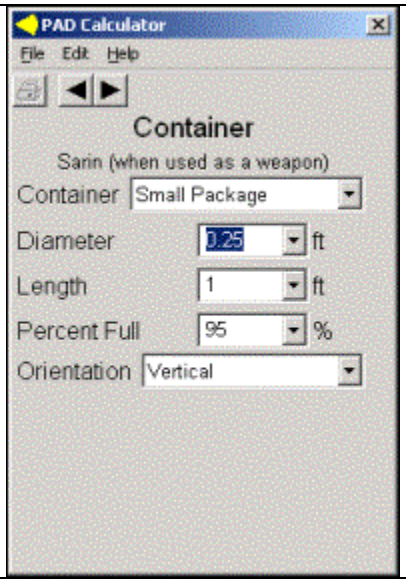
quarts in size) with Sarin is released using an explosive charge. The temperature is about 40°F, the winds are 2 mph, and it's a clear day (no clouds).

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 last screen displays the PAD based on the provided information.



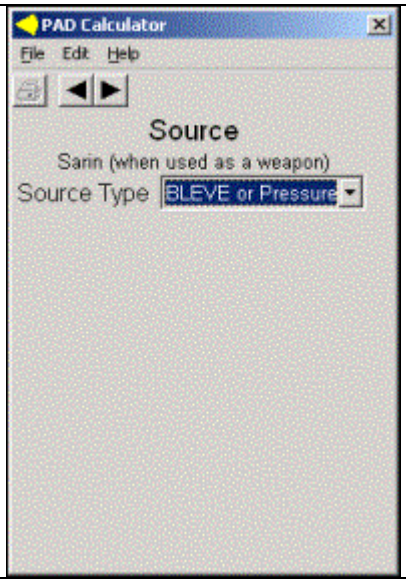
Meteorology

It's Denver in December and the temperature about 40°, 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 (stadium).



Container

We have selected from our list of container sizes the **Small Package** selection. This provides us with a default size that should get us pretty close to the actual size.



Source

Since the scenario has Sarin released with an explosive charge, we've selected a **BLEVE or Pressure Explosion** as the **Source** type of release.

Figure 6 – Calculating a PAD using the PEAC System

By pressing the right arrow at the top of the screen, the PEAC system will display a warning message as shown in Figure 7.

Figure 7 – Warning/Information message displayed if the PAD is greater than 7 miles

Clicking or tapping on the **OK** acknowledges the warning/information message and will display a Protective Action Distance (PAD) as shown in Figure 8.

Figure 8 – Default PAD for Sarin (distance in ERG2000)

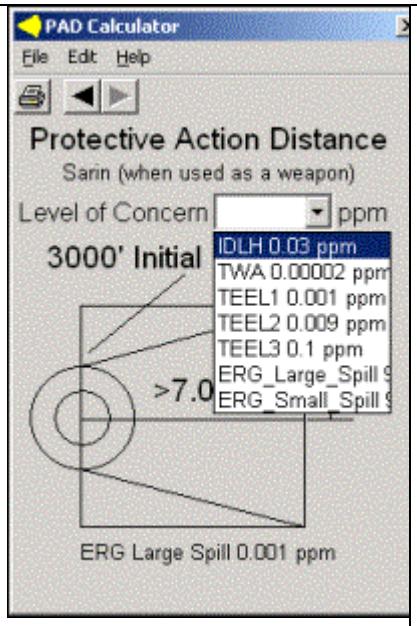


Figure 9 – Selecting a different Level of Concern

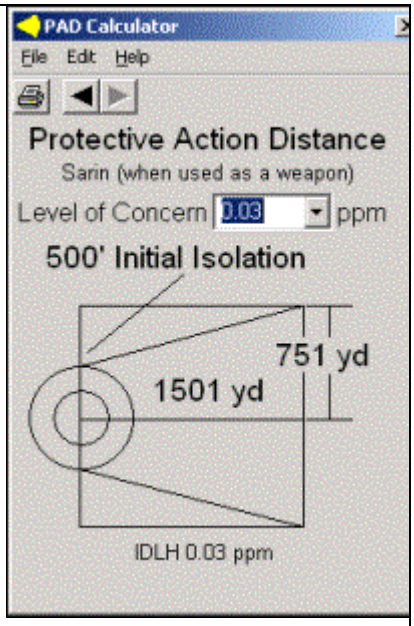


Figure 10 – The PEAC computation for PAD using the IDLH

The default PAD for Sarin is taken from the US DOT Emergency Response Guidebook for a large daytime spill. The DOT ERG2000 distance for the PAD is the initial PAD displayed whenever a chemical warfare agent that can be used as a weapon is selected. This is based on an agreement reached between AristaTek and the Technical Support Working Group (TWSG) under a project funded by TSWG and completed in 2000. It provides the responder with a basic initial guideline tied to a government agency's predicted evacuation distances. The PEAC user can still access the PEAC PAD calculator and its computed PAD value by selecting any other established toxicity value or entering a concentration value in the Level of Concern field. Figure 9 demonstrates selecting the IDLH for the PAD computation and Figure 10 displays the PAD computed by the PEAC system for our scenario for Sarin at Invesco Field at Mile High.

Portions of this discussion of Sarin were adapted from the WEB site supported by the Hardy Research Group, Department of Chemistry, The University of Akron.