Let's Take a PEEK at the PEAC Software

PEAC Example – Anhydrous Ammonia

This month our example is Anhydrous Ammonia, which has a chemical formula of NH_3. Ammonia is readily dissolved in water to form Ammonium Hydroxide a corrosive, alkaline solution at high concentrations. Ammonia is listed under more than one UN # (United Nations Number) by the US Department of Transportation: UN 2672 (between 12% and 44% aqueous solution), UN 2073 (>44% aqueous solution), UN 1005 (anhydrous gas or >50% aqueous solution).

Description: At room temperature, anhydrous ammonia is a colorless, highly irritating gas with a pungent, suffocating odor. It is lighter than air and flammable, with difficulty, at high concentrations and temperatures. It is easily compressed and forms a clear, colorless liquid under pressure. Anhydrous ammonia is hygroscopic. Ammonia dissolves readily in water to form ammonium hydroxide, an alkaline solution. The concentration of aqueous ammonia solutions for household use is typically 5% to 10% (weight:volume), but solutions for commercial use may be 25% (weight:volume) or more and are corrosive. Aqueous ammonia is commonly stored in steel drums. Anhydrous ammonia is stored and shipped in pressurized containers, fitted with pressure-relief safety devices, and bears the label "Nonflammable Compressed Gas". However, Anhydrous Ammonia can form flammable mixtures with air at certain concentrations and therefore should be treated as flammable.

Ammonia's odor threshold is sufficiently low to acutely provide adequate warning of its presence (odor threshold = 5 ppm; OSHA PEL = 50 ppm). However, ammonia causes olfactory fatigue or adaptation, making its presence difficult to detect when exposure is prolonged. Anhydrous ammonia is lighter than air at ambient temperature and will therefore rise (will not settle in low-lying areas); however, vapors from liquefied gas are initially heavier than air (because of the cold temperature) and may spread along the ground. Asphyxiation may occur in poorly ventilated or enclosed spaces.

Children exposed to the same levels of ammonia vapor as adults may receive larger dose 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 ammonia vapor found nearer to the ground.

It is a health hazard because of its toxicity and it is flammable forming mixtures with air that are flammable or explosive.

Sources/Uses: Ammonia is manufactured by reacting hydrogen with nitrogen. About 80% of the ammonia produced is used in fertilizers. It is also used as a refrigerant gas, and in the manufacture of plastics, explosives, pesticides, and other chemicals, as a corrosion inhibitor, in the purification of water supplies, as a component of household cleaners, in the pulp and paper, metallurgy, rubber, food and beverage, textile and leather industries, and in the manufacture of pharmaceuticals. Ammonia is also produced naturally from decomposition of organic matter and under unusual conditions, can reach dangerous concentrations.

Synonyms: include Ammonia gas; Ammonia, anhydrous; Anhydrous ammonia; Aromatic Ammonia, Vaporole; Nitro-Sil; and Spirit of Hartshorn.

NIOSH IDLH (immediately dangerous to life or health) = 300 ppm.

AIHA ERPG-2 (maximum airborne concentration below which it is believed that nearly all persons could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action) = 200 ppm.

Incompatibilities: Ammonia reacts with strong oxidizers, acids, halogens (including chlorine bleach), and salts of silver, zinc, copper, and other heavy metals. It is corrosive to copper and galvanized surfaces.

Acute Exposure: Anhydrous ammonia reacts with moisture in the mucous membranes to produce an alkaline solution (ammonium hydroxide). Exposure to ammonia gas or ammonium hydroxide can result in corrosive injury to the mucous membranes of the eyes, lungs, and gastrointestinal tract and to the skin due to the alkaline pH and the hygroscopic nature of ammonia.

Chronic Exposure: Repeated exposure to ammonia may cause chronic irritation of the respiratory tract. Chronic cough, asthma and lung fibrosis have been reported. Chronic irritation of the eye membranes and dermatitis have also been reported.

Anhydrous Ammonia gas has a boiling point of -28°F and a melting point of -108°F. Its molecular weight is 17, and has a relative vapor density is 0.6 (compared to air). It will rise but because it is normally stored or shipped as a compressed liquified gas when it is released it will rapidly cool and because of this initial low temperature it will seek low areas. The lower Explosive Limit (LEL) is 15%; the Upper Explosive Limit (UEL) is 28%.

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 - Keep material out of water sources and sewers. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Neutralize with vinegar or other dilute acid. Water spill: Neutralize with dilute acid. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

Stability - Reactive only under extreme conditions. Reacts vigorously with oxidizing materials.

Incompatibilities - Reacts violently or produces explosive products with fluorine, chlorine, bromine and iodine and bromine pentafluoride and chlorine trifluoride May react violently with boron halides, ethylene oxide (polymerization), perchlorates and strong oxidizing agents (chromyl chloride, chromium trioxide, chromic acid, nitric acid, hydrogen peroxide, chlorates, fluorine, nitrogen oxide, liquid oxygen).

Hazardous Decomposition - Shock-sensitive compounds are formed with mercury, silver and gold oxides.

Static Charges - Liquid ammonia can cause ignition if sprayed in a tank containing air.

Health related information

Exposure effects - Increases in blood pressure and pulse have been reported. An altered mental status (coma) may be seen, but is not characteristic unless hypoxemia occurs. Seizures may occur with extensive absorption. Decreased egg production has occurred in experimental animals. Ammonia crosses the ovine placental barrier.

Ingestion - Nausea and vomiting occur frequently following ingestion. Swelling of the lips, mouth, and larynx, and oral or esophageal burns may occur if concentrated ammonia solutions are ingested.

Inhalation - Vapors are extremely irritating and corrosive.

Skin - Concentrated ammonia may produce liquifaction necrosis and deep penetrating burns.

Eyes - A small quantity in the eye will cause permanent damage. Also frostbite. Vapor causes a burning sensation and irritation. Cold vapor may cause frostbite.

First aid

Ingestion - Seek medical assistance.

Inhalation - Move victim to fresh air. Apply artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Effects may be delayed.

Skin - Remove contaminated clothing and wash exposed area thoroughly with soap and water. A physician should examine the area if irritation or pain persists.

Eyes - In case of contact with liquefied gas, thaw frosted parts with lukewarm water immediately flush skin with running water for at least 20 minutes.

In using the PEAC application we access information for the chemical by first locating Anhydrous Ammonia 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.

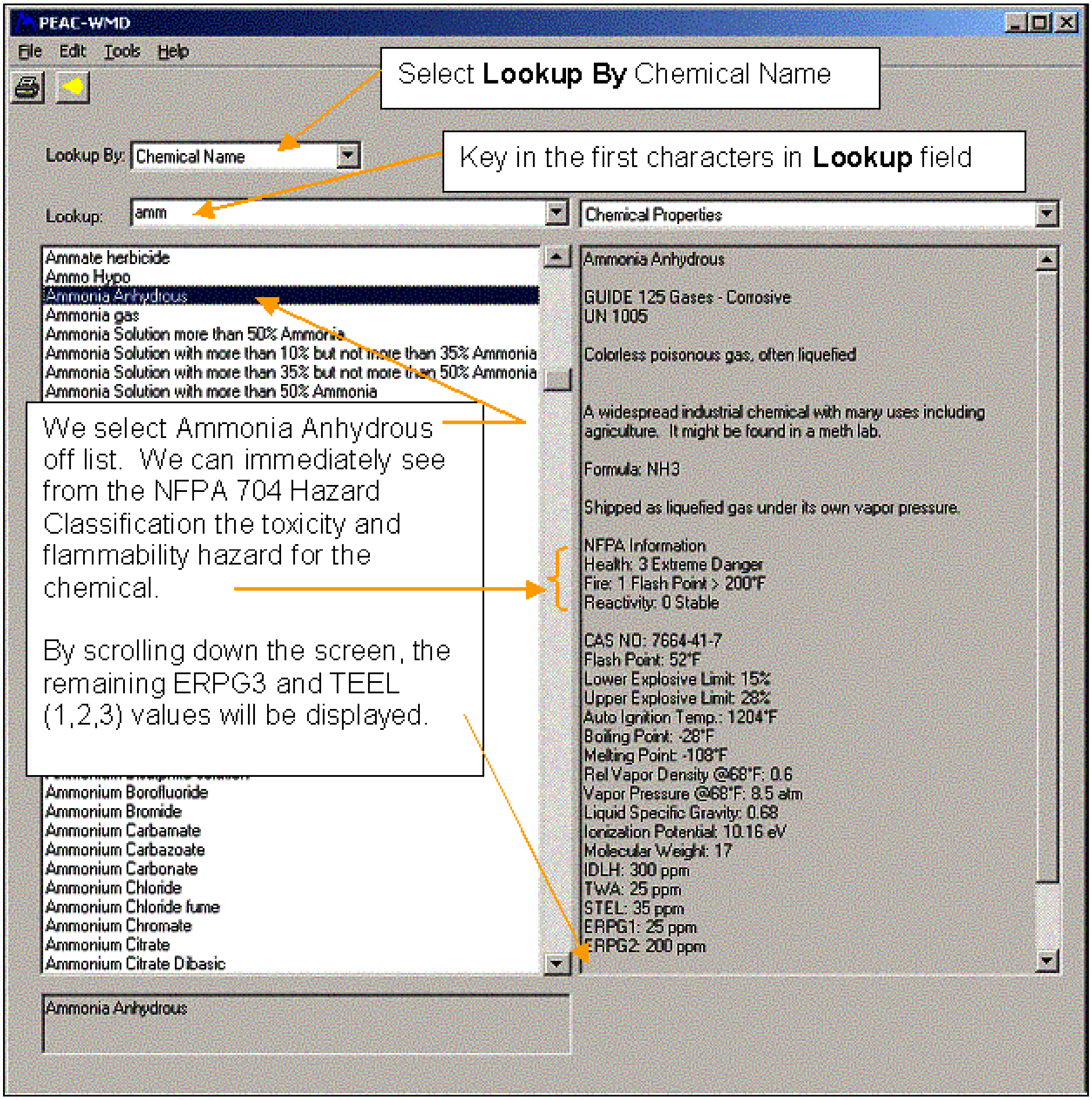


Figure 1 - Using the Lookup By: Name for Anhydrous Ammonia using the PEAC-WMD for Windows application

Review of the information displayed in the chemical properties screen whether in Figure 2 (above) or Figures 3-5 (below), show chemical properties values discussed earlier at the top of this discussion. As you can see, the published toxicity values, e.g., IDLH, ERPGs (Emergency Response Protection Guidelines) published by American Industrial Hygiene Association, 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.

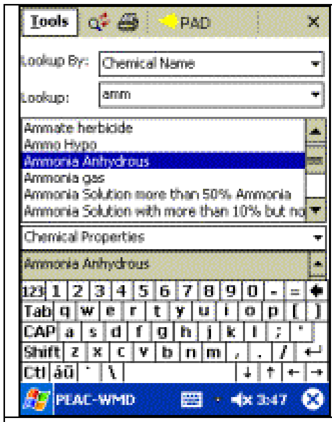


Figure 2 – Selecting Anhydrous Ammonia using the PEAC-WMD for Pocket PC application

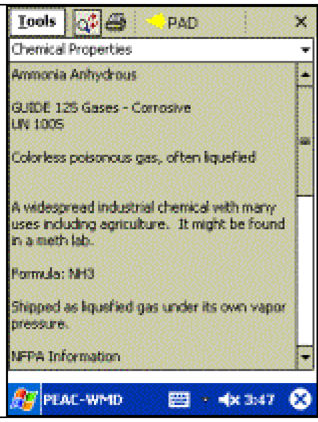


Figure 3 – The top portion of the Chemical Properties Data Display Screen

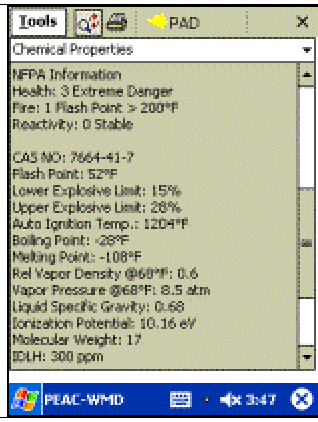


Figure 4 – The middle portion of the Chemical Properties Data Display Screen

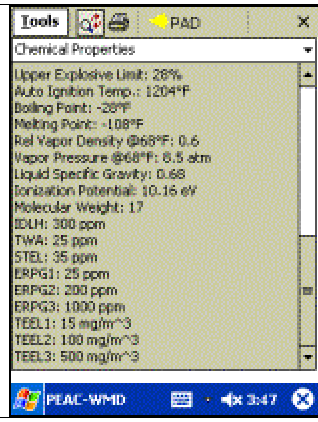


Figure 5– The bottom portion of the Chemical Properties Data Display Screen

The PEAC-WMD application provides more than just the **Chemical Properties** for the identified material, the **Chemical Properties** are just the default information screen displayed, by clicking (if running the Windows version, see Figure 6) or tapping (if running the Pocket PC version, see Figure 7) on the drop-down box where **Chemical Properties** is displayed on the screen, the user is provided with a list of other databases that provide information for the selected chemical (Anhydrous Ammonia in our current example). So the search is done once, and the user is indexed into the different databases easily and quickly.

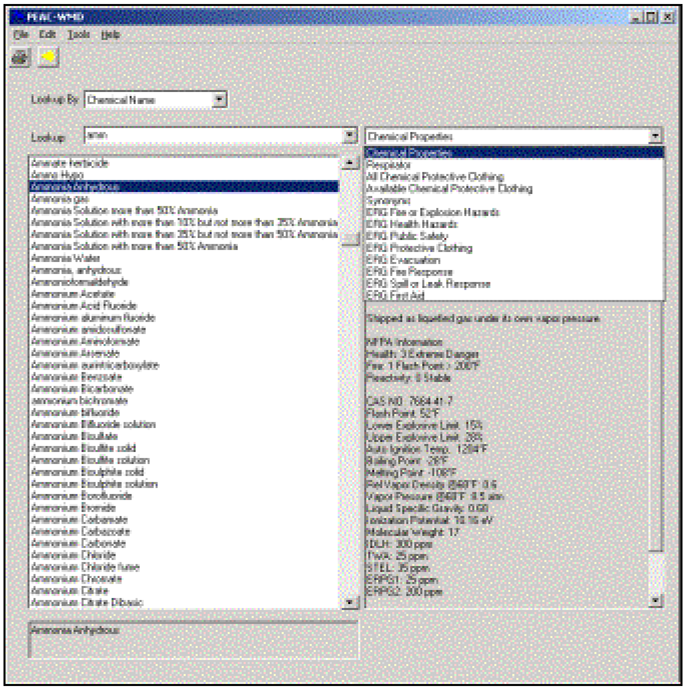


Figure 6 – Accessing other databases from the PEAC-WMD for Windows application

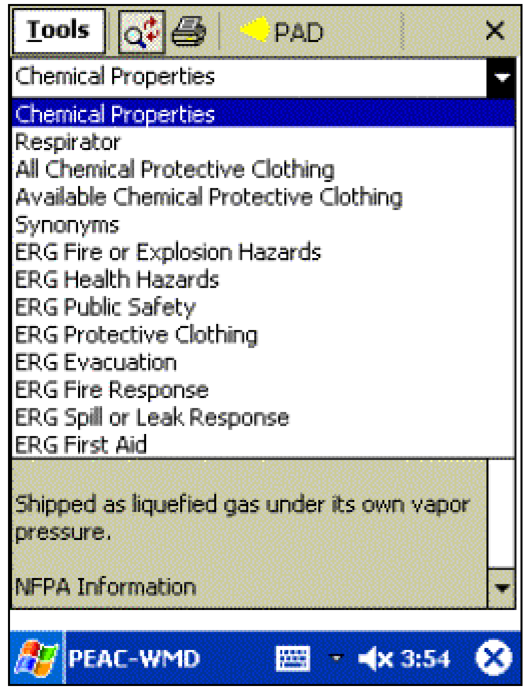
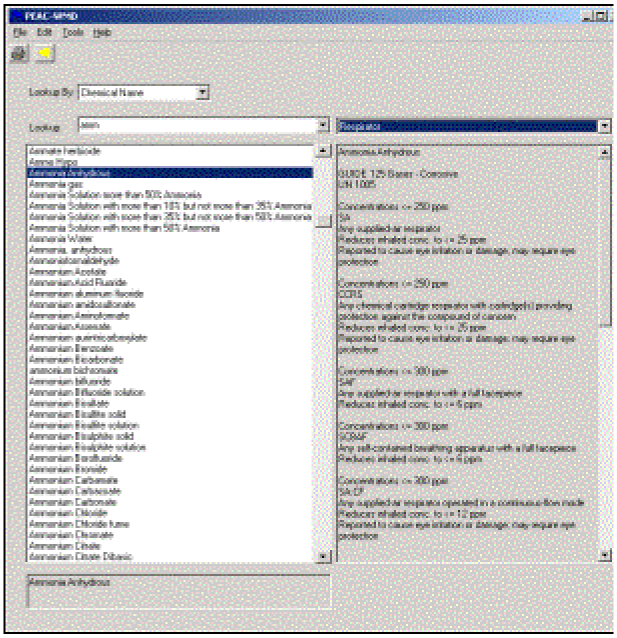


Figure 7 – Accessing other databases from the PEAC-WMD for Pocket PC application

A quick review or sampling of the type of information available in each of these screens is now provided. First is access to **Respirators Recommendations**, these are primarily taken from the NIOSH Pocket Guide and provide the user with different types of respirators for increasing concentrations. A sample of the information is provided in Figure 8. Likewise the **Chemical Protective Clothing (CPC)** database can be accessed by clicking on either the **All Chemical Protective Clothing** or the **Available Chemical Protective Clothing** selection as shown in Figure 9. The **All Chemical Protective Clothing** displays all the CPC entries in the PEAC-WMD database for the selected chemical vs. the **Available Chemical Protective Clothing** displays just those CPC entries that match the manufacturers the user has previously identified as the products the response organization typically keeps in inventory.



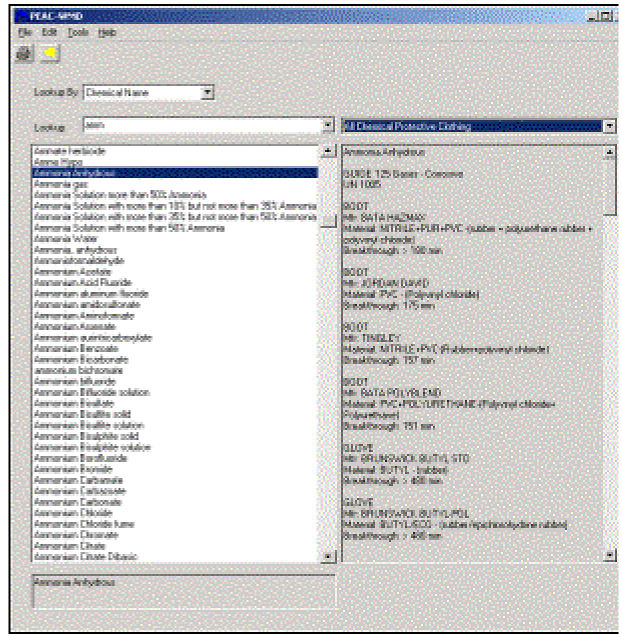
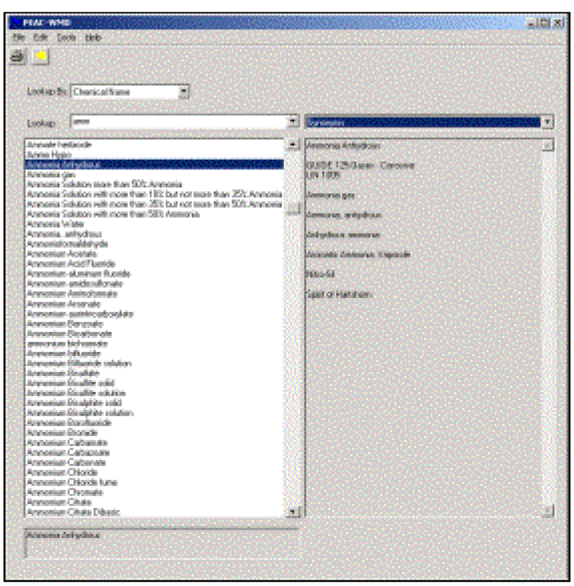


Figure 8 – Respirator Recommendations for Anhydrous Ammonia

Figure 9 – Chemical Protective Clothing for Anhydrous Ammonia

The IC (Incident Commander) will typically utilize more than a single resource for developing a response plan but sometimes the information in other resources will use a different name for the same substance. Clicking on the **Synonyms** selection will provide a quick list of other names the substance may be referenced by in other resources as shown in Figure 10. To further assist the responder in initiating the best response plan, PEAC-WMD also provides the generic guidelines found in the 'orange pages' of the DOT Emergency Response Guidebook (ERG). These are categorized into different types of procedures depending on the incident and the problem to be mitigated. An example for **Spill or Leak Response** is shown in Figure 11. >



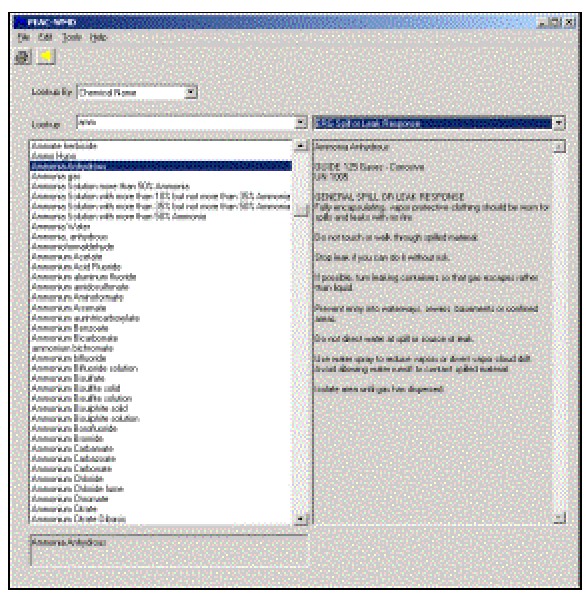


Figure 10 – Synonyms

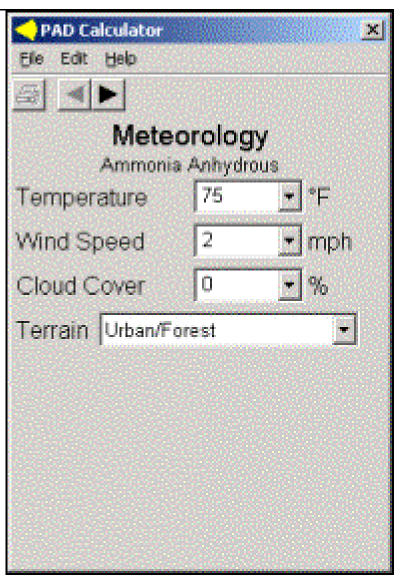
Figure 11 – ERG Spill or Leak Response

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. Depending on the incident Anhydrous Ammonia can be released from a container as either a vapor or a liquid. 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.

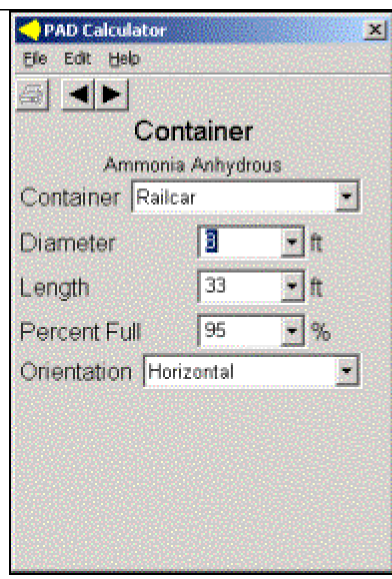
Anhydrous Ammonia is a common chemical used primarily for agriculture purposes although it is also used for refrigeration so it can be found in numerous settings. A relatively recent event involving Anhydrous Ammonia occurred in Minot, ND in January of 2002. A number of railcars derailed close to the city late at night releasing hundreds of thousands of gallon of Anhydrous Ammonia. There was only one fatality and numerous long-term health effects that are currently in the process of litigation. Considering the extreme potential of the hazard the Minot community was fortunate since the consequences could have been much more severe, although certainly those with the long-term health effects probably don't share the same perspective.

For our hypothetical scenario using Anhydrous Ammonia as the spilled chemical we'll set the location to be on the Southwest outskirts of Omaha, NE where the Union Pacific Railroad passes beneath I-80. The time is 4:00 AM on June 15th and a railcar of Anhydrous Ammonia on the UP Railroad has been derailed and breached, dumping its contents. The temperature is about 75°F, the winds are about 2 mph, and it's a clear night (no clouds). There are residential and commercial areas nearby and light traffic on the nearby highways.

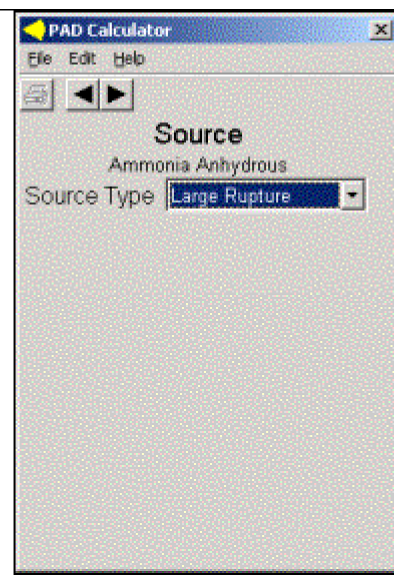
As seen at the top of the data display screens, there is a yellow icon displayed; this is the PEAC icon for notifying the user that a Protective Action Distance can be calculated. Clicking or tapping on the PAD icon will display a screen as shown in Figure 12. Following through the screens, we provide information on the Meteorology, Container Size, and Type of Release (Source). The last screen displays the PAD based on the provided information. If you decide to follow along on this example, remember to change the location to Omaha and the time to 4:00 AM, June 15th.



Meteorology



Container



Source

It’s Omaha in June and the temperature about 75°, 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.	We have selected from our list of container sizes the **Railcar** selection. This provides us with a default size that should get us pretty close to the actual size.	Since the scenario calls for a loss of contents, we’ve selected a **Large Rupture** as the **Source** type of release.

Figure 12 – Calculating a PAD using the PEAC-WMD System

By pressing the right arrow at the top of the screen, the PEAC system will display a screen as shown in Figure 13. This just reminds the user that the PEAC-WMD tool has calculated a PAD greater than 7 miles and to use the results with caution. This is primarily because wind speed and terrain can change significantly over long distances.

Figure 13 – Warning Message to use the results with caution because things vary of long distances

Once the warning message has been acknowledged by clicking or tapping on **[OK]**, the PAD calculated is displayed as shown in Figure 14. This calculates a **PAD** (Protective Action Distance) based on the default **Level of Concern** the IDLH of 300 ppm. This evacuation or standoff distance is based on the toxicity of Anhydrous Ammonia, not its flammability. Since it is flammable at certain concentrations, care needs to be given to ignition sources in the immediate vicinity of the release.

Figure 14 – Default PAD for Anhydrous Ammonia-Using the IDLH of 300 ppm

Clicking or tapping on the pop up list for the **Level of Concern** a list of published toxicity values for Anhydrous Ammonia is displayed. Clicking or tapping on the ERPG-2 value of 200 ppm (Figure 15) and will allow the PEAC tool to recalculate a PAD for the 200 ppm concentration **Level of Concern**. In our example the PAD for the 200 ppm concentration is displayed (Figure 16).

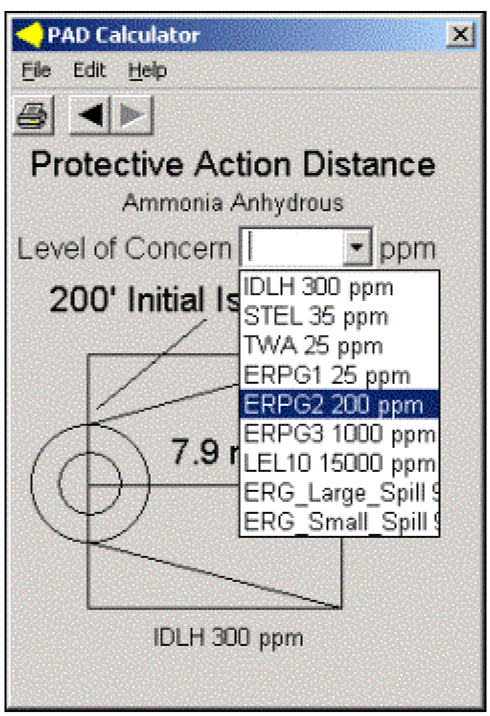


Figure 15 – Selecting another Level of Concern

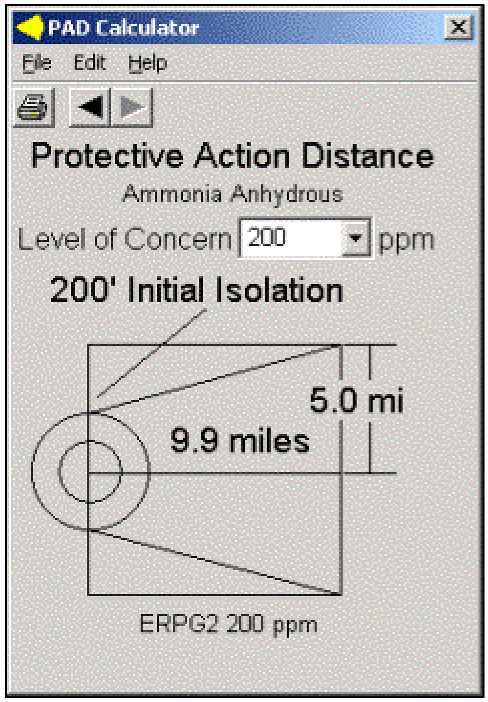


Figure 16 – PAD for ERPG-2 (200 ppm)

Portions of this discussion were adapted from the WEB site supported by the Hardy Research Group, Department of Chemistry, The University of Akron: http://ull.chemistry.uakron.edu/. Additional information was also adapted from the Agency for Toxic Substances and Disease Registry (ATSDR) Web site for Medical Management Guidelines at: http://www.atsdr.cdc.gov/.