A new capability for the PEAC-WMD™ Explosion Calculator tool

Explosives have two primary hazard components; the blast effects from the over-pressure generated by the explosive material's rapid detonation and the shrapnel or fragmentation thrown from the explosion with sufficient energy to cause bodily injury to persons in the vicinity. The PEAC-WMD **Explosion Calculator** has dealt with the over pressure component in the past and now provides algorithms to estimate the fragmentation hazard.

Background

The **Explosion Calculator** input requirements are the same as previously; the user selects which explosive substance is involved with the explosive device and a specific over-pressure value. In some cases the user may not know what explosive material is involved and a guess may have to be made. For many of the explosive substances in the PEAC-WMD database, a TNT equivalence factor is available, for those explosive substances where a TNT equivalence factor is not known; a equivalence factor of 1.0 is assumed. This equivalence factor is used in the computations for both the over-pressure or blast effects and in the fragmentation calculations.

The over-pressure value provided by the user allows the **Explosion Calculator** to compute a distance from the center of the explosion to the concentric circle where the over-pressure is at or below the over-pressure value provided. The basic assumption is that the explosion is modeled as in an open-air setting and there are no major obstacles (buildings, vehicles, or other shielding objects) between the explosion and that distance. The user should be aware that if there are obstacles between or adjacent to the explosion and the calculated distance, the over-pressure value may be different (higher or lower) depending on the arrangement or location of those obstacles. Therefore the **Explosion Calculator** is a first, best estimate as to the consequences of the explosion with respect to the blast or over-pressure effects.

AristaTek made the decision to provide the user with the option to select the over-pressure level that was of most interest to them. If personnel were in the vicinity or buildings with windows vulnerable to breakage, then a lower over-pressure level might be appropriate for developing a safe standoff distance. If personnel are inside a reinforced concrete building, a higher over-pressure might be selected as being safe.

The inclusion of the fragmentation hazard component is the recent capability that I will discuss. Most explosive devices have some fragmentation associated with them, if nothing more than the container, which surrounds the explosive material. If that is the only material involved, the fragmentation hazard maybe minimal. But usually fragmentation from an explosive device is much more lethal if the device has been constructed for illegal or criminal purposes, i.e., these devices are usually constructed to cause as many injuries as possible. These devices are commonly referred to as IED (improvised explosive devices) and have become the primary means of attack against coalition troops in the Iraq and Afghanistan combat zones. Most of the IEDs used in

these combat zones appear to be modified military munitions rigged to explode on command from remote locations when troops or civilians are nearby or by suicide bombers that carry them in vehicles, hence the name VBIED (vehicle borne improvised explosive devices).

These devices are extremely lethal because they were designed with high explosives for the explosive material and casings that are designed to fragment upon detonation into optimum killing fragments that would have sufficient energy to damage personnel near the detonation.

IEDs are found in other setting, e.g., the late June 2007 London car bombs and the frequent suicide bombers through out many parts of the world. The shrapnel used in these IEDs can be homemade, e.g., using nails, chains, ball bearings or any other material that will survive the explosion and be propelled in every directions with sufficient energy to cause injury or death to personnel in the area.

The US Navy EOD (Explosive Ordinance Disposal) teams have developed computational tools to assist them in evaluating and disposing of munitions or explosive devices. The tools have algorithms that compute safe standoff distances for over-pressure blast effects and for hazardous fragments that might be produced. Similar algorithms have now been incorporated into the PEAC® **Explosion Calculator** to provide standoff distances fro fragmentation.

Over-pressure Hazard Information

The PEAC **Explosion Calculator** calculates distances for three different over-pressure values vs. the single user specific value as with the previous version of the **Explosion Calculator**. The first distance reported and displayed on the graphic result window is the distance related to the user specified over-pressure value. As explained previously, the user selects this value based on the incident and what kind of damage threshold concerns they may have related to the incident and the surroundings.

The other two evacuation distances calculated for over-pressure are referred to as: (1) the Unintentional Detonation and (2) Intentional Detonation, both of which are Navy EOD terms. The terms are defined as follows:

1. Unintentional Detonation refers to the accidental detonation and based on a K factor of 50, which corresponds to an over-pressure value of 0.89 psig. This is part of the Navy EOD safety protocol when dealing with ordinance that may be unintentionally detonated and a safety zone around the area must be established in case there is a detonation.
2. Intentional Detonation refers to the anticipated detonation and based on a K factor of 328, which corresponds to an over-pressure value of 0.07 psig. This is part of the Navy EOD safety protocol when dealing with ordinance that will be intentionally detonated and a safety zone around the area must be established for this detonation.

Fragmentation Hazard Information

The PEAC **Explosion Calculator** automatically generates two different types of fragmentation information that are provided in the Explosion Calculator Results Report. These values are computed without the user having to select a Level of Concern since they are a function of the equivalent amount of TNT involved in the device.

The first value computed is the Hazardous Fragments distance, which corresponds to a distance based on one hazardous piece per 600 square feet with an impact energy of 58 ft-lb. This value is reported and displayed on the graphic.

The second value computed is the Maximum Fragment Throw distance, which is the maximum distance any fragment will be thrown.

Running the Explosion Calculator

To demonstrate the new **Explosion Calculator** I'll run through a fictitious scenario that involves a large suspicious suitcase found setting outside a downtown hotel in Denver, CO. The estimated volume of the suitcase is 5,000 in^3, and there is no idea what the contents might be. The assumption is that it might be an explosive device and a quick estimate needs to be developed on how far to move people back till the bomb squad arrives and make a determination.

Since there is no evidence of what might be in the suitcase, the assumption will be to use TNT as the explosive, which is selected from the list of explosives in the PEAC database (Figure 1)

If the user has a GPS installed in the platform they are using or they have available a handheld GPS, the next screen displayed will allow them to specify the geographical location (latitude and longitude) of their position plus an offset (direction and distance) to the specific incident, in this case the suitcase. For simplicity, we have left that screen out and just provided a general location (latitude and longitude) of Denver and not used the GPS options. This will still plot the stand off distances on a street map, and we can modify where the shapefile is positioned for the final location.

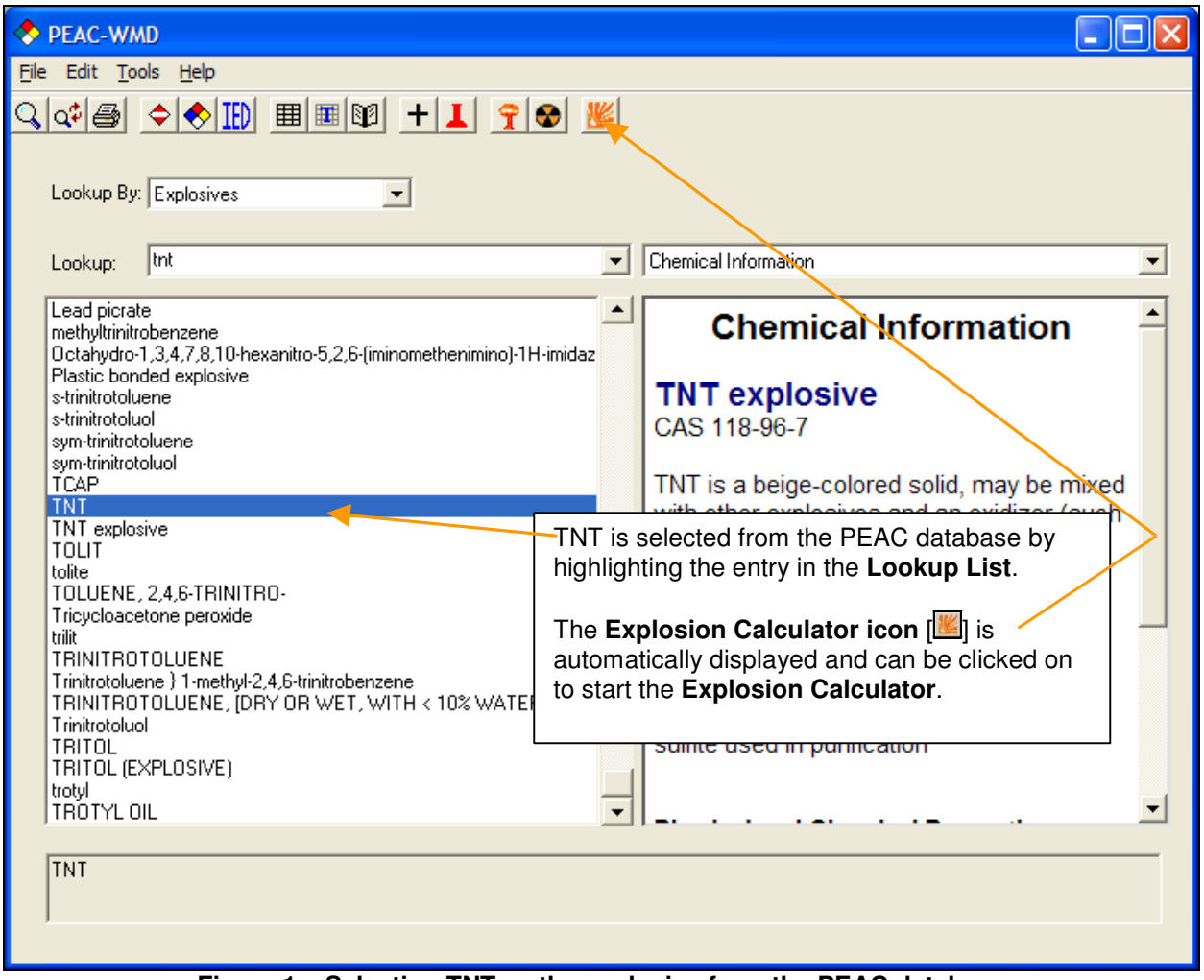

Figure 1 – Selecting TNT as the explosive from the PEAC database

As shown in Figure 1, the **Explosion Calculator icon** [ ] can be clicked on to start the **Explosion Calculator**. The first screen to appear is the warning screen that describes the limitations and basic assumptions made when running the calculator (Figure 2). The user simply clicks on [Yes] to proceed. This window is only displayed the first time the calculator is used during a session.

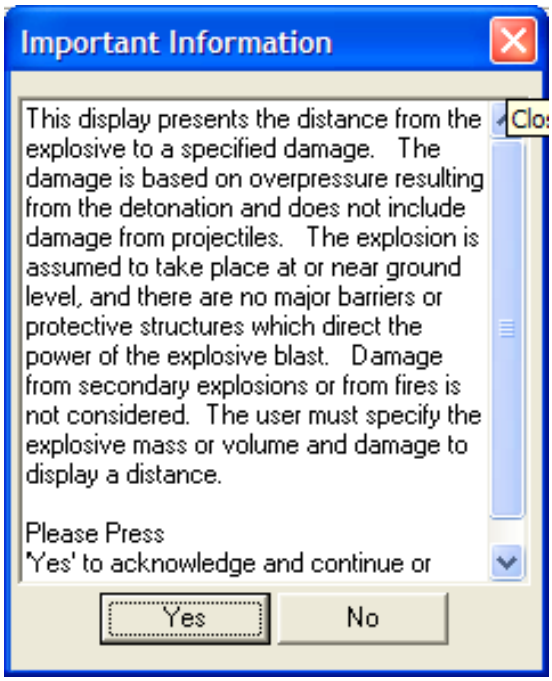

Figure 2 – The Explosion Calculator warning screen.

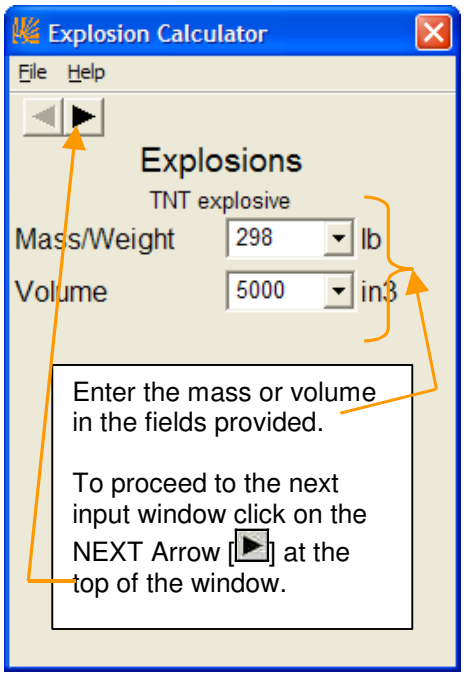

Figure 3 – Providing either the mass or volume of the package

The next window displayed is the input window for mass of explosive involved or volume. Since the PEAC database has density for TNT, we can provide the estimated volume of 5,000 in^3 and the window will fill in the corresponding mass of TNT (Figure 3).

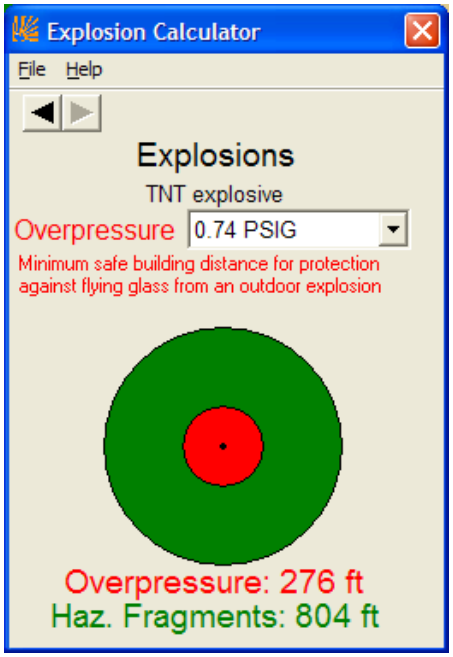

Figure 4 – Specifying the over-pressure level and results displayed

The last input window is for provision of the over-pressure level associated with certain damage threshold for which the user is primarily concerned. In our scenario, I'll specify a 0.74 psi over-pressure level that corresponds to the minimum safe building distance for protection against flying glass from an outdoor explosion (Figure 4).

In addition to this results window being displayed, a PEAC Map Tool window is displayed which displays the graphic to scale on a local street map (Figure 5).

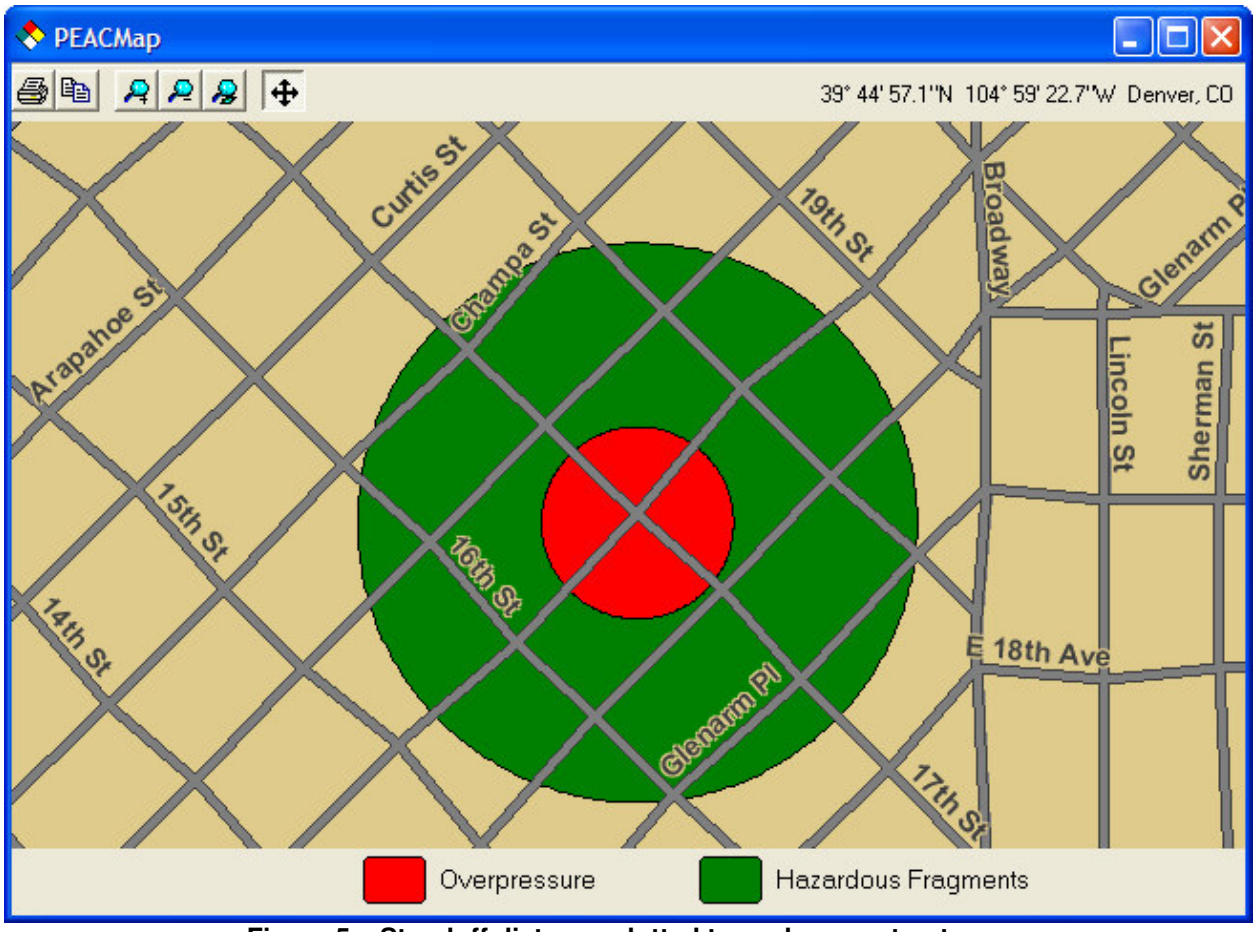

Figure 5 – Standoff distance plotted to scale on a street map

When the user is finished and exits the **Explosion Calculator** window (Figure 4) by clicking on the [X] in the upper right corner, an Explosion Calculator Results Report is automatically generated and displayed (Figure 6 and 7).

The first part of the report recaptures the input and computations made along with the map embedded in the report (Figure 6). The last portion (Figure 7) provides a table of distances to other types of infrastructure damage that may of use to the user. At the end of the report is the warning statement provided on the first screen when the application was started. The report can be printed, reviewed or recalled for later access.

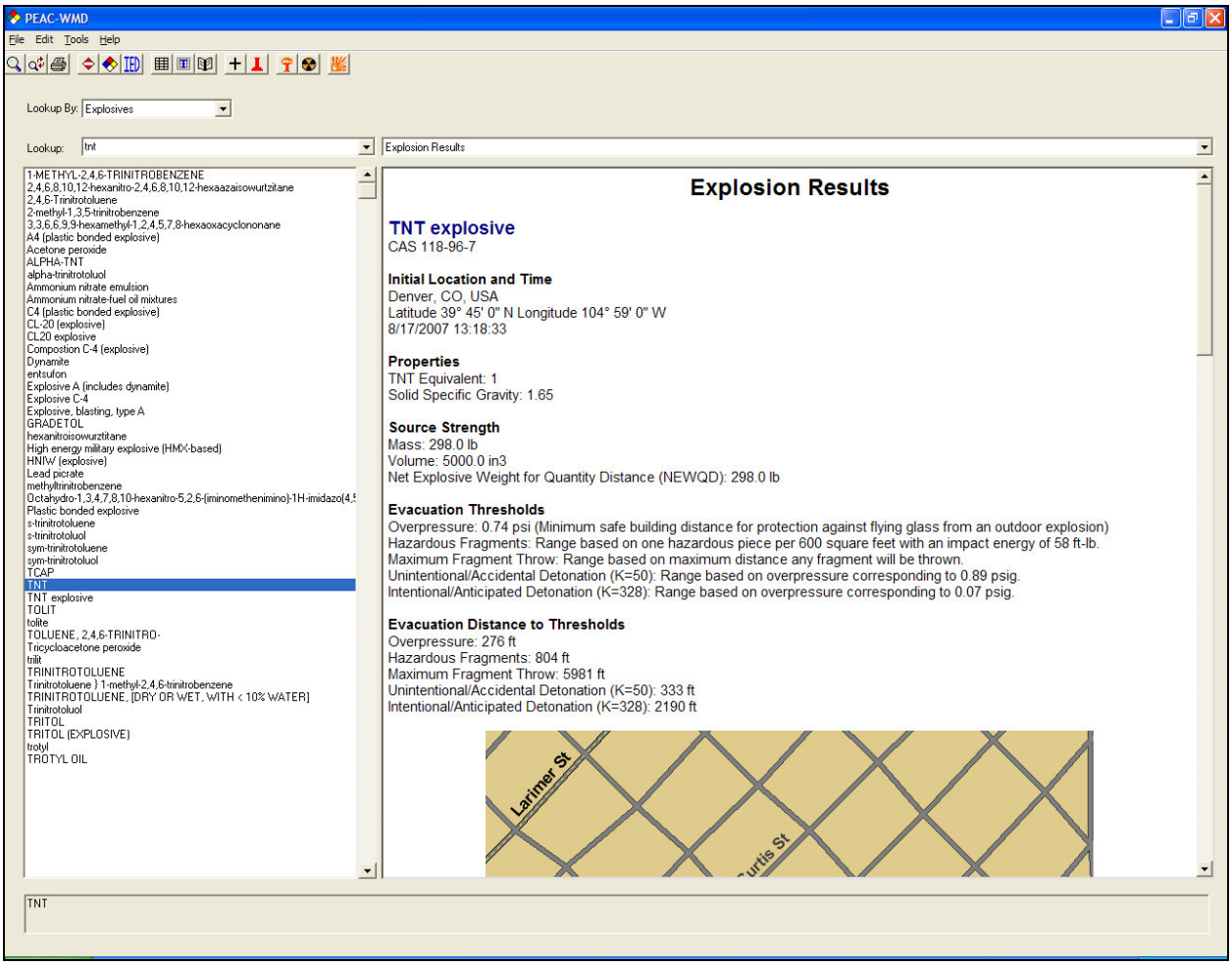

Figure 6 – Top portion of the Explosion Calculator Results Report

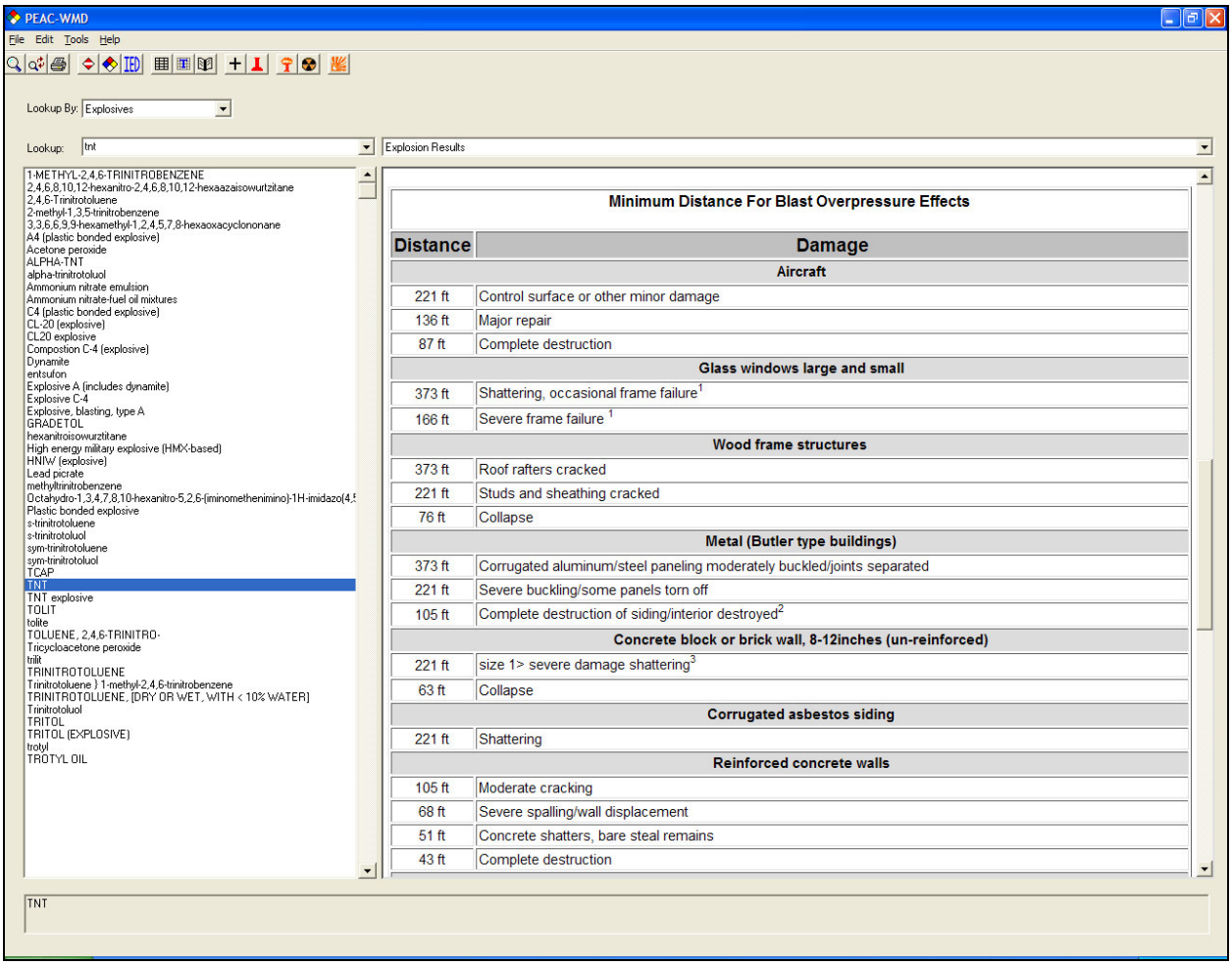

Figure 7 – The table of distances to other blast effects

If a reader needs more information on the **Explosion Calculator** or other computational tools or data contained in the PEAC tool, please give our staff a call at 877-912-2200 or email support@aristatek.com.