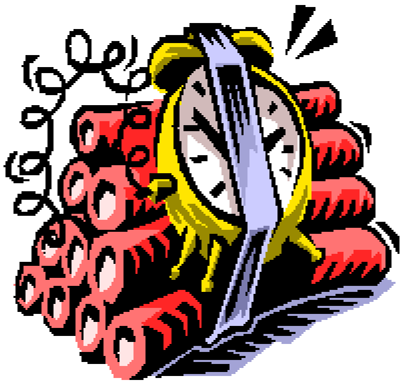
**Technical Dialogue**
TNT Equivalent

The PEAC-WMD 2002 application now provides information on explosives with one parameter being the term "TNT Equivalent." The definition provided in the Glossary of the PEAC-WMD 2002 User's Guide defines this term as follows:



*Explosive materials are rated in terms of equivalent TNT or the mass equivalent TNT. For example, a TNT equivalent of 1.2 would mean that 1 pound of the material would be equivalent to 1.2 pounds of TNT.*

This is a rather generic definition typically found in texts and references that deal with explosive materials but there is more to the concept than what is revealed in the above definition. The following discussion is an attempt to address certain aspects of explosives and why TNT Equivalency may be misused or not appropriate in all cases. Most of this discussion is probably already understood by those experts with extensive experience in working with explosives and this short treatise is really provided for those that are new to explosives and some of the basic concepts associated with their behavior.

A fundamental property of explosive materials is the fact that when they are detonated they produce a shock wave that moves through the material and eventually reaches the interface between the material and the surroundings such as the air. The energy in the form of the shock wave compresses the air and pushes it outwards creating a pressure pulse that radiates in all directions from the center of the explosive material. This pressure pulse and any fragments generated by or projectiles surrounding the explosive material are what produce the destruction created by explosive materials. The faster the shock wave moves through the explosive material, typically the higher the TNT Equivalency of the explosive material. In addition to the pressure pulse generated by the initial compressing of air near the blast is the resulting formation of a vacuum being formed which creates a negative pressure pulse that is associated with the initial positive pressure pulse.

One of the first facts that needs to be understood is why explosives are compared to TNT. Basically there is a wealth of information that has been developed on TNT and its explosive properties. Therefore, if another explosive material can be related to TNT that expresses it's explosive power to TNT on a pound per pound basis, then predictions and estimates can be made as to the behavior of this explosive material.

A second fact is that there are multiple methods used to test, evaluate or rate an explosive material. These methods do not always provide the same results for a TNT Equivalent value. The reason for this is complicated but is primarily based on the manner in which the energy is released when the explosive material is activated. A brief description of explosive materials and their composition may help to explain this point. All explosive materials are composed of two parts, an oxidizer and a fuel. Some explosive materials have these two parts contained in the same molecule while others are formulated as mixtures where the oxidizer and fuel are mixed together, such as ammonium nitrate and fuel oil. As the shock wave moves through the explosive material, chemical reactions between the oxidizer and fuel are initiated. These reactions release a large amount of energy very fast, which contribute to the propagation of the shock wave through the material until all the explosive material is consumed. The faster the shock wave moves through the material the more energy is released and the greater the explosive power of the material. When the oxidizer and the fuel are part of the same molecule, i.e., TNT, then "mixing" is most efficient and the material is called an "ideal" explosive. This is in contrast to the materials that are physically mixed, i.e., ammonium nitrate and fuel oil. These materials are called "non-ideal" explosives.

There are different processes occurring on the molecular level with "non-ideal" explosives that effect the rate at which the oxidizer and fuel make contact and react. These processes and the time required for them to occur means that not all the energy released will support the shock wave. This late arriving energy is still present, it just doesn't support the shock wave as it moves into the surrounding air, and therefore the pressure pulse does not reflect all the energy being released during the detonation.

As mentioned earlier, there are different methods used to test or measure the explosive power of different explosive materials. Some of these measure all the energy produced, both the initial shock wave or pressure pulse plus the later arriving energy. Other methods only measure the peak pressure pulse/shock wave and therefore don't provide a measurement of the late arriving energy typically exhibited by "non-ideal" explosives. Therefore, when developing the TNT Equivalent value for explosive material, different evaluation methods used can result in different TNT Equivalency values.

An additional factor must be remembered: the typical effects exhibited by "ideal" and "non-ideal" explosives are different because of the rate or velocity the shock wave moves through the explosive material. Since most of the energy is released in the pressure pulse, "ideal" explosives provide the ability to shatter the objects it is in contact with. In contrast, "non-ideal" explosives that release energy behind the shock wave tend to have more "heave" or "push" than the "ideal" explosives.

The bottom line is that a TNT Equivalent value is useful but the user should understand the implications of using such a value and develop a solid technical understanding through study, training and experience.