Explosion Consequence Modeling: Balancing Model Sophistication with Finite Resources

*Brian Holland, Stephen Koch, Qiguo Jing, Ph.D., Tiffany Gardner, and Weiping Dai, Ph.D.,
CM, P.E.
Trinity Consultants Inc.
Dallas, TX 75251, USA
(972) 661-8100

*Presenter E-mail: bholland@trinityconsultants.com

Abstract

Explosion consequence modeling (ECM) techniques vary significantly in computational complexity. At one end of the spectrum, simple distance-from-blast calculations such as TNT-equivalency and multi-energy methods have utility and are very efficient in terms of computational and labor effort, but have limitations. On the other extreme, computational fluid dynamics (CFD) tools provide a valuable refined modeling capability and are applicable to a wide range of situations, but require a level of resources for a detailed analysis that may be prohibitive for some users.

This paper will present the technological foundations of the BREEZE Explosion Damage Assessment Model (ExDAM), which seeks to fill the “sophistication gap” between purely distance-based simple models and CFD tools. The BREEZE ExDAM model builds on a basic empirical phenomenological pressure-impulse vulnerability framework in several ways:

- Explicit estimation of damage and injury effects based on the Physical Vulnerability System (PVS), a phenomenological-based ECM method developed by the DOD after WWII to predict the damage levels of nuclear explosions.
- Accounts for the role of pulse duration in determining the damage incurred by different materials.
- Models the protective shielding effects of structures/individuals on other structures/individuals using finite line doublets from potential theory.
- Able to estimate the secondary fragmentation of materials and resulting injury potential, as well as primary fragmentation from an explosive device.
- Applicable to both vapor cloud and high explosive situations.

Discussion of the model’s capabilities will include the types of situations it is and is not appropriate for, the level of effort required in comparison to other modeling approaches, and the
strengths and weaknesses of this approach. Some sample real-world applications of the model will be presented, including both a high explosive and vapor cloud explosion case.