AN OVERVIEW OF THE LOS ALAMOS PHO MITIGATION PROJECT. R.P. Weaver[1], G.R Gisler[1], and C. S. Plesko[2], Group XTD-PRI, MS T087, Los Alamos National Laboratory, Los Alamos, NM 87545, rpw@lanl.gov; grg@lanl.gov, and [2]Group XTD-NDA, MS T087, Los Alamos National Laboratory, Los Alamos, NM 87545, plesko@lanl.gov .

Introduction: The Los Alamos national Laboratory (LANL) has started a new project to investigate the wide variety of physics involved in the use of high energy density explosions (nuclear explosive sources) to mitigate the hazard from a potentially hazardous object (PHO), an asteroid or comet that is on an Earth crossing orbit. We are performing detailed radiation-hydrodynamic simulations of the interaction from a strong explosion with sample asteroid models. The purpose of these simulations is to apply modern hydrodynamic codes that have been well verified and validated (V&V) to the problem of mitigating the hazard from PHOs. The code we use for these simulations is the RAGE code from Los Alamos National Laboratory [1-6].

Initial runs were performed using a spherical object and simple (uniform) compositions. Next we ran simulations using the shape form from a known non-spherical asteroid: 25143 Itokawa. This particular asteroid is not a PHO but we use its shape to consider the influence of non-spherical objects. Explosion sources were studied from “contact/partially buried” bursts to centralized locations and for a non-spherical object from both long and short sides. The initial work was performed using 2D cylindrically symmetric simulations and simple geometries. We then performed a major fully 3D simulation. For a medium size object (~500 m) and an explosion energies ranging from 0.5 - 1 megatons, the velocities imparted to all of the PHO "rocks" in all cases turned out to be many m/s. The velocities calculated were much larger than escape velocity and would preclude re-assembly of the fragments. The dispersion of the asteroid remnants is very directional from a surface burst, with all fragments moving away from the point of the explosion. This detail can be used to time the intercept for maximum movement off the original orbit. Results from these previous studies will be summarized for background.

In the new work presented here we show a variety of parametric studies around these initial simulations. We modified the explosion energy by +/- 20% and varied the internal composition from a few large "rocks" to several hundred smaller rocks. The results of these parametric studies will be presented. We have also extended our work [6],[7] to stand-off nuclear bursts and will present the initial results for the energy deposition by a generic source into both uniform and non-uniform composition asteroid models. The goal of this new work is to obtain an "optimal stand-off" distance from detailed radiation transport-hydrodynamic simulations from generic explosion properties. This optimal height-of-burst (HOB) is obtained by carefully considering the spectral energy absorption in representative asteroid materials together with the re-emission of energy from the heated surface. The optimum HOB will depend strongly on the composition of the object, the internal structure and the opacity and cross section of the material to both x-rays and neutrons. The initial results of these two studies will also be presented.

References: [1] Gitting, Weaver et al “The RAGE radiation-hydrodynamics Code,” Comp. Sci. Disc. 1 (2008) 015005 November 21, 2008 [2] Huebner, W.F. et al, “The Engagement Space for Countermeasures Against Potentially Hazardous Objects (PHOs),” International Conference in Asteroid and Comet Hazards, 2009 held at the Russian Academy of Sciences, St. Petersburg 21-25-September 2009. [3] Gisler, Weaver, Mader, & Gittings, Two and three dimensional asteroid impact simulations, Computing in Science & Engineering, 6, 38 (2004). [4] NASA geometry courtesy of S.J. Osto et al. (2002) in Asteroids Book 3 [5] Itokawa image courtesy of JAXA: [6] Plesko, C et al "Looking Before we Leap: Recent Results from an Ongoing, Quantitative Investigation of Asteroid and Comet Impact Hazard Mitigation" Division of Planetary Sciences 2010. [7] Plesko, C et. al. "Numerical Models of Asteroid and Comet Impact Hazard Mitigation by Nuclear Stand-Off Burst." Planetary Defense Conference 2011.