MOMENTS-MATCHING METHOD FOR OPTIMAZING THE FIDELITY OF SYNERGETIC THERMAL/BLAST SIMULATION

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Combined thermal and blast simulation testing should stimulate a target so that its temperature distribution at the time of shock arrival is the same as had it been exposed to the threat environment. Then its response to the blast will include any synergistic effects due to the heating. A TRS thermal pulse does not have the temporal shape of the threat pulse, but moments-matching corrects for this. The optimal flux, fluence, and timing are selected so as to match the zeroth, first, and second temporal moments of the simulator thermal pulse to those moments of the threat pulse. Formulae for moments--matched burn parameters of rectangular and TRS-like pulses and approximate formulae for moments of the threat pulse are presented.

Nonlinear effects due to various convective and radiative cooling conditions and due to temperature-dependence of the material parameters (thermal conductivity and heat capacity) were included in our computations of target response. For thick targets, Lees' extrapolated Crank-Nicolson algorithm was used to compare the temperature profiles resulting from various pulse shapes and timings. These tests show: moments-matching performs well; matching the threat peak flux and centering on the time of the threat peak flux also works; matching the threat peak flux but delaying the pulse as near as possible to shock arrival provided very poor fidelity. Our nonlinear multilayer thin-skin model was used to compute layer temperatures for thin targets. These tests show that peak-matched pulses cannot be relied upon, since their timing must be adjusted for each specific target composition and thickness, which is impractical for real thermal testing. Moments-matching proved inadequate only for extremely thin foils (which would fail under shock loading anyway) due to severe cooling. In all realistic cases tested, moments-matched TRS pulses provided a high fidelity of stimulation at shock arrival time, independent of target structure.