HEIGHT-OF-BURST CURVES REVISITED

John M. Dewey, Alex A. van Netten
Dewey McMillin & Associates Ltd 1741 Feltham Rd, Victoria, B.C. V8N 2A4 Canada

When an explosion occurs at some height above the ground surface, it produces a spherical blast wave that interacts with the ground. The physical properties of the blast wave vary with distance from ground zero (GZ), and for a given charge size, depend on the height-of-burst (HOB). The loci of specific blast properties, such as isobars of peak hydrostatic overpressure, can be plotted for a specified charge size, in the HOB - ground range plane. These are known as height-of-burst curves.

The peak pressure immediately behind the reflected shock of a regular reflection (RR) can be calculated using the von Neumann two-shock theory. For intermediate and low shock strengths, this theory predicts a significant increase of pressure just before transition to Mach reflection (MR), and this increase has a large effect on the HOB curves, giving them pronounced "knees". This means that there are high overpressures at unexpectedly large distances from GZ, and the peak overpressures in some regions may increase rather than decrease with distance. In order to predict the hazards from a HOB explosion it is important to have trustworthy HOB curves.

The earliest HOB curves, produced using two-shock theory, showed pronounced knees for peak hydrostatic overpressure, but these were not confirmed by experimental measurements on HOB tests with nuclear and chemical explosives. The HOB curves were therefore redrawn without the knees, and questions were raised about the validity of the pressure increase predicted by theory in the region of transition from RR to MR. Pressure increases were observed in shock tube experiments involving the reflection of plane shocks from plane wedges, but not in experiments in which the shocks reflected from curved surfaces when there was a dynamic transition from RR to MR. An extensive set of experiments by Reichenbach and Kuhl [1], using 0.5 g charges detonated above plane rigid surfaces, also failed to show any pressure increase at transition.

More recently, van Netten and Dewey [2] made numerical simulations of plane shock reflections from curved surfaces, and these showed a pressure increase at transition, the magnitude of which was dependent on the resolution of the calculational grid. The pressure increases were confirmed in shock tube experiments using very small and sensitive pressure transducers mounted in a reflecting surface with a large radius of curvature. As a result of these findings, the data from HOB field experiments have been re-examined and a number of these show a pressure increase at transition. The AirBlast expert system has been used to interpolate between the experimental results so that a revised set of HOB curves can be drawn. These curves do have knees, but not as pronounced as those predicted by two-shock theory.

Reasons why the pressure increase at transition may not have been detected in some of the nuclear and chemical HOB experiments, are suggested. It is also be hypothesized that the extent of the knees in HOB curves is dependant on the size of the explosion and the relative size and sensitivity of the detection system, be it pressure transducer or loaded structure. In other words, applicable HOB curves are charge-yield dependent.