WEATHERVANE: A SINGLE-POINT MODEL FOR BLAST INJURY APPROXIMATIONS

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ABSTRACT

In studies of personnel blast vulnerability, shock diffraction induced intra-thoracic injuries have received considerable attention over the years. More specifically, quantitative relationships linking overpressure history to injury levels have been formulated. A single-numerical-gauge-point based personnel vulnerability model, called Weathervane, has been developed with the goal to efficiently and accurately assess primary blast injuries to the human thorax. It is an extension of the Axelsson-Yelverton model, which relies on a rigid instrumented cylinder, known as a Blast Test Device (BTD), to act as a thorax surrogate. The Weathervane model simplifies this approach by replacing the BTD and associated pressure gauges with a single numerical gauge that is invisible to blast flow. Instead of explicitly capturing the in situ effect of the BTD geometry, an approximate prediction of the reflected flow conditions on the BTD is made by applying gas dynamic relations to artificially reflect the peaks within the pressure history captured by the single gauge. This calculated reflected condition, along with the captured flow conditions, are used as inputs to the Axelsson model, which in turn generates an injury estimate.

In both computational and experimental assessments of blast protective measures, the inclusion of increasingly detailed geometric models, such as vehicles or structures, is becoming more common. The Weathervane approach reduces the geometric complexity of the flow field of interest significantly and allows injury estimates to be made wherever a numerical gauge is present in this flow field. Computational testing of the model included a mesh resolution study, blasts in the free field, near a wall, and near a corner. The resulting injury levels are in good agreement with those from the BTD-Axelsson model. Future refinements of the model should include the effect of blast wave clearing about the BTD.