Simulated Combined Abnormal Environment Fire Calculations for Aviation Impacts

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Abstract

Aircraft impacts at flight speeds are relevant environments for aircraft safety studies. This type of environment pertains to normal environments such as wildlife impacts and rough landings, but also the abnormal environment that has more recently been evidenced in cases such as the pentagon and world trade center events of September 11, 2001, and the FBI building impact in Austin. For more severe impacts, the environment is combined because it involves not just the structural mechanics, but also the release of the fuel and the subsequent fire. Impacts normally last on the order of milliseconds to seconds, whereas the fire dynamics may last for minutes to hours, or longer. This presents a serious challenge for physical models that employ discrete time stepping to model the dynamics with accuracy. Another challenge is that the capabilities to model the fire and structural impact are seldom found in a common simulation tool. Sandia National Labs maintains two codes under a common architecture that have been used to model the dynamics of aircraft impact and fire scenarios. Only recently have these codes been coupled directly to provide a fire prediction that is better informed on the basis of a detailed structural calculation. To enable this technology, several facilitating models are necessary, as is a methodology for determining and executing the transfer of information from the structural code to the fire code. A methodology has been developed and implemented. Previous test programs at the Sandia National Labs sled track provide unique data for the dynamic response of an aluminum tank of liquid water impacting a barricade at flight speeds. These data are used to validate the modeling effort, and suggest reasonable accuracy for the dispersion of a non-combustible fluid in an impact environment. The capability is also demonstrated with a notional impact of a fuel-filled container at flight speed. Both of these scenarios are used to evaluate numeric approximations, and help provide an understanding of the quantitative accuracy of the modeling methods.