Analysis of Boiling Liquid Expanding Vapor Cloud Explosion (BLEVE) Events at DOE Sites

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Several DOE standards and/or orders require the analysis of hypothetical releases of hazardous materials. The consequences of such releases for nonnuclear facilities are reported in safety analysis reports (SARs) (DOE Order 5481.1B), basis for interim operation (BIO) analyses (DOE Standard 3011-94), and/or emergency response planning hazard assessments (DOE Order 151.1). For flammable materials such as liquefied petroleum gas (LPG) or propane stored as pressurized liquefied materials (i.e., stored as liquids in pressurized vessels), a boiling liquid expanding vapor explosion (BLEVE) event may prove to be a credible accident scenario.

A BLEVE occurs when a vessel containing a superheated liquid (e.g., propane) catastrophically fails, usually as a result of external fire exposure (i.e., a pool fire under the vessel or a jet- or torch-type fire impinging on the vessel walls). The fire pressurizes the vessel, causing the relief valve to open, which allows the pressurized vapor to escape. As the liquid level in the vessel decreases, the flames impinge on the vessel wall above the liquid level. The vessel wall rapidly heats up due to the poor heat transfer provided by the vapor on the inner side of the vessel wall. The wall weakens and then tears, resulting in a sudden catastrophic failure of the vessel.

The consequences of a BLEVE event are (1) the overpressure blast wave that is generated as a result of the rapid expansion of the superheated liquid, (2) the fireball thermal radiation generated as a result of the rapid combustion of the released flammable material, and (3) the potential vessel fragments that may be propelled as missiles. BLEVE events have the potential for causing injury and/or facility damage at significant distances from the source of the BLEVE.

The standard techniques for evaluating the thermal radiation from BLEVE events assume that the radiant heat flux is constant over the duration of the BLEVE fireball. This assumption leads to overly conservative predictions of hazard zones for injuries (i.e., second-degree burns). More recent techniques have been developed that account for the time-dependent nature of thermal radiation generated by a BLEVE fireball, leading to a more realistic assessment of hazard zones