3.2 Flammable Cloud Formation

The only operation considered for the LNG DOT-113 tank car in this assessment is the main line movement. The DOT-113s are assumed to have an LNG capacity of 30,000 gallons, and it is expected to be handled at its boiling point temperature (i.e., saturation temperature of -203°F / -142°C) at the design pressure of 90.0 psig. The ½-inch and 2-inch hole size scenarios conservatively assumed a constant leak source at these conditions; it was assumed that the LNG was released at this same pressure and temperature for the catastrophic release scenario. For calculation of vaporization rates due to the evaporation of spilled LNG, it was assumed that the LNG was spilled on dry soil. The release elevation used in the analysis was 6-ft, and all releases were assumed to be directed horizontally to conservatively maximize the flammable vapor dispersion distance.

The release conditions, LNG vaporization, cloud formation and dispersion, and flammable cloud envelope as a function of time were calculated in PHAST Risk v6.7. PHAST Risk is a commercial software package developed and distributed by Det Norske Veritas (DNV). PHAST Risk combines a phenomenological release and consequence analysis model with a risk analysis sub-model to evaluate spills, sprays, and gas dispersions and the resulting toxic, fire, and explosion consequences on populations.

PHAST is widely used for the calculation of hazard distances from the release of several hazardous substances, including LNG. PHAST is approved by the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) for evaluating LNG release exclusion zones. The PHAST code uses the Unified Dispersion Model (UDM) as an integral calculation model to estimate the dispersion following a pressurized release or an unpressurised release. It consists of the following linked modules (as shown in Figure 6):

- Near-field jet dispersion
- Non-equilibrium droplet evaporation and rainout, touchdown
- Pool spread and vaporization
- Heavy gas dispersion
- Far field passive dispersion

The UDM allows for continuous, instantaneous, constant finite-duration and general time-varying releases. The UDM also allows for possible plume lift-off if a grounded plume becomes buoyant. The UDM has been validated extensively with experimental data and is the subject of