the PHAST Risk delayed ignition probability model considers only the potential for ignition due to the surrounding population. The default PHAST Risk ω for ignition due to population used in this analysis was 1.68×10^{-4}/person (for outdoor populations only). Thus, the ignition effectiveness factor, ω, in the QRA is dependent on the population specified in the domain. The probability of delayed ignition increases with increasing population which then increases the overall risk as population increases.

3.4 Flammable Effects on a Population

The flammable effects resulting from a release of LNG include pool fires, jet fires, flash fires, and BLEVEs. The probability that an exposed population will suffer a fatality due to exposure to a flammable effect depends on the extent of exposure and protection of the population (indoor versus outdoor). For the IR calculations, PHAST Risk assumes that the entire population is outdoors. For the SR calculations, the standard model assumes that 90% of the population is indoors and 10% is outdoors. All calculations assume that people are at ground level, so the ground level effect zones are used in calculating consequence outcomes.

The flammable effects and fatality consequences are calculated in PHAST Risk utilizing a grid cell system to calculate fatalities in effect zones, and the probability of fatality as a function of distance is calculated. As previously described, the model domain is split into grid cells, and the size of the cells is an integer value dependent on the size of the model domain. The effect zones for fireballs, jet fires, and pool fires are modeled as ellipses. The shape of the vapor cloud determined from the dispersion calculations defines the shape of the flash fire. For grid cells where the flammable effect only overlaps a portion of the cell, the fraction of overlap is considered in calculating the fatality probability.

The flammable effect in a grid is then compared to the populations in that grid to determine the probability and number of expected fatalities. For the IR calculations, the model only considers whether a person is located in a grid cell, which is always assumed to be yes. To obtain the SR outputs, the flammable effect consequences are integrated by the number of people present in the grid cell (defined by the population density and size of the grid cell) to obtain the number of expected fatalities.

The flammable effect consequence methods used in PHAST Risk are consistent with the guidelines published in the Dutch Green Book[40] (and applied to QRA in the Dutch Purple Book[41]).[42] The Probit Method, which is dependent on radiation level and exposure time, is used

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[40] Chapter 1, Damage Caused by Heat Radiation, in *Methods for the Determination of Possible Damage* (Dutch Green Book), Publication Series on Dangerous Substances, Ministerie van Verkeer en Waterstaat (1992).

[41] Chapter 5, Modeling Exposure and Damage, in *Guideline for Quantitative Risk Assessment* (Dutch Purple Book), Publication Series on Dangerous Substances, Ministerie van Verkeer en Waterstaat (2005).

[42] PHAST Risk Technical Documentation, "MPACT Theory," DNV Software, pages 66-94 (2010).