3. Formation of flammable atmosphere—following an LOC, the LNG must vaporize and the flammable vapors must mix with air in the appropriate concentrations. The size and downwind distance of the flammable clouds are calculated in PHAST Risk.
4. Ignition of flammable atmosphere—the flammable atmosphere must be ignited in order for a fire or explosion to occur. The ignition probabilities, as a function of time, distance, and population as the flammable cloud is formed and dispersed, are calculated in PHAST Risk.
5. Exposure to a population—the populations that may be affected by an incident involving LNG are estimated using U.S. Census data, and the population data is input into PHAST Risk for calculation of the IR[13] and SR. The potential for a fatality, given a specific thermal event (i.e. flash fire, pool fire, jet fire, or explosion), is calculated in PHAST Risk.

Figure 1 provides a representative event tree starting with the initiating event (train accident) carried through to a flammable event to illustrate the general probabilistic calculation approach for each type of outcome.[14] A detailed discussion of these key QRA parameters, as considered and evaluated for the proposed ETS shipping of DOT-113 project, is provided in subsequent sections.

Given the nature of the project, several variables were approximated or estimated to provide this QRA. For example, accident rates involving LNG DOT-113 tank cars via rail in the US are not available. Currently, the Federal Railroad Administration (FRA) has not codified guidelines for acceptable risk to individuals or society. Thus, the quantitative risk criteria for stationary LNG facilities provided by NFPA 59A were used to establish risk levels of potential concern. The representation of NFPA 59A risk criteria for IR in this report has been done for the purposes of comparing the transportation risk to a set of related criteria and may not be appropriate or directly applicable for assessing acceptability of transportation risk.

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[13] Note that IR assumes continuous potential exposure of personnel or the public; thus, it is not directly related to population like SR. However, population density is an input to the probability of the ignition model employed in the software; hence, IR is a function of population.

[14] The example event tree depicts an initiating event and event tree probabilities for the transport of LNG DOT-113s along the mainline track, for train speeds less than 25 mph. See the following sections for more details. The event tree for mainline track with train speeds 25-50 mph can be found in Appendix B.