

explosions, and to calculate the resulting Individual Risk (IR) and Societal Risk (SR) for the mainline. Typically, stakeholders (e.g., government agencies, investors, communities) set a threshold risk level that is deemed acceptable. This is called quantitative risk criteria and may vary from region to region and depends upon the type of facility or transportation activity. Currently, the U.S. Department of Transportation (DOT) Federal Railroad Administration (FRA) has not codified quantitative risk criteria for LNG hazardous materials transportation scenarios. Additionally, QRA analyses are not common regulatory requirements in the U.S. and no broadly-accepted risk criteria are employed by domestic communities or industries.

The quantitative risk criteria that may be considered by stakeholders for evaluating the IR presented in this report were referenced to those presented for stationary LNG plants in NFPA 59A *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2016 edition. The stationary LNG plant risk criteria are not directly applicable to rail movement of LNG, so international methods for adopting stationary facility risk criteria to transport risk are discussed for reference. The risk criteria presented in NFPA 59A are summarized in the following table.

**Table E1. Summary of IR quantitative risk criteria developed from NFPA 59A (2016) and referenced in this report.**

IR Criteria (yr <sup>-1</sup> )	Not Permitted
Zone 1: IR ≥ 10 <sup>-5</sup>	Residential, office, and retail
Zone 2: 10 <sup>-6</sup> ≤ IR < 10 <sup>-5</sup>	Shopping centers, large-scale retail outlets, restaurants
Zone 3: 3 × 10 <sup>-7</sup> ≤ IR < 10 <sup>-6</sup>	Sensitive Targets: churches, schools, hospitals, major public assembly areas

## E.2 Findings

The QRA generated several findings regarding shipping LNG DOT-113 tank cars on the example route. The analysis required development of an accident model to calculate the release scenarios, which was then used to calculate the risk for the LNG DOT-113 movement along the route. The Societal Risk (SR) and Individual Risk (IR) for the mainline transportation were evaluated on a per-route mile basis as a function of train speed and population density. Finally, the Societal Risk was calculated for an example route using the per-route mile segments.

### E.2.1 Accident Model

An accident model was developed as part of the QRA to address mainline movements of LNG DOT-113 tank cars in unit trains. For train movements, loss of containment of LNG from a DOT-113 was assumed to occur as the result of a derailment accident. LNG was assumed to be the only hazardous material involved in any incident. FRA data and Pipelines and Hazardous