condition where an LOC of an LNG ISO may occur. Therefore, it was assumed that only train accidents leading to the derailment of cars could potentially result in an LOC (as discussed in more detail in Section 3.1.3). The 21-year accident data was analyzed to determine the probability that a train accident will lead to a derailment of any of the rail cars for one of three cases: (1) yard movement, (2) mainline movement with train speeds from 25 mph and 60 mph, and (3) mainline movement with train speeds less than 25 mph.[25] As listed in Table 5, the calculated results indicate that in 71.3% of yard train accidents, the accident will lead to derailment of at least one rail car. The other accident-leading-to-derailment probabilities were found to be 68.8% for mainline movement with train speeds less than 25 mph and 56.0% for mainline movement with train speeds between 25 mph and 60 mph. These are the probabilities of at least one car being derailed in a train accident; however, there is a different probability that the derailment will involve LNG ISOs. The calculation of the probability that an accident-leading-to-derailment involves LNG ISOs is addressed in the next section.

3.1.3 Derailment Probability for LNG ISO-Containing Well Cars

Not all accidents-leading-to-derailment will involve an LNG ISO car, as most of the cars in an FECR train are expected to contain freight other than an LNG ISO. Several factors are expected to affect the likelihood than an LNG ISO car is derailed including: (1) the position of the LNG ISO car(s) within the train and (2) the number of LNG ISOs grouped together. These two factors were explored in estimating the derailment probability for LNG ISO cars. First, the historical FRA accident data was analyzed to develop a model for estimating the probability of derailment of an individual car versus its position in the train. This model was then applied to trains containing LNG ISOs in a parametric study to evaluate various train configurations.

3.1.3.1 Probability of Derailment and Number of Cars Derailed

The probability of derailment for one or more LNG ISO cars is dependent on the position of the first car derailed in the train, the average number of cars derailed during an accident, and the location of LNG ISOs in the train. These parameters are expected to be affected by both the type of train movement (yard versus mainline) and the train speed, which were explored here using the FRA 21-year accident data.

The FRA 21-year accident data from 1995-2015 was first filtered to include only those accidents for Class 1 and Class 2 railroads. The resulting Class 1 and 2 railroad accidents were then subdivided into either yard accidents or mainline accidents. The mainline accidents were then further split into either low speed mainline accidents with train speeds less than 25 mph or high speed mainline accidents with train speeds inclusive between 25 mph and 60 mph. Next,

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[25] Note that 25 mph data was included in the high speed mainline accident rates, however the 25 mph data is shown separately in Table 5 to illustrate that including the 25 mph data in the low speed (i.e. < 25 mph) derailment probabilities would be expected to result in a negligible change to the resulting risk profiles.