

Quantitative Risk Analysis (QRA) for LNG Facility Siting

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What is Siting?

- Design, location, and construction of an LNG plant such that the *public* is protected
- 49 CFR 193, Subpart B (IBR: NFPA 59A, Chapter 2)
 - Site selection
 - Equipment spacing
 - Exclusion Zones: vapor dispersion, fire radiation

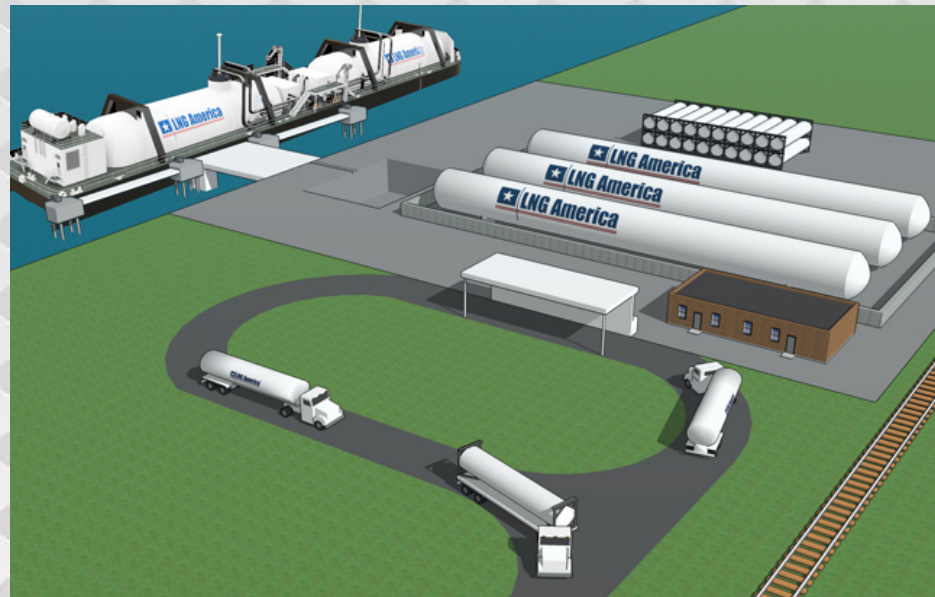
What is QRA?

- Quantitative Risk Analysis
- Quantitative means numerical, comprehensive
- Risk = consequence x probability x *vulnerability*
 - Risk to the public because of the LNG plant

Why Risk-Based Siting?

- Proposed changes to 49 U.S. Code § 60103 –
(Standards for liquefied natural gas pipeline facilities)
Includes language to consider risk-based siting
for small-scale LNG facilities
- Requests from operators
- Need to adapt to changing LNG industry

Why Risk-Based Siting?



Why Risk-Based Siting?



Why Risk-Based Siting?

- Internationally accepted methodology for site location studies and other evaluations
- Provides compliance with corporate and/or regulatory standards
- Captures all hazards at the LNG plant

QRA Benefits

- QRA considers all possible release sources – LNG, refrigerants, natural gas, condensate/NGL
- QRA considers all hazards: flammable vapor cloud dispersion, fire radiation, explosion, toxic vapor clouds, etc.

QRA Benefits

- QRA reflects the size and layout of the plant
- QRA fully represents the failure rates of the various components in an LNG plant
- QRA probabilistically represents the local weather conditions (wind speed/direction, stability)

How Could We Implement QRA?

- Develop regulatory language for the structure and methodology of a QRA for plant siting
- Capture many of requirements of 49 CFR 193, NFPA 59A, and current expectations for siting evaluations (PHMSA FAQ)
- NFPA 59A-2016 Chapter 15?

NFPA 59A (2016) – Chapter 15

- *Performance (Risk Assessment) Based LNG Plant Siting*
- **15.1.1** *This chapter includes the calculation of risks to persons outside the boundary of a liquefied natural gas (LNG) plant, arising from potential releases of LNG and other hazardous substances stored, transferred, or handled in the plant.*
- **15.1.2** *Where approved, the requirements of this chapter shall be complied with, in LNG facility siting and layout analysis, as an alternative to the assessments required in Chapter 5 of this code.*

Does Chapter 15 Properly Describe QRA?

- Hazard Identification
- Frequency Analysis
- Consequence Analysis
- Risk Mapping
- Risk Assessment
- Partial
- Partial
- Yes...but
- Yes...but
- Yes

59A: Hazard Identification

- Includes releases from specific equipment
- Includes design spills + “credible” large events
- Includes input from PHA or HAZID studies
- No requirement to evaluate various release sizes (or hole sizes)

59A: Frequency Analysis

- Table 15.6.1 “Example Component Failure Database” shall be used
- Only 12 failure frequency values are listed (ruptures and catastrophic incidents)
- Consideration of site-specific modifications to Table 15.6.1 also required (?)

59A: Consequence Analysis

- Release material behavior; calculate release rates or source terms; consider various hazards
- Consider topographic features, ignition sources
- Use of validated models

59A: Consequence Endpoints

- Radiation: persons outside, persons in building, steel impacts, concrete impacts, wood ignition
- Explosion overpressure: windows, doors, buildings, human injury
- → Inconsistent set of hazard endpoints

59A: Risk Mapping

- Combination of consequences and probabilities
- Risk contours: location-specific individual risk (LSIR)
- F-N curves: societal risk
- Consideration of uncertainty?
- Risk onsite & offsite, persons & property

59A: Risk Assessment (Criteria)

- Comparison of calculated LSIR to criteria
 - $IR > 10^{-5}$: no residential, office, retail
 - $IR > 10^{-6}$: no shopping centers, restaurants, large retail
 - $IR > 3 \times 10^{-7}$: no churches, schools, hospitals, etc.
- Comparison with other human activities
- Comparison of calculations to societal risk criteria

59A: Does Some Things Well

- Introduction of QRA-based siting
- QRA basics are addressed
- Good approach to consequence models
- Provides good risk acceptability criteria for the risk assessment

59A: Methodology Needs Improvement

- Better hazard identification requirements
- Improved and expanded failure frequency data
- Consistent set of consequence endpoints
- Clarification in scope for calculation of risk to offsite persons only

What's Next?

- Evaluate need for risk-based siting
- Evaluate feasibility of risk-based siting
- Adopt NFPA 59A Chapter 15, *OR* write regulatory language for risk-based siting?
- Apply to small, or all, facilities?