Comparison of Exclusion Zone Calculations And Vapor Dispersion Modeling Tools

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Public Abstract

- This project will compare the various design spill selection methodologies and compare the exclusion zone results for various facility types. The comparison will include a review of the DEGADIS, Phast, and FLACS modeling tools currently approved by DOT PHMSA to perform dispersion modeling to calculate vapor dispersion exclusion zones.
- The project will also evaluate several design spill selection methodologies and apply them to export, peak-shaving, bunkering and fuel loading Liquefied Natural Gas (LNG) plants. This project will calculate vapor dispersion exclusion zones with each associated design spill. As a result, this project will help DOT PHMSA better define the approach for determining vapor dispersion exclusion zone distances.

Background

- Each LNG facility under the scope of 49 CFR Part 193 is required to calculate vapor dispersion exclusion zones in accordance with NFPA 59A (2001 edition), as incorporated by reference.
- Neither 49 CFR Part 193, NFPA 59A (2001 edition) define a “single accidental leakage source” that is required to calculate design spills.
- FERC developed a Failure Rate Table which can be applied to facility piping and equipment which was adopted by DOT PHMSA.
- DOT PHMSA has allowed passive mitigation to reduce the size of vapor dispersion exclusion zones

Approach

- CH·IV will follow the same process project developers are required to follow to calculate “single accidental leakage sources”.
  - Task 1: A generic design basis and plot plan will be created for each facility type
  - Task 2: Failure Criteria will be defined based on current DOT PHMSA requirements
  - Task 3: Failure Criteria will be applied to the generic design basis and plot plan to identify the “single accidental leakage sources” for each facility type. The differences in methodologies and calculation of “single accidental leakage sources will be discussed
  - Task 4: Unmitigated vapor dispersion exclusion zones will be calculated for the “single accidental leakage sources” for each facility type using Phast, FLACS, and DEGADIS. Sensitivity modeling and mitigation features will then be applied and [illegible] re-model vapor dispersion exclusion zones to identify the difference in results

Task 1: Design Basis and Plot Plans

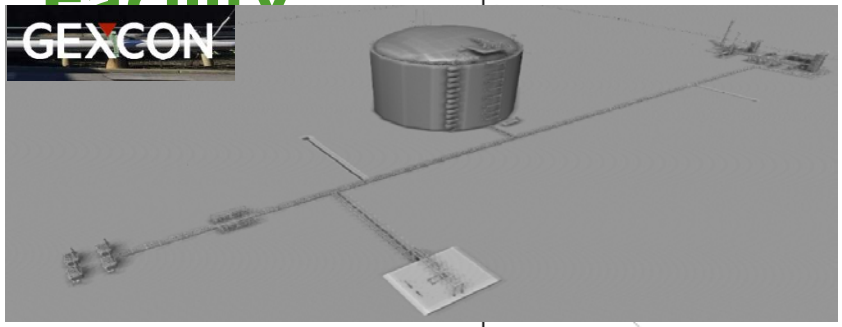
- CH·IV performed research on the typical configuration for LNG export, peak-shaving, bunkering and fuel loading facilities. This research looked at overall facility acreage, liquefaction configuration, liquefaction train size, piping configurations, LNG storage tank size and layout, marine piping configurations, truck loading configurations, and other aspects important to LNG facility plot plan developments.
- Based on that research and the typical factors and design elements which led to bounding scenarios for vapor dispersion, generic design basis and plot plans were developed for each facility type.
- GexCon built 3D models of each facility type based on the plot plan and generic design basis

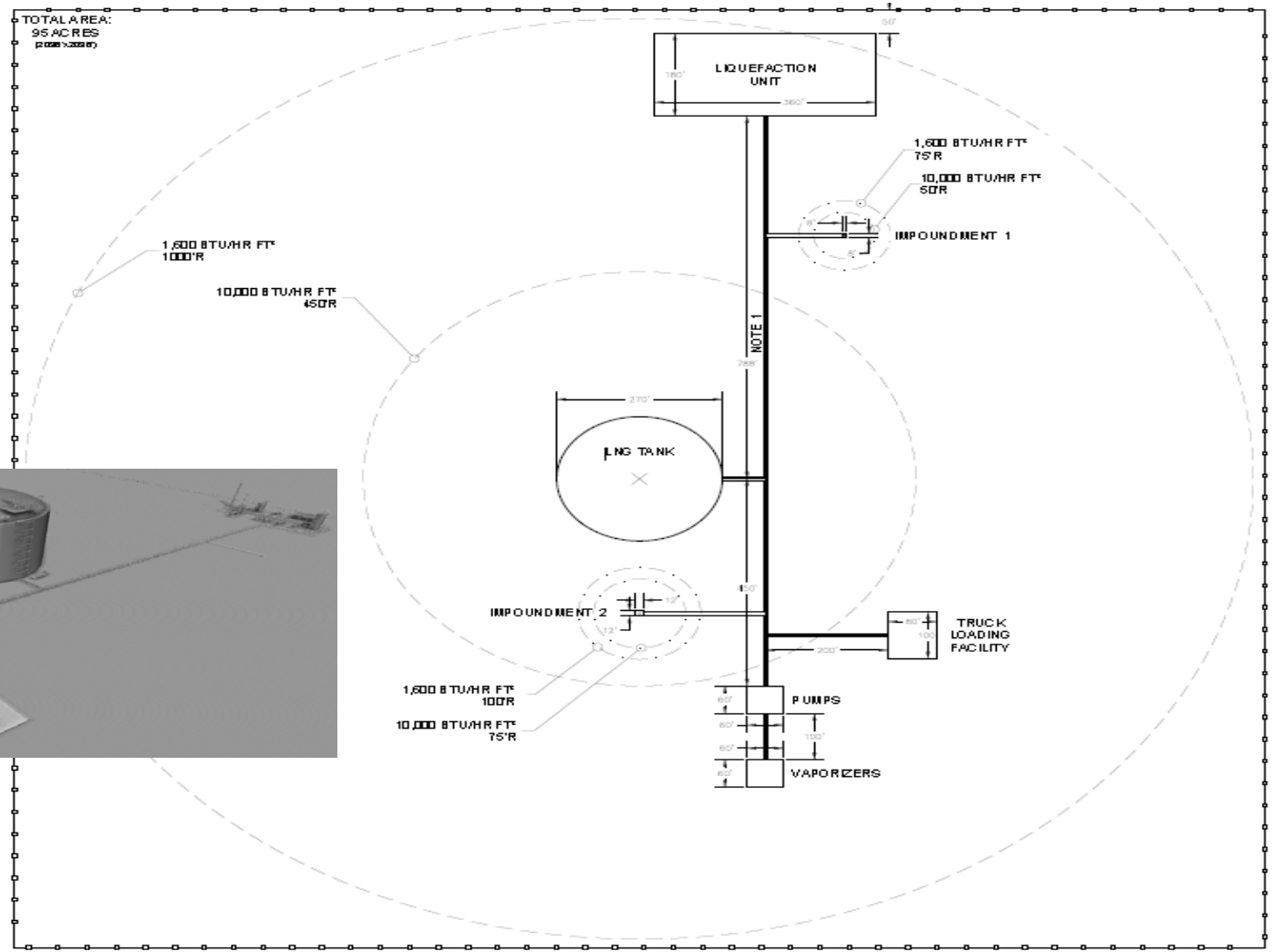
Task 1: Facility Summary

	Export	Peakshaver	Bunkering	Fuel Loading
Acreage:	121	95	34	25
Liquefaction:	15 MTPA (3 x 5 MTPA)	25 MMSCFD (1 unit)	8 MMSCFD (1 unit)	8 MMSCFD (1 unit)
Storage	160,000 m^3 x 3 tanks	160,000 m^3 x 1 tank	1,000,000 gallon x 1 tank	1,000,000 gallon x 1 tank
Loading / Sendout:	12,000 m^3/hr (marine loading)	400 MMSCFD (sendout)	2,000 m^3/hr (bunkering)	300 gpm (fuel loading)
Truck Loading	300 gpm	300 gpm	N/A	N/A

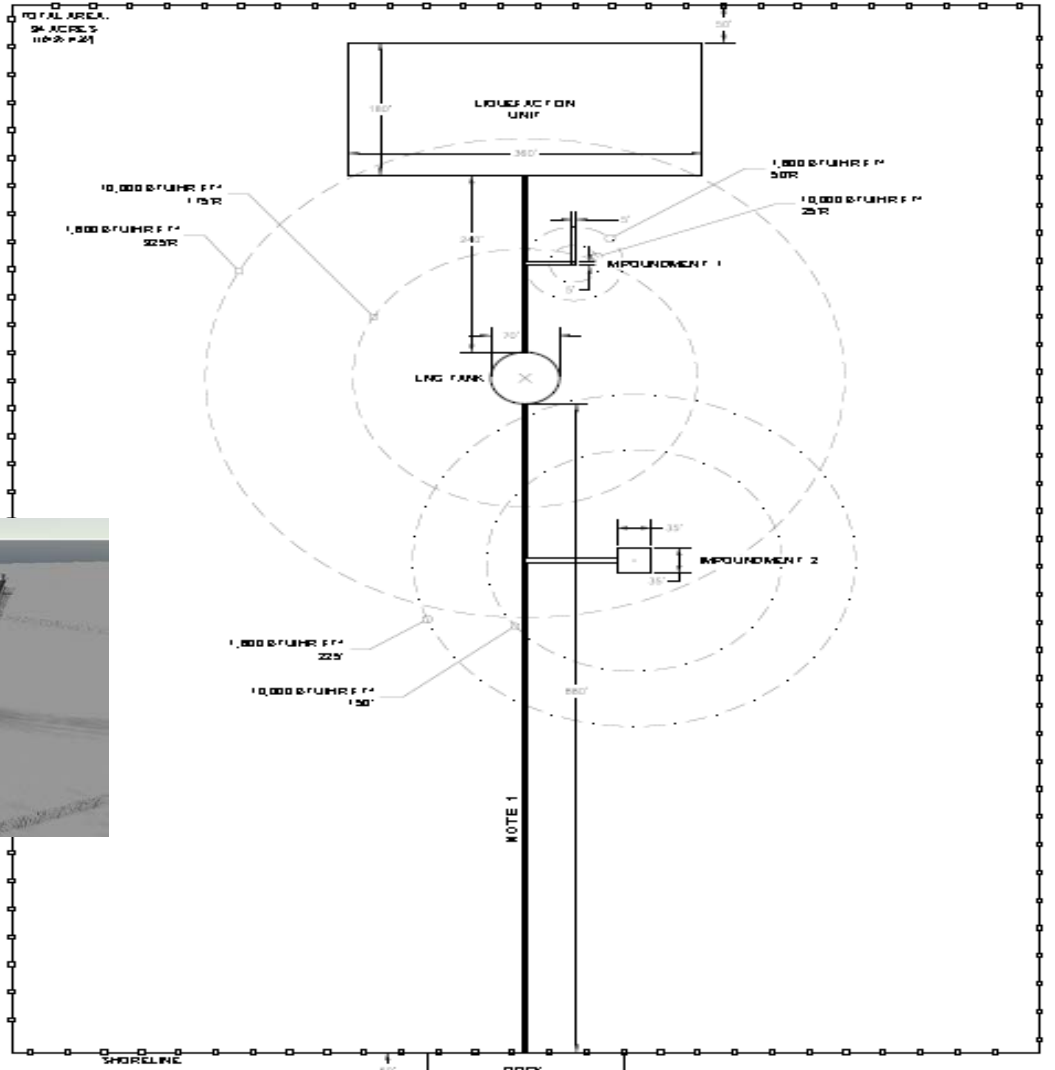
Task 1: Export Facility

Task 1: Peakshaver Facility

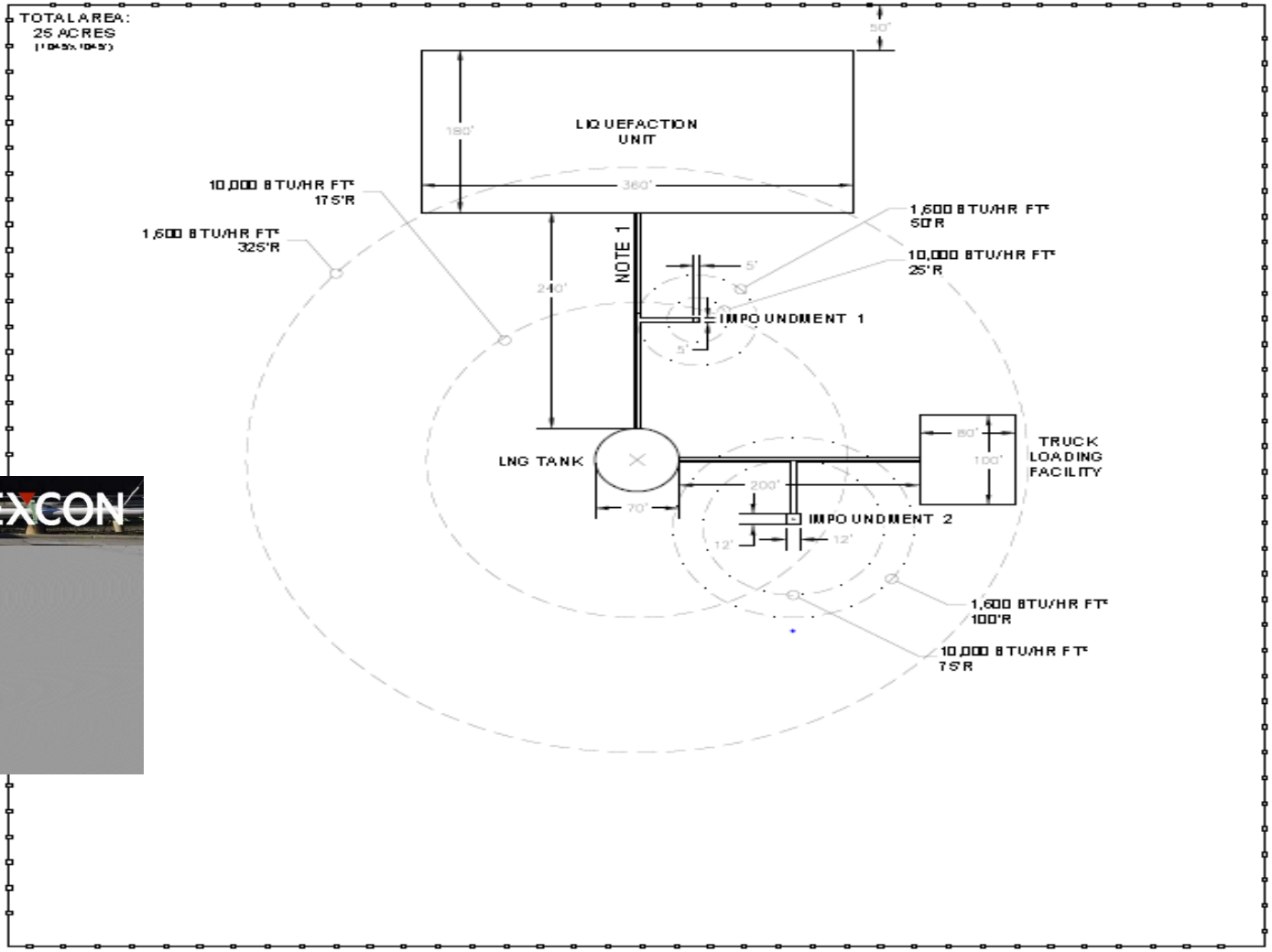




Task 1: Bunkering Facility



Task 1: Fuel Loading Facility

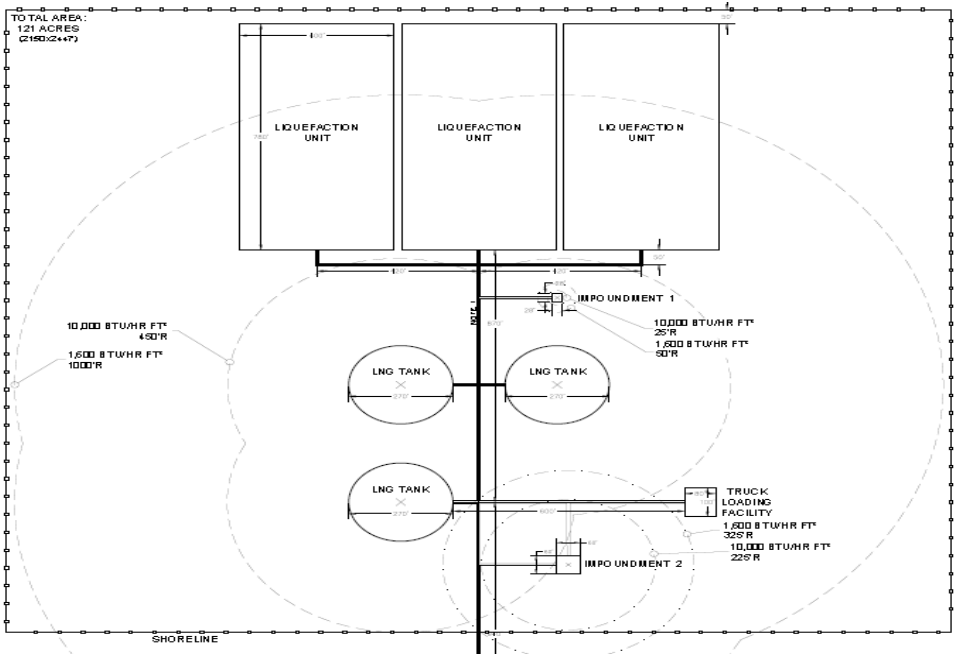


Task 2: Failure Criteria

- To raise the overall level of confidence in the Project, the Failure Criteria detailed by DOT PHMSA on their FAQ webpage will be used as appropriate to ensure that this Project will be held to the same requirements DOT PHMSA is requiring LNG applicants to comply with.
- This requires developers to have Process Flow Diagrams, Heat and Material Balances, Piping and Instrumentation Diagrams, and Plot Plans developed.
- Both a length based failure determination (Failure Rate Methodology) and a connection based failure (Connection Methodology) will be applied.

Task 3: Single Accidental Leakage Source Determination (Export)

- Rundown Lines:
  - Failure Rate: Up to 5.3” Hole
  - Connections: 4, 3, 2, 1” Hole
- Rundown Header:
  - Failure Rate: Up to 9.3” Hole
  - Connections: 4, 3, 2, 1” Hole
- Marine Loading Line:
  - Failure Rate: Up to 12” Hole
  - ctions: 4, 3, 2, 1” Hole



Task 4: Vapor Dispersion Results (Unmitigated)

- We are currently modeling all of the single accidental leakage sources in Phast, FLACS, and DEGADIS using 2 m/s wind speed and 0.03 surface roughness factors
  - Jetting and Flashing: Phast and FLACS
  - Impoundments: Phast and Degadis
  - Conveyance to and including Impoundments: FLACS

Task 4: Vapor Dispersion Results (Sensitivity)

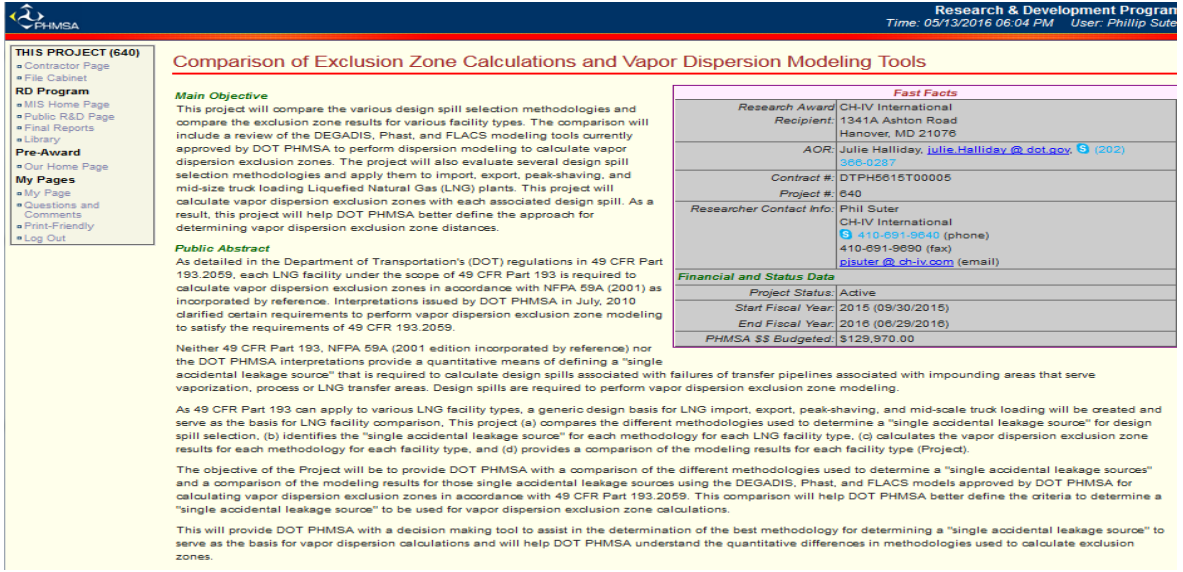
- We will then perform sensitivity modeling on the same single accidental leakage sources for 1 m/s wind speed and 0.01 surface roughness factors
  - Jetting and Flashing: Phast and FLACS
  - Impoundments: Phast
  - Conveyance to and including Impoundments: FLACS

Task 4: Vapor Dispersion Results (Mitigated)

- We will then model all of the single accidental leakage sources using mitigation
- Duration: ESD valves will be accounted for and a shorter release duration will be modeled
  - Jetting and Flashing: Phast and FLACS
  - Impoundments: Phast
  - Conveyance to and including Impoundments: FLACS
- Obstacles: Vapor fences will be added to the facility geometry and will be accounted for
  - Jetting and Flashing: FLACS
  - Conveyance to and including Impoundments: FLACS

Task 5: Final Report

- Once all modeling is completed, a Final Report will be developed which will detail all aspects of the research and the results of the modeling comparison
- Final report will be available for public review at the DOT project webpage:



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Comparison of Exclusion Zone Calculations and Vapor Dispersion Modeling Tools

Main Objective

This project will compare the various design spill selection methodologies and compare the exclusion zone results for various facility types. The comparison will include a review of the DEGADIS, Phast, and FLACS modeling tools currently approved by DOT PHMSA to perform dispersion modeling to calculate vapor dispersion exclusion zones. The project will also evaluate several design spill selection methodologies and apply them to import, export, peak-shaving, and mid-size truck loading Liquefied Natural Gas (LNG) plants. This project will calculate vapor dispersion exclusion zones with each associated design spill. As a result, this project will help DOT PHMSA better define the approach for determining vapor dispersion exclusion zone distances.

Public Abstract

As detailed in the Department of Transportation's (DOT) regulations in 49 CFR Part 193.2059, each LNG facility under the scope of 49 CFR Part 193 is required to calculate vapor dispersion exclusion zones in accordance with NFPA 59A (2001) as incorporated by reference. Interpretations issued by DOT PHMSA in July, 2010 clarified certain requirements to perform vapor dispersion exclusion zone modeling to satisfy the requirements of 49 CFR 193.2059.

Fast Facts

Research Award Recipient:	CH-IV International 1341A Ashton Road Hanover, MD 21076
AOR:	Julie Halliday, julie.Halliday @ dot.gov, (202) 366-0287
Contract #:	DTPH5615T00005
Project #:	640
Researcher Contact Info:	Phil Suter CH-IV International 410-691-9640 (phone) 410-691-9690 (fax) psuter @ ch-iv.com (email)
Financial and Status Data	
Project Status:	Active
Start Fiscal Year:	2015 (09/30/2015)
End Fiscal Year:	2016 (06/29/2016)
PHMSA $$ Budgeted:	$129,970.00

Neither 49 CFR Part 193, NFPA 59A (2001 edition incorporated by reference) nor the DOT PHMSA interpretations provide a quantitative means of defining a "single accidental leakage source" that is required to calculate design spills associated with failures of transfer pipelines associated with impounding areas that serve vaporization, process or LNG transfer areas. Design spills are required to perform vapor dispersion exclusion zone modeling.

As 49 CFR Part 193 can apply to various LNG facility types, a generic design basis for LNG import, export, peak-shaving, and mid-scale truck loading will be created and serve as the basis for LNG facility comparison, This project (a) compares the different methodologies used to determine a "single accidental leakage source" for design spill selection, (b) identifies the "single accidental leakage source" for each methodology for each LNG facility type, (c) calculates the vapor dispersion exclusion zone results for each methodology for each facility type, and (d) provides a comparison of the modeling results for each facility type (Project).

The objective of the Project will be to provide DOT PHMSA with a comparison of the different methodologies used to determine a "single accidental leakage sources" and a comparison of the modeling results for those single accidental leakage sources using the DEGADIS, Phast, and FLACS models approved by DOT PHMSA for calculating vapor dispersion exclusion zones in accordance with 49 CFR Part 193.2059. This comparison will help DOT PHMSA better define the criteria to determine a "single accidental leakage source" to be used for vapor dispersion exclusion zone calculations.

This will provide DOT PHMSA with a decision making tool to assist in the determination of the best methodology for determining a "single accidental leakage source" to serve as the basis for vapor dispersion calculations and will help DOT PHMSA understand the quantitative differences in methodologies used to calculate exclusion zones.

Questions

- Q&A