

COMPARISON OF EXCLUSION ZONE CALCULATIONS AND VAPOR DISPERSION MODELING TOOLS

3RD QUARTERLY REPORT JUNE 30, 2016

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| PHMSA Solicitation: | DTPH56-15-RA-000001 |
| Research area: | Liquefied Natural Gas (LNG) |
| Prepared for: | US Department of Transportation Pipeline and Hazardous Materials Safety Administration |
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1 INTRODUCTION

CH·IV International (CH·IV) has contracted with DOT PHMSA to provide research on vapor dispersion modeling (Project). 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.

2 PREVIOUS COMPLETED WORKS

- Agreement #DTPH5615T00005 was executed by CH·IV and DOT PHMSA and effective starting September 30, 2015.

2.1 Kick Off Meeting and TAP Update

- On October 8, 2015, an initial kick off meeting was held with CH·IV and DOT PHMSA to discuss the overall timeline and scope of the research project. Call attendees were Phil Suter and Jenna Wilson with CH·IV and Julie Halliday with DOT PHMSA. The proposal was to perform vapor dispersion for an LNG import, export, peak shaving, and mid-scale truck loading. As a result of the call and based on current projects being proposed, the scope of the proposal was changed to include LNG export, peak shaving, truck loading, and bunkering.
- Scope of Work Change: Change LNG import, export, peak shaving, and mid-scale truck loading to LNG export, peak shaving, truck loading, and bunkering.
- It was also discussed that there was a potential to add additional modeling for mitigated releases but a decision on that would be made later in the project.
- The Technical Advisory Panel (TAP) members were also discussed on the call and both CH·IV and DOT PHMSA were in favor of adding additional members from DOT PHMSA, DOE, USCG, and FERC to the TAP to raise the overall level of confidence in the research.
- DOT PHMSA reached out to FERC, DOE and USCG. As a result, Andrew Kohout from FERC, Kyle Moorman from DOE, and Ken Smith from USCG were added to the TAP. Additional personnel from DOT PHMSA and FERC will also be involved in reviewing each Task but Andrew Kohout and Julie Halliday will remain the main points of contact.
- On November 19, 2015 a full kick off meeting was held with DOT PHMSA and the TAP to re-introduce the project to the new members of the TAP who were recently added.

2.2 Task 1

Technical Status: The Project identified a generic design basis for the following LNG facility types: bunkering, export, peak-shaving, and mid-scale LNG fuel loading. The design basis was then broken up into the major areas of LNG facilities (such as marine loading/unloading, tank storage area, liquefaction area, vaporization area, etc.) and was populated with common design parameters for each area. The design basis includes information necessary to serve as the basis for vapor dispersion modeling and provides a consistent means for comparing results across different methodologies and modeling tools. The generic design basis captured design elements common to the majority of currently proposed LNG projects and therefore the associated vapor dispersion exclusion zones will be applicable to the majority of currently proposed LNG projects. A generic LNG facility plot plan was developed based on each generic LNG facility design basis to represent a generic layout of each facility type.

- On December 7, 2015 a draft of Task 1 deliverables were sent to the TAP for review with a review deadline on December 18, 2015.
- Comments were provided by DOT PHMSA, FERC, and Rich Kooy on the draft Task 1 deliverables. CH-IV consolidated all comments into a single document and provided responses to all comments. On December 29, 2015 the consolidated comments and responses were provided to DOT PHMSA for review.
- On December 30, 2015, CH-IV and DOT PHMSA convened a TAP Task 1 comment response review call and made final decisions on the comments from the TAP.

2.3 Task 2

Technical Status: The Project team researched the failure criteria used by LNG facility applicants to determine a “single accidental leakage source” and defined a generic Connection Based and Failure Rate Based Methodology. The Project team utilized its previous experience working for applicants during the DOT PHMSA design spill review process and utilized information presented on DOT PHMSA’s FAQ website to determine an acceptable approach.

- On February 4, 2016, a draft of Task 2 deliverables were sent to the TAP for review with a review deadline on February 19, 2016.
- Comments were provided by DOT PHMSA, Filippo Gavelli, James Davis, and Brian Eisentrout on the draft Task 2 deliverables. CH-IV consolidated all comments into a single document and provided responses to all comments. On March 11, 2016 the consolidated comments and responses were provided to DOT PHMSA for review.
- On March 21, 2016, CH-IV and DOT PHMSA convened a TAP Task 2 comment response review call. On March 23, 2016 DOT PHMSA made final decisions on the comments from the TAP. On March 24, 2016 CH-IV provided the final comment responses to the TAP members.

2.4 Task 6

- Completed quarterly report 1 for the quarterly period through December 31, 2015.
- Completed quarterly report 2 for the quarterly period through March 31, 2016.

3 FUNDS AND WORK COMPLETED DURING THIS QUARTERLY PERIOD

3.1 Task 3

Technical Status: The Project team applied both the generic Connection Based Methodology and Failure Rate Based Methodology to each generic design basis for each LNG facility to identify “single accidental leakage sources”. This resulted in defined generic “single accidental leakage sources” for each facility type. An excel spreadsheet was made for each generic facility type to create a sample piping and equipment inventory database similar to what applicants are required to prepare for DOT PHMSA. The Project prepared on a comparative discussion on the differences in the “single accidental leakage sources” based on the different methodologies for each facility type.

- On April 21, 2016, a draft of Task 2 deliverables were sent to the TAP for review with a review deadline on May 6, 2016.
- Comments were provided by DOT PHMSA, Filippo Gavelli, Karla Bathrick, and Brian Eisentrout on the draft Task 3 deliverables. CH-IV consolidated all comments into a single document and provided responses to all comments. On May 16, 2016 the consolidated comments and responses were provided to DOT PHMSA for review.
- On May 17 2016, CH-IV provided the final comment responses to the TAP members.

3.2 Task 4a

Technical Status: The Project team performed a screening analysis and sensitivity modeling of the identified “single accidental leakage sources” to determine the bounding scenarios to be modeled for vapor dispersion. Based on the results of the sensitivity modeling, the Project prepared a FLACS Modeling Assumptions document for TAP review and approval along with marked up plot plans illustrating all proposed release locations. After approval from TAP panel, CH-IV and GexCon commenced modeling of all identified.

- On June 10, 2016, a draft of the FLACS Modeling Assumptions document was sent to the TAP for review with a review deadline on June 17, 2016.
- No comments were received on the release locations. Comments were provided by Karla Bathrick on the discharge coefficient and surface roughness factors which were resolved with DOT PHMSA.
- On June 22 2016, CH-IV and GexCon commenced with all modeling.

3.3 Task 6

- Completed quarterly report 3 for the quarterly period through June 30, 2016.

4 PRESENTATIONS

4.1 DOT PHMSA Technical Workshop

Technical Status: On May 18-19, 2016, DOT PHMSA held a Technical Workshop in Washington, DC. Phil Suter of CH·IV presented on the status of the research. A commenter provided comments on the flow rate used for bunkering and stated it was higher than some proposed facilities. Upon review of the comment, it was determined that a few of the bunkering projects with higher flow rates were no longer being pursued. The TAP team agreed to reduce the bunkering design flow rate and the design basis for bunkering was updated.

4.2 Peer Review #1

Technical Status: On May 25, 2016, DOT PHMSA held Peer Review #1 via teleconference. Phil Suter of CH·IV presented on the status of the research.

5 SCHEDULE UPDATE / FOURTH QUARTER TASK PROJECTIONS

- Completion of Tasks 4a and 4b.