U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

1200 New Jersey Ave, S.E.
Washington, D.C. 20590

DEC 22 2010

Ms. Lisa Tonery
Fulbright & Jaworsky L.L.P.
666 Fifth Avenue, 31st Floor
New York, NY 10103-3198

RE: Interpretation of the Flammable Vapor-Gas Dispersion Protection Requirements for Liquefied Natural Gas Facilities in 49 CFR § 193.2059

Dear Ms. Tonery:

By letter dated June 25, 2010, you requested an interpretation of 49 CFR § 193.2059, the regulation that prescribes the flammable vapor-gas dispersion protection requirements for liquefied natural gas (LNG) facilities. Specifically, you asked whether Freeport LNG Development, L.P. (Freeport LNG or the Company) can use a particular source term model (FLNG Source Term Model) to determine the vapor-gas-dispersion (VGD) exclusion zone for the sump in a natural gas liquids (NGL) extraction system that the Company plans to build at its LNG Import Terminal in Quintana Island, Texas.[1]

In our opinion, the FLNG Source Term Model uses generally-accepted assumptions for heat transfer and conservative assumptions for pool spreading and vapor retention. Accordingly, Freeport LNG can use that source term model to determine the VGD exclusion zone for its NGL extraction system, provided the conditions described in this letter are satisfied.

Background

The Pipeline and Hazardous Materials Safety Administration (PHMSA) issues Federal safety standards for determining the location of new LNG facilities.[2] Those standards require that an operator or governmental authority exercise control over the activities that can occur within an "exclusion zone," the area around an LNG facility that could be exposed to unsafe levels of

[1] Freeport LNG filed an application with the Federal Energy Regulatory Commission for authorization to build the NGL extraction system in August 2009. http://www.freeportlng.com/NGL_Extraction.asp (accessed December 15, 2010).

[2] Pipeline Safety Act of 1979, Pub. L. No. 96-129, § 152, 93 Stat. 989 (1979) (currently codified at 49 U.S.C. § 60103(a)).

thermal radiation or flammable vapor gas in the event of a release.[3] They also require that certain mathematical models be used to calculate the size of these exclusion zones.[4]

In the case of VGD, two computational models may be used: (1) the DEGADIS Dense Gas Dispersion Model (DEGADIS), an integral model that simulates the downwind dispersion of dense gases in the atmosphere, and (2) FEM3A, another dispersion model designed "to account for additional cloud dilution which may be caused by the complex flow patterns induced by tank and dike structure."[5]

If DEGADIS is used to calculate the VGD exclusion zone for an LNG facility, the user must first specify the vaporization rate and radius as a function of time that will serve as the input for that dispersion model. That input, or source term, is a representation of the physical phenomena that occur immediately after an LNG release, but prior to atmospheric dispersion.[6]

PHMSA has stated that the source term used with DEGADIS must have a suitable basis to comply with 49 CFR § 193.2059.[7] "Otherwise, a user could select whatever source term is likely to produce the most favorable outcome (e.g., the smallest or largest possible exclusion zone, or even at random.)"[8] That result would not be consistent with the limitations of DEGADIS or our obligation to ensure that the public is protected from the hazards associated with an LNG plant.

PHMSA has also determined that a particular source term model, SOURCE5, can no longer be used with DEGADIS to calculate the VGD exclusion zone for an LNG facility.[9] That determination was supported by the critical findings in a recent technical report (i.e., that SOURCE5 does not accurately represent the likely effects of pool spreading and the resulting flammable vapor flashing or vapor accumulation within impoundments, and that these

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[3] 49 CFR § 193.2007 (defining exclusion zone).

[4] 49 CFR §§ 193.2057-2059.

[5] 49 CFR § 193.2059(a). The Administrator may also approve the use of alternative vapor-gas dispersion models that "take into account the same physical factors and have been validated by experimental test data." 49 CFR §§ 193.2057(a) and 193.2059(a), 49 CFR § 190.11 (2010) (authorizing the submission of petition for finding or approval with the Administrator); Liquefied Natural Gas Facilities: Obtaining Approval of Alternative Vapor-Gas Dispersion Models, (75 FR 53371;Aug. 31, 2010) (advisory bulletin providing guidance on the requirements for obtaining the Administrator's approval of alternative VGD models).

[6] During the formation of the source term, "the behaviour [sic] of the fluid is dominated by conditions under which the fluid was stored (for example pressure and temperature) and the particular conditions of release (such as geometry and location)." Ivings, et al., LNG Source Term Models for Hazard Analysis: A review of the State-of-the-Art and an Approach to Model Assessment, p. 1 (Mar. 2009) (on file with PHMSA). However, "[f]urther downstream, as the influence of the source decays, the atmosphere becomes increasingly important and controls fluid behaviour [sic]." *Id.*

[7] *In the Matter of Mssrs Keppel and Miozza*, PHMSA Interp. (July 7, 2010) (available at www.phmsa.dot.gov).

[8] *Id.*

[9] *In the Matter of Mrs. Lisa Tonery*, PHMSA Interp. (July 16, 2010) (available at www.phmsa.dot.gov).

deficiencies could compromise the integrity of an operator's VGD exclusion zone for an LNG facility.)[10]

PHMSA has further stated that a source term model should account for the effects of jetting and flashing in appropriate cases, including where a design-spill scenario involves a failure of pressurized piping or equipment.[11] In our view, using a source term model which ignores such an effect (or any other phenomena that has a similar influence on the discharge, vaporization, or conveyance of LNG) could also compromise the integrity of an operator's exclusion zone analysis (e.g., by distorting the downwind dispersion of flammable vapor gas, a result that would not be consistent with public safety.)

Analysis

Your letter states that Freeport LNG plans to use DEGADIS to calculate the VGD exclusion for the NGL extraction system sump. It further states that the Company hired a third-party expert, Exponent, Inc. (Exponent), to determine the source term that should be used as the input for that dispersion model, and that Exponent developed the FLNG Source Term Model for that purpose.

In our opinion, the FLNG Source Term Model uses generally-accepted assumptions for heat transfer and conservative assumptions for pool spreading and vapor retention. Specifically, it assumes instantaneous spreading of the LNG pool across the floors of the NGL extraction system sump, an assumption that the Company has shown, through a parametric analysis, will produce the longest flammable vapor-gas cloud. It also uses the generally-accepted, one-dimensional transient Fourier heat transfer method to determine the amount of vapor generated by the sump's concrete floors and walls. The Company has further shown that the passive mitigation measure that will be installed in that sump, a Foamglass block system, will have a negligible effect on the VGD exclusion zone for that portion of the NGL extraction system. Finally, the FLNG Source Term Model does not assume that any of the vapors produced during an LNG release are retained by the sump's walls.

For these reasons, we conclude that the FLNG Source Term Model has a suitable basis and can be used as the input for DEGADIS under these circumstances.[12] We note, however, that Freeport LNG has not yet accounted for other phenomena that could influence the discharge, vaporization, or conveyance of LNG to that sump, including the effects of jetting and flashing

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[10] Ivings, et al., LNG Source Term Models for Hazard Analysis: A review of the State-of-the-Art and an Approach to Model Assessment, p. vi (Mar. 2009) (on file with PHMSA).

[11] *In the Matter of Mrs. Lisa Tonery*, PHMSA Interp. (July 16, 2010) (available at www.phmsa.dot.gov).

[12] Our opinion on the suitability of the FLNG Source Term Model only applies to the NGL extraction system sump.

for any design-spill scenarios that involve the failure of pressurized piping or equipment. Such a showing must be made to properly calculate the VGD exclusion zone for that portion of the NGL extraction system.

Sincerely,

John A. Gale
Director, Office of Standards
and Rulemaking

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June 25, 2010

Jeffrey D. Wiese
Associate Administrator for Pipeline Safety
PMHSA
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590-0001

Re: Request for Interpretation of 49 CFR Part 193

Dear Mr. Wiese:

Freeport LNG Development, L.P. (Freeport LNG) has an application pending before the Federal Energy Regulatory Commission (FERC) in Docket Nos. CP03-75-006 and CP05-361-004 for authorization to construct and operate a natural gas liquids (NGL) extraction system at its Quintana Island liquefied natural gas (LNG) terminal. In conjunction with that pending application, pursuant to 49 CFR Section 190.11(b)(1), we are requesting an interpretation of the Part 193 Subpart B LNG Facilities Federal Safety Standards Siting Requirements. Specifically, we seek a written interpretation concerning 49 CFR Section 193.2059 as set forth below.

Flammable Vapor Source Term

As you are aware, the Fire Protection Research Foundation (FPRF) funded research on LNG spill source term modeling and, in March, 2009 its findings were included in a report entitled "LNG Source Term Models for Hazard Analysis: A Review of the State-of-the-Art and an Approach to Model Assessment". As you are also aware, the report presented a methodology for assessing the suitability of LNG source term models used in determining pool spread and vaporization. The report concluded that the SOURCE5 model generally used within the LNG industry, could result in under-prediction of hazard distances in some cases because it does not accurately represent pool spreading and the resulting flammable vapor flashing, and vapor accumulation within impoundments.

Exponent, Inc. (Exponent) was retained by Freeport LNG to address general concerns raised by FERC, as a result of the March 2009 FPRF report, regarding the approach used to model the vaporization source term for LNG design spills in accordance with 49 CFR Part 193, and in particular, the source term used for the Freeport LNG NGL extraction process area sump vapor dispersion hazard zone calculations. In this regard, Exponent has quantified the vaporization of the design spill into the NGL extraction process area impoundment using the

generally accepted[1,2] one-dimensional transient Fourier conduction heat transfer from the concrete floor and walls. SOURCE5 was not used in any of these calculations and no credit was taken for vapor retention within the impoundment.

A copy of the report and associated calculations on thermal radiation and flammable vapor dispersion hazard zones previously filed with FERC is attached to this letter as Attachment 1.[3] Given the concerns regarding use of SOURCE5 as the source term model discussed above, PHAST was used to provide input into DEGADIS by Freeport LNG in its calculations. Specifically, PHAST was used to determine the pool spreading and vaporization rate and these results were then input into DEGADIS to determine the flammable vapor exclusion zones. Additionally, no vapor holdup from the sump was assumed in this analysis, thus the LNG dispersion result represents a conservative exclusion zone analysis. Nonetheless, FERC issued a number of data requests to Freeport LNG seeking additional information regarding its calculations.

Freeport LNG has prepared a source term calculation that addresses the specific concerns raised in the March 2009 FPRF report (and the FERC Environmental Information Request numbers 55, 56 and 58 issued November 10, 2009 in Docket No. CP03-75-006 and CP05-361-004) and provides input to the DEGADIS Dense Gas Dispersion Model that is specified in 49 CFR Section 193.2059. The following summarizes how Freeport LNG has addressed the particular concerns raised by the FPRF report:

Pool Spreading and Flammable Vapor Production

The speed of the spreading liquid on the floor of the sump is a parameter that can have significant impact on the source term. Various models exist for the spreading pool, some of which may represent the physics of the pool more scientifically accurately than others. For this reason, Exponent performed an analysis of the sensitivity of the vapor dispersion distance to the speed of the spreading liquid by varying it over a broad range and quantifying the corresponding vapor dispersion distances. In the cases considered, the LNG pool was made to spread and cover the sump floor over prescribed durations ranging from instantaneous to 100 seconds. Additionally, the contribution of the side walls of the sump to the vapor generation was taken into consideration. SOURCE5 was not used in any of these calculations and no credit was taken for vapor retention within the impoundment. The vapor source was input into DEGADIS to

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1 D.M. Webber, S.E. Gant, M.J. Ivings and S.F. Jagger, "LNG Source Term Models for Hazard Analysis: a Review of the State-of-the-Art and an Approach to Model Assessment, *Final Report,"* Prepared by Health & Safety Laboratory for the Fire Protection Research Foundation, February 2009, pg 64.

2 F.P. Incropera, D.P. DeWitt, *Fundamentals of Heat and Mass Transfer*, fourth ed., John Wiley & Sons, New York, 1996, pp. 236-239.

3 See AcuTech August 3, 2009 Report, "Consequence Modeling Results, NGL Extraction Project, Siting Requirements – Thermal and Flammable Vapor Dispersion Exclusion Zones." See also attached Data Response Numbers 55 and 56 filed with FERC on November 30, 2009 in Docket No. CP03-75-006 and CP05-361-004 in response to the FERC Environmental Information Request dated November 10, 2009.

calculate the corresponding length of the ignitable vapor cloud over time. Using this approach, Exponent was able to quantify the maximum possible vapor dispersion distance independently of the choice of the model for the liquid spreading speed while including the heat input of the sump walls. A copy of the parametric analysis and associated findings is attached to this letter (See Attachment 2, "*Freeport LNG – Parametric Study of the 49 CFR 193 Vapor Dispersion Distance from Spills into the NGL Extraction Process Area Sump*").

Recent 2009 revisions of the NFPA 59A standard now allow the use of passive mitigation measures in the modeling and calculation of thermal exclusion zones.[4] These measures include methods to affect the burning rate of the LNG, to reduce the size and/or radiant heat emission of an LNG fire, or to impede the transmission of radiant heat transfer from the fire to exposed objects. A Foamglas block system is one such mitigation method which has been utilized by Freeport LNG to reduce the effective burning rate of LNG. In response to a data request (No. 58 dated November 10, 2009) issued by FERC as to the impact of the Foamglas system on vapor dispersion in the absence of a fire, Exponent quantified the maximum possible vapor generation associated with the Foamglas block system using the generally accepted one dimensional transient Fourier conduction heat transfer law for the Foamglas blocks and the heat capacity per unit area for the steel mesh support structure in the parametric analysis in Attachment 2. The analysis concludes that if the Foamglas blocks and supporting mesh are raised one foot above the sump floor, the Foamglas system does not contribute to the generation of vapor from spilled LNG.

Flammable Vapor Retention

The SOURCE5 model defines the source of vapor to be precisely zero until the liquid depth, plus the depth of vaporized (but undiluted) LNG, becomes equal to the height of the dike wall. This is not credible if there is any wind at all. Furthermore, air entrainment and mixing during the evaporation process will also dilute the LNG vapors. For these reasons, the calculation prepared by Freeport LNG does not take credit for any vapor retention or hold-up within the sump. This approach results in an earlier release of vapors at a time when the rate of evaporation is at its highest and higher than the rate of evaporation when the vapors begin to spill out of retention in the SOURCE5 model. In reality, sump walls do provide some degree of vapor retention and hold-up. Therefore, the method used by Freeport LNG results in a rate of vapor formation that is larger than would be expected in reality.[5]

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4 NFPA 59A, Sections 5.3.3.3 and A.5.3.3.3.

5 See p. 14 Model Assessment Report on SOURCE5 Version 5 revision 1, Ref. No. *CE5/04 MAR/HSL/SOUR,* Version 4 February 2009, in Appendix A of "LNG Source Term Models for Hazard Analysis: a Review of the State-of-the-Art and an Approach to Model Assessment, *Final Report,"* Prepared by: Dr D.M. Webber, Dr S.E. Gant, Dr M.J. Ivings and S.F. Jagger, Health & Safety Laboratory, March 2009.

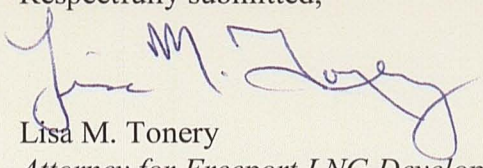
Request for Interpretation of 49 CFR Part 193

Freeport LNG is requesting an interpretation that:

> Use of the foregoing methodology as summarized above and described in greater detail in Attachment 2, and supported by Appendices A,[6] B[7] and C,[8] is consistent and in compliance with 49 CFR Section 193.2059; and

Freeport LNG respectfully requests that the above-requested guidance be provided at the earliest date possible so that the Freeport LNG project may move forward in the FERC permitting process. To that end, please feel free to contact the undersigned with any questions concerning the foregoing.

Respectfully submitted,



Lisa M. Tonery
Attorney for Freeport LNG Development, L.P.

Attachments

cc: Charles Helm
Keith Coyle
Terry Turpin
Mark Mallett
Michael Johns
Harri Kytomaa

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6 Appendix A – Source Model Details.

7 Appendix B – MathCAD Source Term Calculation Sheets.

8 Appendix C – DEGADIS Summary Output Sheets.