



**MARY KAY O'CONNOR  
PROCESS SAFETY CENTER**  
TEXAS A&M ENGINEERING EXPERIMENT STATION

---

**19<sup>th</sup> Annual International Symposium**  
**October 25-27, 2016 • College Station, Texas**

---

**Report on the PHMSA LNG Regulation Workshop**

Jeffrey D. Marx, Quest Consultants Inc., Norman, OK  
Julie Halliday, US DOT PHMSA, Washington, DC

Presenter E-mail: [jdm@questconsult.com](mailto:jdm@questconsult.com)

**Abstract**

In May 2016, the Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) held a two day public workshop to solicit input and obtain background information for the formulation of a future regulatory change to 49 CFR part 193, Liquefied Natural Gas Facilities: Federal Safety Standards. Representatives from the public, industry, and governmental agencies were offered an opportunity to participate in a future rule making by providing their desired changes to Part 193. Part 193 was promulgated in 1980 and the last major revision was in 2000 when requirements were removed from Part 193 and replaced by incorporating additional requirements from National Fire Protection Association (NFPA) 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG). This paper serves to report the major outcomes of the workshop and outline some of the challenges that are present in updating the regulation. This paper in no way represents a definitive path forward for Part 193 and is not an advance notice of proposed rulemaking. The discussion contained in this paper is intended for information purposes only.

**Introduction**

The LNG industry is nearly 60 years old. During the industry's first expansion in the United States it became obvious that consistent, national regulation was needed. In 1972 the Department of Transportation amended Part 192 to create § 192.12 to establish Federal safety standards for liquefied natural gas (LNG). The 1971 edition of NFPA 59A was incorporated by reference as an interim measure while permanent regulations were being developed. Part 193 was promulgated in 1980 as required by the Pipeline Safety Act of 1979 and as re-codified in 49 United States Code Section 60103. PHMSA must periodically issue updates to standards incorporated by reference (IBR). PHMSA assess the impact of new editions to public and the environment. When revised safety standards are clearly an improvement to the public, the environment, and pipeline safety, the new addition is adopted. In 2000 Part 193 Subparts on siting, design, construction, equipment, and fire protection were largely removed and instead referenced chapters 1 through 9 of NFPA 59A (1996 edition). Until then, Part 193 referenced NFPA 59A in only a few instances concerning

siting, design, and fire protection. In 2009, PHMSA reviewed NFPA 59A's 2006 edition, but noted that the recent revisions to NFPA 59A lacked sufficient justification and did not address several of PHMSA's concerns. At the time of the 2010 periodic update, PHMSA only adopted specific sections on seismic design of LNG storage tanks and certain nondestructive test requirements from the 2009 version of 59A. In the 2010 IBR final rule, PHMSA stated that it, "believes that the NFPA 59A committee has yet to reconcile issues relating to dispersion analyses for vapor releases from process and safety equipment; containers with liquid penetrations at grade; design spill cases for full and double containment containers; standards for impoundment sizing for snow accumulation, severe weather, emergency depressurization, and fuel bunkering". While there have been 25 amendments to the regulation, other than the 2000 rule, most changes have been procedural. In contrast, NFPA 59A has published revision in 2006, 2009, 2013 and 2016. These newer editions include new technologies (e.g. membrane tanks, vacuum jacketed pipe), incorporate additional safety standards, adopt more current version of standards incorporated by reference, provide for a method to approve radiant heat flux models, and add risk based siting. Other changes were made to address the new use of LNG as fuel and for marine export facilities. The prevailing perception of the industry and public is that PHMSA's regulations are lagging behind an industry that is rapidly evolving.

To address this shortcoming, PHMSA is developing a proposed rulemaking. This began with investigation into the shortcomings of the current code to better understand where changes may be necessary. A significant effort to evaluate NFPA 59A-2016 for IBR is underway.

As part of these efforts, a public workshop was organized to discuss some of the major issues surrounding the LNG industry today. PHMSA maintains that early and continuous public involvement brings a broad range of viewpoints into the decision-making process. This process enables PHMSA to make better informed decisions through collaborative efforts and builds mutual understanding. The workshop featured 23 speakers, covering a variety of topics from siting and design to emergency response. A question and answer session followed each day's presentations. The May workshop attracted approximately 160 people in Washington, DC. Another 200 joined via the simultaneous webcast. Audience members included stakeholder representatives from the LNG, rail and maritime industry, associations, technical committees, engineering consultants, risk & safety management, the public, emergency responders, laboratories, manufacturers, law firms, insurance companies, and state, federal, and foreign governmental agencies. This effort was initiated in order to open a public dialogue about some of the shortcomings of Part 193 and lead to a proposal for an appropriate set of changes in the future. Workshop details are available at PHMSA's web site (<http://primis.phmsa.dot.gov/meetings/MtgHome.mtg?mtg=111>) and as a recorded video feed on YouTube. A Federal docket was made available for this workshop and remains open for any interested party to provide comments. (Docket PHMSA-2016-0005, <https://www.federalregister.gov/articles/2016/04/26/2016-09653/pipeline-safety-public-workshop-on-liquefied-natural-gas-regulations> )

## **Workshop Summary**

Alan Mayberry, Acting Associate Administrator for Pipeline Safety, kicked off the workshop. Mr. Mayberry established the goals of the workshop – to listen to stakeholders, to collect public input as a catalyst for revising and updating Part 193, and to communicate the path forward to adapt the

code to address new technologies and scale of the LNG industry. He emphasized how the underlying principles of Part 193 are to understand and manage risk. He stated that code requirements are the minimum bar and industry should seek continual movement toward improved safety performance. His presentation tied into PHMSA's mission to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives and its vision to be the most innovative safety transportation organization in the world. DOT's introduction was wrapped up by Kenneth Lee, Director of the Engineering & Research Division, Office of Pipeline Safety. Mr. Lee described the ongoing research projects conducted by DOT, including work to better define equipment failure rates for LNG plants and a project to expand the understanding of vapor dispersion and radiant heat flux exclusion zone calculations. The first day various stakeholders provided their perspectives. The following are highlights from stakeholder group presentations:

### *Governmental Agencies*

- The Office of Hazardous Materials Safety (OHMS) regulates transportation of LNG in commerce but does not regulate the transport of LNG used as fuel. (Air transportation of LNG is prohibited.) DOT is working in collaboration with the Federal Railway Administration to establish a baseline bulk tank car and locomotive tender design standard for LNG. While transport of LNG by rail tank car is currently prohibited, portable tanks and cargo tanks are authorized on a rail car with approval from Federal Railroad Administration. There are approximately 28,000 LNG tank (truck) trailers in service. Within this fleet, there have been 10 highway incidents over last 15 years with no fires or explosions. Transport of LNG above deck on a cargo vessel, or a passenger-carrying vessel is also permitted with a restriction on the number of passengers, depending on vessel length, and stowage must be clear of living quarters.
- OHMS is researching LNG product flows to understand future LNG transportation needs, as well as continuing research with the FRA for portable LNG containers and rail cars.
- PHMSA presented the definitions and criteria for incident reporting at LNG plants. Since LNG incident reporting began on January 1, 2011, there have been nine reported LNG incidents with one on-site fatality and one on-site injury. Failure causes include inadequate purging and equipment/material failure. The service age of currently regulated LNG plants was also reviewed. The percentages of LNG facilities entering service by decade was found to be:
  - 10% 1960-69
  - 61% 1970-79
  - 4% 1980-89
  - 10% 1990-99
  - 10% 2000-09
  - 4% 2010-2016
- A State pipeline inspector provided a detailed presentation covering the safety aspects of inspection of LNG Facilities. Inspectors review O&M procedures, maintenance schedules, equipment control panels for sieves and compressors, relief valve inspections, and review upgrades, among many other inspection duties.
- The Gas Technology Institute (GTI) presented on behalf of the emergency responder community. They emphasized the importance of training all stakeholders and provided

sources for training guidance. GTI supports the LNG industry through training classes for LNG hazards and emergency response. They highlighted the need for regulations to keep up with industry practices.

### *The LNG Industry*

- Large Scale Operator – Cheniere’s Sabine Pass LNG was the first U.S. LNG export facility since Kenai LNG opened in 1969. They provided an overview of the growing and maturing LNG industry. Older versions of standards referenced in the regulation negatively impact design, construction and operations. Ultimately, LNG regulations should reflect industry best practice and a risk based approach.
- Mid-scale Operator – The proposed Tacoma LNG project will combine peak-shaving and marine bunkering to serve an LNG powered container ships. They highlighted some challenges of the regulatory environment including obtaining over 16 federal and state approvals. Some of the agencies require different versions of the same code. The site is a prime industrial waterfront property and a relatively populated environment. They emphasized the importance of relationships between industry, regulators and the public.
- GTT – Membrane LNG storage tank technology is permissible in NFPA 59A 2016. Membrane tanks are pose similar risk as 9% Ni tanks. They have been used on ships for over 40 years. They provide cost advantages over concrete and nickel steel tanks.
- Braemar Engineering – Various tank and containment types were covered. The presentation covered previous issues PHMSA had identified with full containment concrete tanks and the newly incorporated standard, ACI 376, for concrete tanks.
- Chart Technology covered modular cryogenic systems for smaller-scale operations. They discussed the issues surrounding complying with ASME BPVC 1992 edition allowable stress and test pressure requirements. Cold stretching is permitted with the latest edition of ASME BPVC but PHMSA has not adopted it yet. They also discussed work performed by CGA Natural Gas Committee.

### *Associations*

- NFPA 59A Committee – A historical overview of the NFPA 59A standard was given, with emphasis on the portions of the standard that have changed since the 2001 version. The 59A committee has been more active in recent years to maintain a good working relationship with PHMSA, and hopes that one of the recent or forthcoming versions of 59A can be incorporated by reference into Part 193. The public input comment period closes in January, 2017.
- AGA explained how the LNG industry has an excellent safety record partly due to the codes and standards that are part of the industry. The presentation explored the issue of managing aging LNG plants and the importance of operational and maintenance data. Emphasis was also made on the challenges of managing facilities to outdated industry standards.

### *Public*

- A presentation from a board member of the Pipeline Safety Trust detailed the various ways LNG plant siting could be done, including prescriptive, performance, and “other” methods, which may include insurance requirements or public planning. An emphasis was made on the importance of public involvement in LNG plant planning, including through standards organizations, regulatory hearings, and public partnering programs. The current LNG siting is based on precautionary measures using worst-case scenarios, but does not allow for public participation.
- Several members of the public were in attendance and actively asked questions of the presenters.

The second day addressed hazards at LNG facilities including a presentation on an LNG accident and emergency response, vapor cloud explosions, consequence modeling, risk base siting, and process safety management. The following are highlights from the second day’s presentations.

### *LNG Incident and Response*

- The Williams Plymouth LNG Plant in Washington State is a 1970s era peakshaver. An incident occurred in 2014. They presented information about the incident investigation and evidence preservation.
- The incident involved a vessel failure during plant startup. The root cause was described as: “The lack of a complete purge left an air and natural gas mixture in plant piping downstream of the adsorber towers. During startup the flammable mixture was pulled into the salt bath purification heater where it then ignited, creating a rolling detonation back through the purification piping until it reached adsorber D-20A which then failed, dissipating the energy of the rolling detonation.”
- The explosion caused significant local damage, as well as sending projectiles several hundred feet. Five plant personnel suffered minor (non-reportable) injuries.
- A projectile penetrated to the outer shell of one LNG storage tank and dented the inner tank. Cold natural gas and perlite insulation were released.
- A projectile damaged a small fitting on an LNG line, resulting in a small LNG release; other shrapnel caused gas releases at several locations.
- One projectile damaged a rail line offsite; no other significant offsite impacts were realized.
- The explosion damaged the electronic safety systems. The process systems had to be manually isolated.
- Emergency response, including involvement of outside responders, public communication, regulatory liaison, and evidence preservation, is crucial during events such as this one.
- It is extremely important to maintain good relationships between operating plants and emergency responders so that if an incident occurs, the response is timely and appropriate.
- Local Emergency Planning Committees (LEPCs) should be aggressive in engaging with hazardous materials facilities, using all the resources available to be prepared.

### *Addressing Hazards at LNG facilities*

- Research into historical vapor cloud explosions (VCE) was conducted to help determine if such events could be considered credible events at LNG plants. The investigation used forensic evidence from catastrophic VCE events that have occurred around the world. In

each event, the size of the vapor cloud was attributed to an accidental release of small to moderate size that continued unmitigated and undetected for a significant time period, during atmospheric conditions of low or no wind. The applicability of these findings to LNG plants in the USA will be the focus of a future phase of the work.

- A study to revise the existing model evaluation protocol (MEP) was presented. The work seeks to correct the data and standardize the max arc-wise concentration methodology used for the MEP, eliminate some statistical inconsistencies in the data set, add some new features, and provide a new model to data comparison tool for use in future model evaluations.
- A project by Quest Consultants involving risk-based siting, within the scope of small-scale facilities, is in progress. The presentation introduced this concept, explained the characteristics of quantitative risk analysis (QRA), and provided some potential directions for siting studies in the future. A review of the QRA option in NFPA 59A's Chapter 15 was also provided.
- A second presentation on risk-based siting was given by DNV-GL. Their approach would evaluate potential exposure, location, process, and technological factors to implement a qualitative risk-informed approach to siting.
- A research project by CH-IV to evaluate the current design spill and single accidental leakage source (SALS) selection methodology and the associated vapor dispersion modeling was introduced. The study seeks to identify the typical range of release scenarios for a range of LNG plant types, and to evaluate the sensitivities to several variables, as well as the impact of common mitigation measures applied to these plants.
- AcuTech provided background information about process safety management and industry best practices introduced in 1992. Process management involves the handling, storing, or processing of hazardous chemicals using a structured, risk-based management system. A comparative evaluation of the requirements of Part 193 to those found in OSHA's 29 CFR 1910.119 was made. The LNG industry has been most successful in managing safety using a combination of conservative industry practices and regulations that exceed most other similar industry or regulatory models. PHMSA intends to continue to explore process safety management for LNG facilities.
- Cameron LNG presented their process safety management program that embraces many PSM elements. Cameron is an import facility that has been approved for expansion to an export terminal. Complete and accurate written information concerning process chemicals, process technology, and process equipment is essential to an effective PSM program and to a process hazard analysis (HAZOP) study. Additionally, Cameron has implemented a management of change process and a mechanical integrity program to supplement the requirements of Part 193.

## **Workshop Findings**

During the two days of the workshop, there were multiple recurring topics in the discussions and the questions proposed by workshop participants.

*“Why hasn't PHMSA adopted a newer version of NFPA 59A?”*

This question was posed several times during the workshop. The participants, especially members of industry, seemed very concerned that the latest developments incorporated into the NFPA 59A standard by its committee were not available for use at LNG plants in the U.S. Due to the rapidly changing industry, LNG plant operators (or those wishing to build one) are increasingly finding that the regulations do not adequately address the LNG facilities that companies would like to build. Incorporation of the latest version of NFPA 59A into Part 193 would alleviate some of these concerns.

*“Does Part 193 address the \_\_\_\_\_ technology?”*

The evolving LNG industry has seen many technology changes since Part 193 was promulgated, and many since the 2001 version of NFPA 59A. These include, but are not limited to, full containment storage tanks, membrane storage tanks, pipe-in-pipe solutions for insulation, new liquefaction technologies, modern process controls technology, better hazard detection devices, and more efficient equipment. In addition, the industry has been innovative in how it supplies LNG, growing into larger export plants as well as into smaller fueling applications of many varieties.

*“PHMSA needs to look at risk based siting.”*

There is a perception by the public that risk based siting provides a better safety margin than prescriptive requirements. Industry is seeking risk based siting so that they can use active mitigation and new technologies to safety site LNG facilities in locations where prescriptive requirements would not afford.

## **Future Work**

Moving forward, PHMSA is evaluating NFPA 59A-2016 for incorporation by reference. It is also addressing issues identified in the 2010 IBR final rule which prevented adoption of the 2006 edition, as well as the FAQs that have been developed to supplement the current regulations and provide guidance for hazards analysis in order to enhance regulatory certainty. PHMSA is considering the information presented at the May workshop, the discussions that occurred there, the questions and concerns posed by participants, and comments posted to the docket. PHMSA is reviewing investigation, inspection and enforcement data to identify regulatory gaps and assessing siting requirements for new LNG plants. PHMSA is required to perform an alternative analysis to determine if there are less burdensome ways to meet the objectives as well as an economic analysis to determine whether the benefits of the rule justify its cost. When PHMSA publishes the notice of proposed rulemaking (NPRM) in the federal register, there will be an open comment period where any interested parties can provide input for PHMSA’s consideration.