

A Guide to LNG

What All Citizens Should Know



**Federal Energy Regulatory Commission
Office of Energy Projects
Washington, DC**

I. Background and Purpose

Natural gas accounts for about one quarter of all energy consumed in the United States. Approximately 14 percent of U.S. natural gas consumption is for electricity generation. Residential uses for heating, cooling and cooking account for 22 percent; industry consumes 40 percent; and the business sector uses 15 percent. Natural gas also serves as the raw material to make paint, plastics, fertilizer, steel, fabrics, glass and numerous other products. Natural gas is vital to the U.S. economy.

The U.S. Energy Information Administration forecasts natural gas demand by 2025 will grow more than 38 percent. With domestic natural gas production apparently at or past its peak, liquefied natural gas (LNG) will play an increasingly important role in meeting our nation's energy needs. This will require construction of new LNG import terminals.

This pamphlet, produced by the Federal Energy Regulatory Commission (FERC or Commission), is intended to provide useful information to citizens regarding the nature of LNG, the review process used by FERC staff in analyzing proposed LNG facilities, and how to participate in the review process.

II. LNG Facts

What is LNG?

Natural gas, primarily methane, is colorless, odorless and non-toxic. LNG is natural gas that has been supercooled to a liquid at -260°F (-162.2°C). Liquefying natural gas reduces its volume by more than 600 times, making it more practical for storage and transportation.

Methane is only flammable at air concentration mixtures of 5%-to-15%. At a higher concentration there is not enough oxygen to sustain a flame, while at a lower concentration the fuel becomes too diluted to ignite.

Is LNG Explosive?

LNG is not at all explosive or flammable in its liquid state.

What happens when LNG is warmed?

As a vapor, natural gas mixed with air is flammable in the air concentrations noted previously. As LNG vapor warms above -160°F (-106.7°C), it becomes lighter than air and will rise and disperse rather than collect near the ground. However, it is not explosive unless flammable concentrations of gas occur in enclosed or otherwise confined spaces.

A detailed review performed by FERC and other agencies, such as the Coast Guard, provides a comprehensive analysis of accident and spill scenarios at an LNG facility.

Spill sizes as well as fire sizes, vapor clouds, and resulting hazard zones are extensively analyzed. The coordinated efforts of FERC, the Coast Guard, U.S. Department of Transportation (DOT), and other state and federal organizations strive to assure the safe transit to and storage at the terminal and are described in great detail in the analysis.

What is the operational safety record of LNG Facilities?

LNG has been delivered across the oceans for more than 45 years without major accidents or safety problems, and no serious accidents involving an LNG terminal facility in the U.S. has happened in over 25 years.

On October 20, 1944, at an LNG storage facility in Cleveland, Ohio, a tank without an impoundment dike failed and spilled LNG into the street and storm sewer system. The resulting explosion and fire killed 128 people.

That tank was built during World War II, when metals were strictly rationed, using a steel alloy that had low nickel content. The low nickel content made the tank brittle when exposed to the extreme cold of LNG.

Modern LNG tanks are constructed with materials proven capable of safely containing LNG at cryogenic (supercold) temperatures. Modern day spill containment/dike requirements for LNG facilities ensure that in the unlikely event of an LNG spill, none would leave the plant site.

In 1979, at the Cove Point LNG import facility in Lusby, Maryland, an operational accident occurred when a pump seal failed. Gas vapors entered an electrical conduit and settled in a confined space. When a worker switched off a circuit breaker the gas ignited causing a fatality and heavy damage to the building. Lessons learned from this accident resulted in changes to the national fire codes to ensure that a similar situation could not reoccur.

All newly authorized LNG facilities must comply with the latest safety standards.

Similarly, a Department of Energy/FERC investigation of an explosion at an LNG liquefaction facility in Skikda, Algeria in 2004, led to design and hazard monitoring requirements at all U.S. import facilities.

What is the transportation safety record of LNG ships coming to the US?

During more than 33,000 voyages completed since the inception of LNG maritime transportation in 1959, there have been only eight significant incidents involving LNG ships, none of which resulted in spills from cargo tank ruptures.

Where does LNG come from?

Natural gas is converted to its liquid state (LNG) at export facilities called liquefaction plants. Indonesia, Algeria, Malaysia, Trinidad and Qatar are currently the leading exporters of LNG. Nigeria, Russia, Iran, Australia and other countries also have the potential to

export LNG. The LNG is imported by many countries, such as the U.S. and especially Japan, where natural gas needs are far in excess of the local production capacity.

How is LNG shipped?

Specially designed tankers are used to transport LNG to import terminals. The ships can carry LNG over long distances and are constructed of specialized materials and equipped with sophisticated systems designed to store LNG safely at temperatures near -260 °F (-162.2°C).

There are two basic LNG tanker designs, both of which are double-hulled. In membrane tank designs, the cargo containment system consists of a very thin invar or stainless steel double-walled, insulated cargo envelope that is structurally supported by the vessel's hull. The second design, with independent tanks, use externally insulated spherical aluminum tanks or externally insulated prismatic shaped stainless steel tanks that are self supporting within the vessel's hull.

LNG tanker ships are required to meet international maritime construction and operating standards as well as rigorous Coast Guard safety and security regulations.

Once on shore, LNG is sometimes transported by truck. LNG tanker trucks typically carry between 10,000 and 12,000 gallons (38-to-45 m³) of LNG; enough to supply the daily needs of approximately 1,000 homes. LNG trucks are used to deliver LNG from import terminals to remote or satellite storage facilities.

Where do ships unload LNG?

LNG tankers dock at specially designed terminals where the LNG is pumped from the ship to insulated storage tanks at the terminal. LNG is converted back to a gas at the terminal, which is linked to natural gas pipelines that transport the gas to where it is needed.

How is LNG stored?

LNG is stored at more than 100 U.S. facilities, typically either for use during periods of peak natural gas demand ("peakshaving") or as a baseload source of natural gas. Most of the existing facilities in the U.S. were constructed between 1965 and 1975.

LNG is stored at very low (near atmospheric) pressure in double-walled, insulated tanks. The inner tank contains the LNG, while the outer tank contains the insulation and prevents any natural gas vapor from escaping.

All new LNG facilities are required to have a dike or impounding wall capable of containing 110% of the maximum LNG storage capacity. In the unlikely event of a spill, this feature will prevent LNG from flowing off site.

Storage facilities use advanced monitoring systems to immediately detect any liquid or natural gas leaks or fires at the plant.

Which LNG facilities are authorized by the USCG/MARAD & by FERC?

Under the Natural Gas Act, FERC has primary jurisdiction over the siting and operation of onshore LNG facilities and offshore facilities in state waters, whereas the Coast Guard and Maritime Administration (MARAD) have jurisdiction under the Deep Water Port Act for the siting and operation of offshore LNG facilities in Federal waters.

How are terminals designed?

All LNG storage facility designs must comply with stringent regulations as required by the DOT's safety standards in Title 49 Code of Federal Regulations (CFR) Part 193 - Liquefied Natural Gas Facilities: Federal Safety Standards and NFPA (National Fire Protection Association) 59A - Standard for the Production, Storage and Handling of Liquefied Natural Gas.

In accordance with federal safety standards, vapor-gas dispersion distances must be calculated to determine how far downwind a natural gas cloud could travel from an onshore storage facility and still be flammable. As required by these regulations, these exclusion zones must not reach beyond a property line where other development could occur.

Since a fire would burn with intense heat, each onshore LNG container and LNG transfer system must also have thermal exclusion zones established in accordance with Title 49, CFR, Part 193. These exclusion zones must be legally controlled by the LNG facility operator, or a government agency, to ensure adequate separation between members of the public and the heat from a fire.

Seismic Design Requirements

LNG facilities must meet stringent standards to ensure public safety and plant reliability in the event of an earthquake. Extensive studies of the geological conditions and earthquake history of a proposed LNG site are required to determine appropriate design loads on the critical components of the LNG plant. These critical components must be designed and constructed to maintain LNG containment during and after an earthquake.

What public safety issues are associated with LNG?

If LNG spills it will vaporize. The resulting natural gas vapors will warm and expand, and become lighter than air. The vapors will disperse with the prevailing wind.

If a source of ignition is present where a vapor cloud exists at a 5%-to-15% concentration in the air, the vapor cloud will ignite and burn along a flame-front, back toward the spill site.

The FERC Environmental Impact Statement (described below) gives a detailed review of potential fires and vapor clouds, their size, and the hazards they create.

If LNG spills and vaporizes in the presence of an ignition source, a fire likely will result. The fire will burn back toward the spill site.

Security for LNG Facilities and Ships

FERC is among several federal agencies overseeing the security of LNG import terminals and peakshaving plants. The Coast Guard has lead responsibility for LNG shipping and marine terminal security. DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Department of Homeland Security's Transportation Security Administration (TSA) have security authority for LNG peakshaving facilities. In addition to federal agencies, state and local authorities (police and fire departments) provide security assistance at LNG facilities.

FERC coordinates closely with these other agencies when evaluating security issues as part of its Cryogenic Design Review Process.

Security measures for both onshore and offshore portions of marine terminals are required by Coast Guard regulations under the Maritime Transportation Security Act. Requirements for maintaining security of LNG import terminals are in the Coast Guard regulations at 33 CFR Part 105. The Coast Guard keeps other ships and boats from getting near LNG vessels while in transit or docked by enforcing Regulated Navigation Areas and security zones.

The Coast Guard performs a number of important security and safety checks before allowing an LNG tanker to enter a port and unload its LNG. These include:

- 96-hour advance notification of ship arrival,
- ship safety inspection,
- manifest and crew documentation,
- establishment of a safety zone around ships while en route and during unloading operations, and
- inspection of dock safety systems before allowing LNG to be unloaded

Facilities are required to have a written Security Plan and an Emergency Response Plan. FERC, DOT, and Coast Guard require LNG companies to contact and coordinate procedures with local response organizations (local Emergency Planning Committee, local Fire Department, State Police, and local navigation and safety committees).

FERC Security Review

Safety and security have always been extremely important matters for LNG operators and regulators. Since the attacks of September 11, 2001, heightened concerns over security issues are now being addressed for both operation of existing LNG facilities as well as for the approval of new or expanded facilities.

For example, FERC has removed from its website Critical Energy Infrastructure Information (CEII) that includes engineering design details pertaining to LNG storage facilities. Examples of CEII are all detailed piping and instrumentation diagrams, and other information that could be useful to a person planning an attack on critical infrastructure.

FERC coordinates closely with the Coast Guard and other agencies to address marine safety and security at LNG import facilities.

In February 2004, in an effort to address these and other related issues, the FERC, the Coast Guard, and DOT's PHMSA entered into an Interagency Agreement for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities. The agreement, among other things, delineates the roles and responsibilities of each agency relative to LNG terminals and LNG tanker operations.

FERC participates in the Coast Guard's special waterway suitability assessment conferences with other government and law enforcement agencies to address safety and security issues.

Moreover, a condition placed in every FERC LNG terminal authorization gives the Director of FERC's Office of Energy Projects (OEP) authority to take whatever steps are necessary to ensure operational reliability and to protect human life, health, property or the environment, including authority to direct the LNG facility to cease operations.

III. The FERC Review Process for LNG Projects (Pre-Filing Through Operation)

The FERC LNG Program assures the continued safe operation and system reliability of proposed and operating jurisdictional LNG facilities throughout the United States. FERC coordinates closely with the Coast Guard and DOT to assure a complete and seamless review of LNG operations from the point of entry into U.S. waters.

The project timeline for any LNG project authorization proceeding before the Commission may be segmented into three distinct phases: pre-filing technical consultation, which might include interagency coordination, scoping of issues, alternative siting analysis, and public outreach; pre-authorization review; and post-authorization inspection and monitoring.

Pre-Filing Technical Consultation

Prior to a company filing an LNG-related application, company representatives commonly meet with FERC staff to explain the proposal and solicit advice. These meetings provide prospective applicants the opportunity for FERC staff to offer suggestions related to the environmental, engineering and safety features of the proposal. FERC staff also encourages LNG project proponents to develop and implement a Public Participation Plan that identifies specific tools and actions to facilitate stakeholder communication and dissemination of public information.

In this manner, FERC staff learns about future projects that may be filed at the Commission and can help direct companies in application preparation. This assistance is provided as part of the formal Pre-Filing Process (PF). The PF Process requires applicants to engage stakeholders in early discussions and resolution of issues that must be addressed for each project.

Pre-Authorization Review

Prior to any Commission decision regarding an application for a new LNG terminal, FERC staff prepares an environmental impact statement (EIS) to fulfill the requirements of the National Environmental Policy Act (NEPA). The purpose of the document is to inform the public, other permitting agencies and FERC Commissioners about the potential environmental impacts of proposed projects and their alternatives.

As part of its NEPA analysis FERC must comply with certain statutory requirements. These include section 307 of the Coastal Zone Management Act, section 7 of the Endangered Species Act, section 106 of the National Historic Preservation Act, and the Magnuson-Stevens Fishery Conservation and Management Act. As the lead federal agency FERC staff also coordinates closely with the U.S. Army Corps of Engineers and the U.S. EPA in fulfilling the requirements of the Clean Water Act, the Rivers and Harbors Act, and the Clean Air Act. FERC coordinates with the Coast Guard to ensure the waterways management/navigation safety issues under the Ports and Waterways Safety Act and the maritime security issues under the Maritime Transportation Security Act are addressed.

A thorough analysis of every substantive issue is undertaken during the preparation of an EIS.

The NEPA documents for new LNG facilities (and major expansions of existing sites) include a robust study of potential impacts to public safety. To protect the public from potential incidents at an LNG facility, FERC staff determines if the proposal meets the siting requirements of DOT's regulations in 49 CFR 193 and National Fire Protection Association Standard (NFPA) 59A. The siting analysis includes:

- verification of LNG dike and impoundment volumes,
- equipment spacing,
- design spills, and
- exclusion zone calculations

Thermal radiation and flammable vapor exclusion zones are required within the facility site or on adjacent property controlled by the operator. FERC engineering staff independently calculates and verifies the hazard modeling and presents the results in the EIS.

FERC staff also determines areas of hazard with respect to LNG spills from ships during the analysis of an LNG terminal. Staff uses results from the:

- December 2004 Sandia National Laboratories Report: *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*, and
- the methodology described in FERC's ABSG Consulting Inc. study, *Consequence Assessment Methods for Incidents Involving Releases from Liquefied Natural Gas Carriers* (June 18, 2004)

to calculate thermal radiation and flammable vapor dispersion distances. Results from the analysis are estimates of an average most probable "worst case" scenario that provides guidance in developing the safety and security requirements for LNG vessel transport, as well as in establishing potential impact areas for emergency response and evacuation planning.

FERC staff must address any waterway issues that arise during the process. Issues that typically come to the fore include vessel traffic congestion and security concerns.

Another large component of this analysis is accomplished under a separate *Cryogenic Design Review*, which runs parallel to the environmental review.

The *Cryogenic Design Review* assures the safe design of the proposed facilities and system reliability. During this phase, OEP engineers (and consultants) perform a detailed review of the proposed LNG facility design.

FERC engineers evaluate:

- design features,
- tank foundations,
- piping and instrumentation,
- seismic design,
- pressure relief and venting,
- spill containment,
- hazard detection & control systems,
- fire fighting water systems,
- emergency shutdown,
- security & emergency plans

The completed Cryogenic Design and Inspection Manual summarizes the design, process and equipment proposed at the LNG facility and includes staff's conclusions and recommendations concerning the proposed project. Ultimately, these recommendations appear as conditions in any FERC Order approving the project.

Post-Authorization Inspection and Monitoring

Once a project is authorized, the comprehensive design review and inspection process continues. This occurs in two main phases during construction and during operation. If a company receives FERC Authorization for a project and has met all pre-construction conditions required by a FERC Order, the Director of OEP will authorize construction to begin.

The Director of OEP must issue written authorization before construction is allowed to commence. Prior to commencement of service from the LNG facility, the company must receive written approval from the Director of OEP. Only after complying with all pre-operation conditions listed in the Commission Order would a company receive authorization to begin operation.

Once in operation, each LNG facility under FERC jurisdiction is required to file semi-annual reports to summarize plant operations, maintenance activity and abnormal events for the previous six months. FERC staff conducts regular inspections (focusing on equipment, operation, safety and security) of each facility throughout its operational life.

IV. How to get involved in the review process

How will I first hear about proposed facility construction?

If you live in the vicinity of a proposed project you may first learn of it through newspaper

notices or a direct mailing from FERC or the Applicant. If the Pre-Filing Process is implemented on an LNG project you will likely learn about it through a variety of sources, such as open-house meetings sponsored by the LNG terminal developer, newspaper advertisements, notices mailed by FERC, or discussions with friends and neighbors. If you own land within a half mile of a proposed LNG site, you will be notified by the LNG terminal developer through Certified or First Class mail, in accordance with FERC regulations, once an application is filed with the Commission.

How can I obtain more details about the company's application?

FERC's records on a project are publicly accessible and can be obtained from the FERC website. The application or pre-filing papers may also be viewed or downloaded free of charge through the Commission's website, www.ferc.gov, using the "eLibrary" link and the project's docket number. User assistance is available at 1-866-208-3676.

Note that in most cases you will not be able to view or print copies of maps or similar locational information from the Commission's website. However, the website will provide instructions for obtaining the material.

How do I make my views known?

You may contact the company through the contact person listed in the notification you receive.

There are two ways to make your views known directly to FERC: first, if you want FERC to consider your views on the various environmental issues involved in the location of the facility, you can do so by simply writing a letter. The Commission undertakes several levels of environmental analysis. The Commission affords you the opportunity to comment at various stages in this process. Details are available from the Commission's Office of External Affairs at 1-866-208-3372. Check the Commission's website for details on filing electronically. By filing comments, your views will be considered and addressed in the environmental documents or a final order. Additionally, you will be placed on a mailing list to receive environmental documents in the case.

And the second way?

You may file to become an intervenor. Instructions on how to do this are available from the Commission's Office of External Affairs. Becoming an intervenor is not complicated and gives you official rights. As an intervenor, you will receive the applicant's filings and other Commission documents related to the case and materials filed by other interested parties. You will also be able to file briefs, appear at hearings and be heard by the courts if you choose to appeal the Commission's final ruling. However, along with these rights come responsibilities. For example, you must serve copies of your filings on all other parties.

Typically, you must file for intervenor status within 21 days of FERC's notice of the application in the Federal Register, although the Commission may accept late intervention for good cause. You may also file for intervenor status for the purposes of environmental issues during the comment period for a draft EIS.

A special case exists for projects FERC staff is reviewing under the Pre-Filing ("PF") Process. On PF cases, the objective is to engage all interested stakeholders (private citizens and the general public, affected landowners, as well as industry and resource or permitting agencies) in early open discussions with the goal of resolving substantive environmental issues before a formal application is filed.

Formal interventions are premature during a PF review and are not accepted at that time. Nevertheless, ample opportunity is provided for filing formal interventions after the required application is filed.

For additional information, contact:

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Other related FERC documents:

- [FERC Regulations Implementing the National Environmental Policy Act \(18 CFR Part 380\)](#)
- [Guidance on Risk Analysis and Safety Implication of a Large Liquefied Natural Gas \(LNG\) Spill Over Water , Sandia National Laboratory, 2004 \[PDF\]](#)
- [Guidance: FERC Staff NEPA PreFiling Involvement, February 10, 2004 \[PDF\]](#)
- [Consequence Assessment Methods for Incidents Involving Releases From Liquefied Natural Gas Carriers \[PDF\]](#)
- [Interagency Agreement For Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities \[PDF\]](#)
- [Staff Report: Ideas for Better Stakeholder Involvement In the Interstate Natural Gas Pipeline Planning PreFiling Process \[PDF\]](#)



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