

# A GUIDE TO LNG

LIQUEFIED NATURAL GAS



## WHAT ALL CITIZENS SHOULD KNOW



FEDERAL ENERGY  
REGULATORY COMMISSION  
OFFICE OF ENERGY PROJECTS  
WASHINGTON, DC  
[WWW.FERC.GOV/INDUSTRIES/LNG.ASP](http://WWW.FERC.GOV/INDUSTRIES/LNG.ASP)



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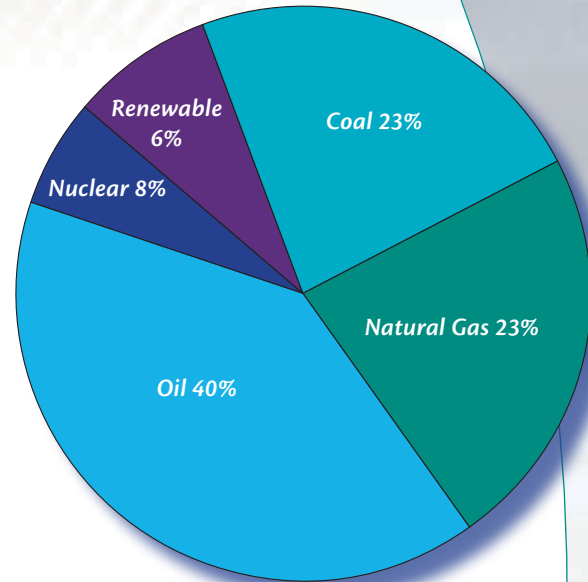
# I PURPOSE AND BACKGROUND

The purpose of "A Guide to LNG" is to provide citizens with information regarding the future demand for natural gas in the United States, the nature of LNG, the Federal Energy Regulatory Commission's (FERC) role in the development of new LNG facilities, and the role of citizens in the review process of LNG terminals.

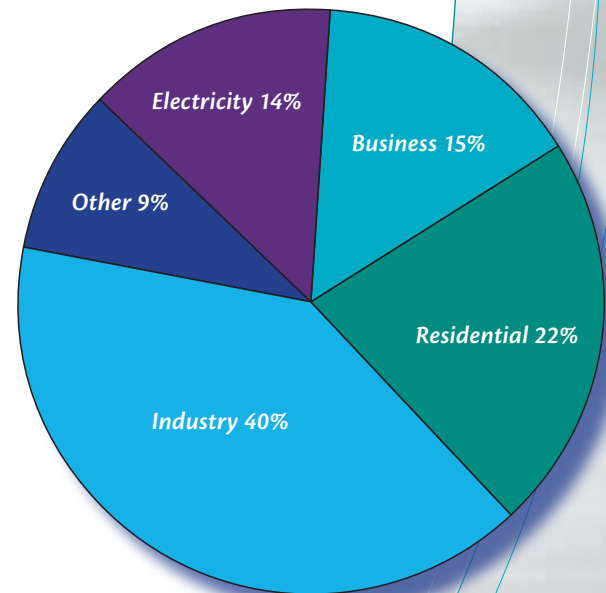
Natural gas accounts for almost one-fourth of all energy consumed in the United States and is vital to the economy. While currently not used as widely as oil or coal, natural gas has numerous benefits. It burns cleanly, produces fewer pollutants, is easy to transport, and has a variety of uses. Today 40 percent of natural gas consumption is for industrial activities; 22 percent is for residential uses, such as, heating cooling, and cooking; 15 percent is accounted for by the business sector; and 14 percent is used for electricity generation.

The U.S. Energy Information Administration forecasts natural gas demand will grow more than 38 percent by 2025. Natural gas consumption has a projected annual growth rate of 1.5 percent, while the total energy consumption is only expected to grow by 1.4 percent. Imports of natural gas are predicted to have an annual growth rate of 4.1 percent, compared to a growth in total energy imports of only 2.6 percent. The demand for natural gas is growing relative to the entire energy sector and increased demand will be met through importing natural gas into the country.

Natural gas production in the continental United States has reached its peak. The Lower 48 States are planning to acquire natural gas from Alaska, Canada, and Mexico via long pipelines. However, acquiring liquefied natural gas (LNG) from overseas and Alaska will play an increasingly important role in meeting our nation's present and future needs. This will require construction of new LNG import terminals.



**U.S. Energy Consumption in 2004 by Fuel Type**



**Natural Gas Consumption in the U.S.**

# II

## LNG FACTS

### What is LNG?

Natural gas 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 to store and transport.

### Where does LNG come from?

Natural gas is converted to its liquid state at export facilities called liquefaction plants. Algeria, Indonesia, Malaysia, Qatar, and Trinidad are currently the leading exporters of LNG. Australia, Iran, Nigeria, Russia, and other countries also have the potential to export LNG. LNG is imported by many countries, such as the U.S. and especially Japan, where 97% of their natural gas comes from LNG. Japan has 27 LNG terminals.

*Trinidad and Tobago in the Caribbean provide 66 percent of the U.S. LNG imports.*



### 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 consist of an outer hull, inner hull, and cargo containment system. In membrane tank designs, the cargo is contained by an Invar or stainless steel double-walled liner that is structurally supported by the vessel's inner hull. The second design uses structurally independent spherical or prismatic shaped tanks. These tanks are constructed of either stainless steel or an aluminum alloy.

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 trucks, which are regulated by the Department of Transportation. LNG tanker trucks typically carry between 10,000 and 12,000 gallons of LNG; enough to supply the daily needs of approximately 1,000 homes. LNG trucks are used to deliver LNG from import terminals or inland liquefaction facilities 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 LNG import 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.

### Who authorizes LNG facilities?

Under the Natural Gas Act, as amended, FERC has the exclusive authority to approve or deny an application for siting, construction, expansion, or operation of LNG terminal facilities, including pipelines, and offshore facilities in State waters. 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.





*The Coast Guard provides security as LNG ship docks at terminal*

Courtesy, U.S. Coast Guard

### **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.

### **Is LNG Explosive?**

LNG is not explosive or flammable in its liquid state.

### **What happens when LNG is warmed?**

As a vapor, natural gas mixed with air is flammable only in the concentration mixtures of 5% to 15%. As LNG vapor warms above  $-160^{\circ}\text{F}$  ( $-106.7^{\circ}\text{C}$ ), 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.

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.



*LNG is pumped from ship to insulated storage tanks*

Courtesy, FERC

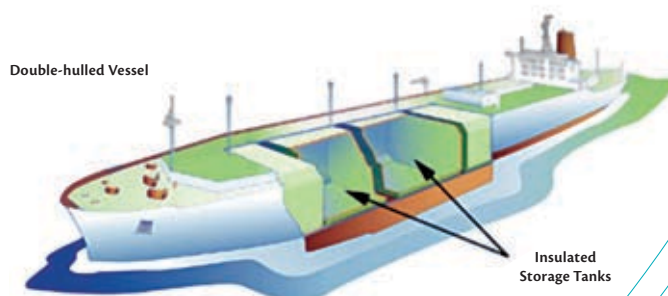
### **How are terminals designed?**

All LNG storage facility designs must comply with stringent regulations as required by the Department of Transportation'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 natural gas vapors or a cloud could travel from an onshore LNG facility and still be flammable. The standards require that the vapor exclusion zone must not reach beyond a property line that can be built upon, thereby resulting in a distinct hazard.

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

Double-hulled Vessel



Insulated Storage Tanks

Courtesy: Center for Liquefied Natural Gas

### **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's Environmental Impact Statements of each LNG facility (see page 6) discuss potential fires and vapor clouds, their size, and the hazards they create.

### **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. No serious accidents involving an LNG terminal facility in the U.S. have occurred 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.

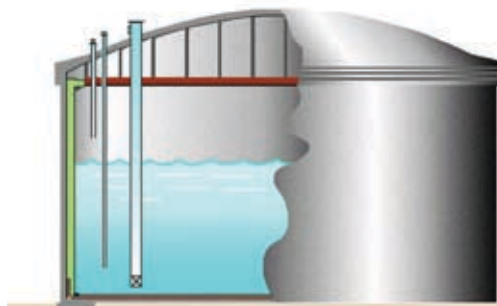
That tank was built during World War II, when metals were strictly rationed, using a steel alloy that had low nickel content. The low nickel content made the tank brittle when exposed to the extreme cold of LNG.

Modern LNG tanks are constructed with materials proven capable of safely containing LNG at cryogenic temperatures ( $-260^{\circ}\text{F}$ ). 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 occur.

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.

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



**Cross section of double-walled  
insulated tanks used to store LNG**



**LNG terminal complex**

### **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.

### **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 and the Department of Homeland Security's Transportation Security Administration 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.



If LNG spills and vaporizes in the presence of an ignition source, a fire could result and burn back toward the source of the spill. In this case, the LNG operator will follow procedures outlined in the Emergency Response Plan to contain and/or extinguish the fire. These procedures may include isolating and shutting off the source of fuel and then using high-expansion foam to contain the fire. They may also protect adjacent structures from heat with water. 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 the 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.

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, FERC, the Coast Guard, and the Department of Transportation entered into an Interagency Agreement for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities. The agreement, among other things, describes 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.

A condition placed in every LNG terminal approval gives the Director of FERC's Office of Energy Projects 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.



*The Coast Guard provides security for LNG tanker*

Courtesy: U.S. Coast Guard



Courtesy: U.S. Coast Guard

*Safety and security are the number one priority for LNG operators and regulators*

# III THE FERC REVIEW PROCESS FOR LNG PROJECTS

(PRE-FILING THROUGH OPERATION)

The FERC LNG Program assures the safe operation and system reliability of proposed and operating jurisdictional LNG facilities throughout the United States. FERC coordinates closely with the Coast Guard and Department of Transportation 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 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-decision review; and post-decision inspection and monitoring.

## Pre-Filing Technical Consultation

Prior to a company filing an LNG-related application, company representatives 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 proposals. LNG project applicants are also required 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. The process requires applicants to engage stakeholders in early discussions and resolution of issues that must be addressed for each project.

## Pre-Decision Review

Prior to any Commission decision regarding an application for a new LNG terminal, FERC staff prepares an Environmental Impact Statement 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.

*LNG projects approved by FERC may be constructed and operated, only after obtaining Clean Water Act, Coastal Zone Management Act, and Clean Air Act permits.*

In addition, 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



*A complete and seamless review of LNG operations is coordinated by FERC, Coast Guard, and Department of Transportation*

Courtesy: U.S. Coast Guard

Engineers, the U.S. EPA, and the States in fulfilling the requirements of the Clean Water Act, the Rivers and Harbors Act, the Clean Air Act, and the Coastal Zone Management 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 Environmental Impact Statement.*

The NEPA documents for new LNG facilities (and major expansions of existing sites) include a thorough 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 the Department of Transportation'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 Environmental Impact Statement.

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 significant component of this analysis is the *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, FERC 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, and
- ◆ 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 approval for a project and has met all pre-construction conditions required by a FERC Order, the Director of Office of Energy Projects will authorize construction to begin.

*LNG terminal owners must receive written authorization from the Office of Energy Projects Director at FERC prior to beginning any construction and operations.*

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.

## Cryogenic Design Review

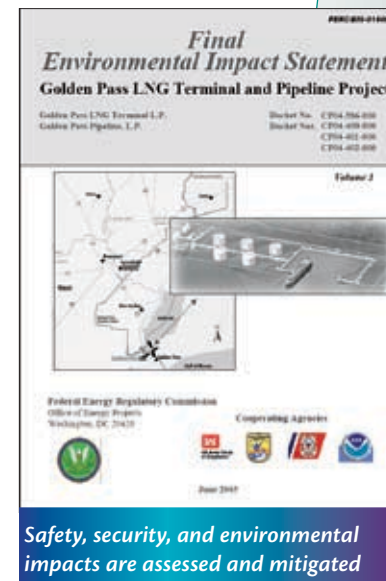
FERC reviews Cryogenic Design and Safety of Project

Technical Conference

Coast Guard / FERC Workshops

Waterway Suitability Report

Coast Guard Letter of Recommendation (issued independently)



# IV GETTING INVOLVED IN THE REVIEW PROCESS

## *How will I first hear about a proposed LNG facility?*

If you live in the vicinity of a proposed project, you may learn of it first through newspaper notices or a direct mailing from FERC or the applicant. Once the mandatory Pre-Filing Process is implemented on an LNG project, you will learn about it through a variety of sources, such as open-house meetings sponsored by the LNG proponent, 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 FERC.

## *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 FERC's website, [www.ferc.gov](http://www.ferc.gov), using the "eLibrary" link and the project's docket number. User assistance is available at 1-866-208-3676 (toll-free).

In most cases you will not be able to view or print copies of maps or similar locational information from the FERC 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. FERC undertakes several levels of environmental analysis and 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 (toll-free). Check the FERC 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.

Secondly, you may file to become an intervenor. Instructions on how to do this are available from FERC's Office of External Affairs and the FERC website at [www.ferc.gov/help/how-to/intervene.asp](http://www.ferc.gov/help/how-to/intervene.asp). 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 also will 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,



*Citizens participate in site visit with FERC staff*

Courtesy FERC

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 Environmental Impact Statement.

*The Pre-Filing Process engages all interested stakeholders in early open discussions with the goal of resolving substantive environmental, safety, and security issues before a formal application is filed.*

Formal interventions are not accepted during the mandatory Pre-filing Review Process. Nevertheless, ample opportunity is provided for filing formal interventions after the required application is filed.







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