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Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation

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Liquefied Natural Gas (LNG) Import Terminals: Siting, Safety and Regulation

Summary

Liquefied natural gas (LNG) is a hazardous fuel frequently shipped in large tankers to U.S. ports from overseas. While LNG has historically made up a small part of U.S. natural gas supplies, rising gas prices, current price volatility, and the possibility of domestic shortages are sharply increasing LNG demand. To meet this demand, energy companies have proposed building dozens of new LNG import terminals throughout the coastal United States. But many of these terminals would be built onshore near populated areas, so local communities fear the terminals would expose them to unacceptable safety and security hazards. Potentially catastrophic pool fires or vapor cloud fires could arise from a serious accident or attack on LNG infrastructure. Faced with the widely perceived need for greater LNG imports, and persistent public concerns about LNG safety, Congress is examining the adequacy of safety provisions in federal LNG siting regulation.

The Federal Energy Regulatory Commission (FERC) grants federal approval for the siting of new onshore LNG facilities under the Natural Gas Act of 1938. This approval process incorporates minimum safety standards for LNG established by the Department of Transportation, which, in turn, incorporate siting standards set by the National Fire Protection Association (NFPA). Although LNG has had a record of relative safety for the last 40 years, and no LNG tanker or land-based facility has been attacked by terrorists, experts have questioned the adequacy of key LNG siting regulations related to safety zones, marine hazards, hazard modeling, and remote siting. Experts have also questioned the validity of LNG hazard studies used by federal regulatory agencies which suggest that LNG terminal risks, while significant, are not as serious as is popularly believed.

Congress may not see a compelling need to change current federal LNG siting requirements if it views the current regulations and processes as sufficient. Holders of this view would continue to rely on the judgment of LNG experts in federal agencies and standards committees to appropriately balance local public safety with national energy needs. While there have been some concerns about specific regulatory provisions, Congress may believe that the responsible government agencies are actively and cooperatively addressing these concerns. On the other hand, Congress may conclude that some aspects of new LNG terminals do pose excessive public risks, or that there is still too much uncertainty about key risks to make final conclusions about public safety. In this case, Congress has several options to further address LNG terminal safety concerns. These options include 1) banning onshore LNG terminals, 2) increasing local LNG siting authority, 3) imposing more stringent federal LNG safety standards, 4) encouraging more LNG research, 5) curbing U.S. natural gas demand, and 6) developing alternatives to natural gas imports. Each of these policy alternatives has significant limitations, however, and may have undesirable consequences for national energy markets and other hazardous material infrastructure. This report will be updated as events warrant.

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Liquefied Natural Gas (LNG) Terminals: Siting, Safety and Regulation

Introduction

Liquefied natural gas (LNG) has long played a role in U.S. energy markets, but concerns about rising natural gas prices, current price volatility, and the possibility of domestic shortages are sharply increasing demand for LNG imports. To meet this demand, dozens of new onshore and offshore LNG import terminals have been proposed in coastal regions throughout the United States. But LNG is a hazardous¹ liquid transported and stored in enormous quantities, often near populated areas. Concerns exist about the safety hazards of new LNG import terminals and the federal government's role in addressing LNG safety in the terminal siting process. In addition, various energy policy proposals could impact the need for new LNG terminals by encouraging the development of alternative U.S. energy supplies and promoting conservation.

This report provides an overview of recent industry proposals for new LNG import terminals. The report summarizes LNG safety hazards and the industry's safety record. It summarizes federal laws and regulations related to LNG terminal siting with a focus on the authorities of key federal agencies and safety provisions in the permitting of onshore facilities. The report discusses controversial safety issues in recent LNG siting proceedings, such as safety zones, marine hazards, hazard modeling, and remote siting. The report outlines policy options related to LNG terminal safety, including 1) banning onshore terminals, 2) increasing local authority, 3) imposing more stringent standards, 4) encouraging more LNG research, 5) curbing gas demand, and 6) developing alternatives to natural gas imports.

Issues Facing Congress

Proposed LNG terminals will directly impact the safety of communities in a number of states and Congressional districts, and they are likely to influence energy costs nationwide. Faced with the widely perceived national need for greater LNG imports, and persistent public concerns about LNG hazards, some in Congress are examining the adequacy of safety provisions in federal LNG siting regulation. If Congress concludes that new LNG terminals as currently regulated will pose an unacceptable risk to public safety, Congress may consider additional LNG safety-related legislation, or may exercise its oversight authority in other ways to influence LNG terminal siting approval. Alternatively, Congress may consider other changes in U.S. energy policy legislation to reduce the nation's demand for natural gas.

¹ 49 C.F.R. § 172.101. *List of Hazardous Materials*. Office of Hazardous Materials Safety, Department of Transportation.

Scope and Limitations

This report focuses on industry and federal activities related to safety in LNG import terminal siting. The report does not address the full range of state and local issues of potential interest to policy makers. The report also focuses on the potential impacts on communities and populations near an LNG terminal, rather than employee safety and general security issues. (For a comprehensive discussion of LNG security see CRS Report RL32073, *Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress*, by Paul W. Parfomak.) This report also deals primarily with those parts of LNG terminals which transfer, store and process LNG prior to injection to natural gas pipelines for transmission off site. For more discussion of general natural gas or pipeline hazards see CRS Report RL31990, *Pipeline Security: An Overview of Federal Activities and Current Policy Issues*, by Paul W. Parfomak. Last, this report discusses mostly onshore facilities and near-shore shipping, since they pose the greatest public hazards. Offshore LNG terminal siting regulations are summarized in the Appendix.

Background

What Is LNG and Where Does It Come From?

When natural gas is cooled to temperatures below minus 260° F it condenses into liquefied natural gas, or LNG. As a liquid, natural gas occupies only 1/600th the volume of its gaseous state, so it is stored more effectively in a limited space and is more readily transported. A single tanker ship, for example, can carry huge quantities of LNG — enough to supply the daily energy needs of over 10 million homes. When LNG is warmed it “regasifies” and can be used for the same purposes as conventional natural gas such as heating, cooking, and power generation.

In 2003, LNG imports to the United States originated primarily in Trinidad (77%), Algeria (10%), and Nigeria (9%). Some shipments also came from Qatar, Oman, and other countries.² Malaysia, Brunei, Australia, Indonesia, and the United Arab Emirates also export LNG, and may be significant U.S. suppliers in the future. In addition to importing LNG to the lower 48 states, the United States exports Alaskan LNG to Japan.

Expectations for U.S. LNG Import Growth

The United States has used LNG commercially since the 1940s, but LNG imports have until recently been small because low domestic natural gas prices made imports uncompetitive. In 2002, for example, LNG imports accounted for only 1% of total U.S. gas consumption. Among several countries with limited domestic gas reserves, however, LNG imports are substantial. Japan, for one, imports 97% of its natural gas supply as LNG — several times as much LNG as the United States. South Korea, France, Spain, and Taiwan are also large LNG importers.

² Jowdy, M. “U.S. LNG Import Levels Double in 2003.” *Oil Daily*. Jan. 15, 2004. p5.

Natural gas demand has accelerated in the U.S. over the last several years due to environmental concerns about other energy sources, widespread building of natural gas-fired electricity generation, and low natural gas prices through the 1980s and 1990s. Domestic gas supplies have not kept up with this demand, however, so prices have recently become high and volatile. At the same time, international prices for LNG have fallen substantially because of increased supplies and lower production and transportation costs, making LNG more competitive with domestic natural gas.

In recent testimony before Congress, the Federal Reserve Chairman called for a sharp increase in LNG imports to help avert a potential barrier to the U.S. economic recovery. According to the Chairman's testimony: "... high gas prices projected in the American distant futures market have made us a potential very large importer... Access to world natural gas supplies will require a major expansion of LNG terminal import capacity."³ If current natural gas trends continue, industry analysts predict that LNG imports could increase to 20% of total U.S. gas supply by 2020.⁴

Proposed LNG Import Terminals in the United States

LNG tankers unload their cargo at dedicated marine terminals which store and regasify the LNG for distribution to domestic markets. Onshore terminals consist of docks, LNG handling equipment, storage tanks, and interconnections to regional gas transmission pipelines and electric power plants. Offshore terminals regasify and pump the LNG directly into offshore natural gas pipelines or may store LNG in undersea salt caverns for later injection into offshore pipelines.

There are five active onshore LNG import terminals in the United States at Everett, Massachusetts; Lake Charles, Louisiana; Cove Point, Maryland; Elba Island, Georgia; and Peñuelas, Puerto Rico. There is also an export terminal in Kenai, Alaska. In addition to these active terminals, developers have been proposing numerous new LNG import terminals in the coastal United States. **Table 1** lists summary information for recent LNG terminal proposals. As **Table 1** shows, many proposed LNG terminals would be located offshore, in part to avoid community opposition and siting obstacles which have delayed or prevented the construction of new on-shore LNG terminal facilities.⁵ Additional terminals to serve U.S. markets have also been proposed in the Bahamas, Mexico, and Canada.

³ Greenspan, A., Chairman, U.S. Federal Reserve Board. "Natural Gas Supply and Demand Issues." Testimony before the House Energy and Commerce Committee. June 10, 2003.

⁴ Yergin, Daniel and Stoppard Michael. "The Next Prize." *Foreign Affairs*. Nov./Dec. 2003.

⁵ Zeus Development Corp. "Six New Offshore Terminal Designs May Expedite LNG Deliveries." Latin Petroleum Analytics. Houston, TX. June 11, 2003.

Table 1. Recently Proposed U.S. LNG Terminals

Location	Name	Developer	Type	Permit Status
Valdez, AK	Valdez	Yukon Pacific	Onshore	Approved*
Mobile, AL	Mobile Bay	Exxon Mobil	Onshore	Applying 2004
Mobile, AL	Pinto Island	Cheniere Energy	Onshore	Studying feasibility
Oxnard, CA	Cabrillo Port	BHP Billiton	Offshore	Reapplying early 2004
Oxnard, CA	Platform Grace	Crystal / Chevron	Offshore	Studying feasibility
Long Beach, CA	Long Beach	Mitsubishi	Onshore	Application filed
Samoa, CA	Humboldt Bay	Calpine	Onshore	Studying feasibility
Vallejo, CA	Mare Island	Bechtel / Shell	Onshore	Developers withdrew
Tampa, FL	Tampa Bay	BP	Onshore	Developer withdrew
Gulf of Mexico, LA	Liberty	HNG Storage/ CGI	Offshore	Developers withdrew
Gulf of Mexico, LA	Energy Bridge	Excelerate Energy	Offshore	Application filed
Gulf of Mexico, LA	Gulf Landing	Shell	Offshore	Application filed
Gulf of Mexico, LA	Main Pass	McMoran	Offshore	Applying early 2004
Gulf of Mexico, LA	Vermillion 179	HNG Storage/ CGI	Offshore	Studying feasibility
Gulf of Mexico, LA	Port Pelican	ChevronTexaco	Offshore	Approved
Hackberry, LA	Cameron LNG	Sempra	Onshore	Approved
Sabine Pass, LA	Sabine Pass	Cheniere Energy	Onshore	Application filed
Fall River, MA	Weaver's Cove	Poten & Partners	Onshore	Application filed
Somerset, MA	Somerset	Somerset LNG	Onshore	Applying early 2004
Harpswell, ME	Fairwinds	Conoco / TCPL	Onshore	Studying feasibility
Sears Island, ME	Sears Island	Not disclosed	Onshore	Studying feasibility
Belmar, NJ	Energy Bridge	Excelerate Energy	Offshore	Studying feasibility
Logan Twp., NJ	Crown Point	BP	Onshore	Studying feasibility
Providence, RI	Fields Point	KeySpan	Onshore	Studying feasibility
Brownsville, TX	Brownsville	Cheniere Energy	Onshore	Studying feasibility
Corpus Christi, TX	Corpus Christi	Cheniere Energy	Onshore	Application filed
Corpus Christi, TX	Corpus Christi	Exxon Mobil	Onshore	Applying 2004
Corpus Christi, TX	Corpus Christi	Occidental Petrol.	Onshore	Studying feasibility
Freeport, TX	Freeport	Cheniere Energy	Onshore	Application filed
Ingleside, TX	Ingleside	ExxonMobil	Onshore	Studying feasibility
Sabine Pass, TX	Golden Pass	Exxon Mobil	Onshore	Application filed

*Export terminal; project is currently suspended by the developer.

Source: Trade press; Company Web sites

Safety Hazards from LNG Terminals

The safety hazards associated with LNG terminals have been debated for decades. A 1944 accident at one of the nation's first LNG facilities which killed 128 people initiated public fears about LNG hazards which persist today.⁶ Technology improvements and standards since the 1940's have made LNG facilities much safer, but serious hazards remain since LNG is inherently volatile and is usually shipped and stored in large quantities. The January 2004 accident at Algeria's Skikda LNG terminal which killed or injured over 100 workers has added to the current controversy over LNG facility safety.⁷

Physical Hazards of LNG

Natural gas is combustible, so an uncontrolled release of LNG poses a hazard of fire or, in confined spaces, explosion. LNG also poses hazards because it is so cold. The likelihood and severity of catastrophic LNG events have been the subject of controversy. While questions remain about the credible impacts of specific LNG hazards, there appears to be consensus as to what the most serious hazards are.

Pool Fires. If LNG spills near an ignition source, the evaporating gas in a combustible gas-air concentration will burn above the LNG pool.⁸ The resulting "pool fire" would spread as the LNG pool expanded away from its source and continued evaporating. A pool fire is intense, burning far more hotly and rapidly than oil or gasoline fires.⁹ It cannot be extinguished — all the LNG must be consumed before it goes out. Because an LNG pool fire is so hot, its thermal radiation may injure people and damage property a considerable distance from the fire itself. Many experts agree that a large pool fire, especially on water (due to heat transfer), is the most serious LNG hazard.¹⁰

Other Safety Hazards. LNG spilled on water could (theoretically) regasify almost instantly in a "flameless explosion," but an Idaho National Engineering Laboratory report concluded that "transitions caused by mixing of LNG and water are not violent."¹¹ LNG vapor clouds are not toxic, but they could cause asphyxiation by

⁶ Bureau of Mines (BOM). *Report on the Investigation of the Fire at the Liquefaction, Storage, and Regasification Plant of the East Ohio Gas Co., Cleveland, Ohio, October 20, 1944.* February, 1946.

⁷ Junnola, Jill *et al.* "Fatal Explosion Rocks Algeria's Skikda LNG Complex." *Oil Daily.* Jan. 21, 2004. p6.

⁸ Methane, the main component of LNG, burns in gas-to-air ratios between 5% and 15%.

⁹ Havens, Jerry. "Ready to Blow?" *Bulletin of the Atomic Scientists.* July/August 2003. p17.

¹⁰ Havens. 2003. p17.

¹¹ Siu, Nathan *et al.* *Qualitative Risk Assessment for an LNG Refueling Station and Review of Relevant Safety Issues.* Idaho National Engineering Laboratory. INEEL/EXT-97-00827 rev2. Idaho Falls, ID. February, 1998. p71.

displacing breathable air.¹² Such clouds rise in air as they warm, however, diminishing the threat to people on the ground. Extremely cold LNG could injure people or damage equipment through direct contact.¹³ The extent of such contact would likely be limited, however, as a major spill would likely result in a more serious fire. The environmental damage associated with an LNG spill would be confined to fire and freezing impacts near the spill since LNG dissipates completely and leaves no residue.¹⁴

Terrorism Hazards. LNG tankers and land-based facilities could be vulnerable to terrorism. Tankers might be physically attacked in a variety of ways to destroy their cargo — or commandeered for use as weapons against coastal targets. LNG terminal facilities might also be physically attacked with explosives or through other means. Some LNG facilities may also be indirectly disrupted by “cyber-attacks” or attacks on regional electricity grids and communications networks which could in turn affect dependent LNG control and safety systems.¹⁵

Safety Record of LNG

The LNG tanker industry claims an impressive safety record over the last 40 years; since international LNG shipping began in 1959, tankers have carried over 33,000 LNG cargoes without a serious accident at sea or in port.¹⁶ LNG tankers have experienced groundings and collisions during this period, but none has resulted in a major spill. The LNG marine safety record is partly due to the double-hulled design of LNG tankers. This design makes them more robust and less prone to accidental spills than single-hulled oil, fuel, and chemical tankers like the *Exxon Valdez*, which caused a major Alaskan oil spill after grounding in 1989.¹⁷ LNG tankers also carry radar, global positioning systems, automatic distress systems and beacons to signal if they are in trouble. Cargo safety systems include instruments that can shut operations if they deviate from normal as well as gas and fire detection systems.¹⁸

The safety record of onshore LNG terminals is more mixed. There are approximately 40 LNG terminals (and more than 150 other LNG storage facilities) worldwide. Since 1944, there have been approximately 13 serious accidents at these facilities directly related to LNG. Two of these accidents caused single fatalities of facility workers — one in Algeria in 1977, and another at Cove Point, Maryland, in

¹² Siu. 1998. p62.

¹³ Siu. 1998. p63.

¹⁴ Quillen. 2002. p28.

¹⁵ Skolnik, Sam. “Local Sites Potential Targets for Cyberterror.” *Seattle Post-Intelligencer*. Seattle, WA. Sept. 2, 2002.

¹⁶ Delano, Fisoye et al. “Introduction to LNG.” University of Houston Law Center, Institute for Energy, Law and Enterprise. Houston, TX. January, 2003. p23.

¹⁷ Juckett, Don. U.S. Department of Energy (DOE). “Properties of LNG.” LNG Workshop. Solomons, MD. February 12, 2002.

¹⁸ Petroplus International, N.V. “Energy for Wales: LNG Frequently Asked Questions.” Internet home page. Amsterdam, Netherlands. August 4, 2003.

1979. On January 19, 2004, a fire at the LNG processing facility in Skikda, Algeria killed an estimated 27 workers and injured 74 others. The Skikda fire completely destroyed the processing plant and damaged a marine berth, although it did not damage a second processing plant or three large LNG storage tanks also located at the terminal.¹⁹ The Skikda accident did not injure the rest of the 12,000 workers at the complex, but it was considered the worst petrochemical plant fire in Algeria in over 40 years.²⁰ According to press reports, early indications were that the accident resulted from poor maintenance rather than a facility design flaw.²¹ Another three accidents at worldwide LNG plants since 1944 have also caused fatalities, but these were construction or maintenance accidents in which LNG was not present.²²

Safety Regulations in Onshore LNG Siting

The Department of Transportation (DOT) and the Federal Energy Regulatory Commission (FERC) are the federal agencies primarily responsible for the regulation of onshore LNG facilities. Although federal statutes do not explicitly designate the relative jurisdiction of DOT and FERC, the agencies have clarified their roles through interagency agreement. These roles and their relation to other authorities are summarized below.

Department of Transportation

The DOT sets safety standards for onshore LNG facilities. The DOT's authority originally stemmed from the Natural Gas Pipeline Safety Act of 1968 (P.L. 90-481) and the Hazardous Liquids Pipeline Safety Act of 1979 (P.L. 96-129). These acts were subsequently combined and recodified as the Pipeline Safety Act of 1994 (P.L. 102-508), and amended again in 2002 by the Pipeline Safety Improvement Act (P.L. 107-355). Under the resulting statutory scheme, DOT is charged with issuing minimum safety standards for the siting, design, construction, and operation of LNG facilities.

The Pipeline Safety Act, as amended, includes the following provisions concerning LNG facility siting (49 U.S.C. § 60103):

The Secretary of Transportation shall prescribe minimum safety standards for deciding on the location of a new liquefied natural gas pipeline facility. In prescribing a standard, the Secretary shall consider the —

- (1) kind and use of the facility;
- (2) existing and projected population and demographic characteristics of the location;

¹⁹ Junnola, Jill et al. Jan. 21, 2004. p6.

²⁰ Hunter, Catherine. "Algerian LNG Plant Explosion Sets Back Industry Development." *World Markets Analysis*. Jan. 21, 2004. p1.

²¹ Antosh, Nelson. "Vast Site Devastated." *Houston Chronicle*. Jan. 21, 2004. pB1.

²² CH-IV International. pp6-12.

- (3) existing and proposed land use near the location;
- (4) natural physical aspects of the location;
- (5) medical, law enforcement, and fire prevention capabilities near the location that can cope with a risk caused by the facility; and
- (6) need to encourage remote siting.

General safety-related regulations may also impact siting decisions and affect the operation of existing facilities. The statute requires the Secretary of Transportation to consider geophysical risks, proximity to populations, adequacy of emergency services, operator qualifications, and security measures when promulgating LNG facility rules (49 U.S.C. § 60103). The Secretary is authorized to order corrective action if operating an LNG facility could be hazardous to life, property, or the environment (49 U.S.C. §§ 60112, 60117). DOT's implementing regulations for the Pipeline Safety Act, as amended, are in 49 C.F.R. §§ 191-199. Safety standards, including those on siting, for LNG facilities are in 49 C.F.R. § 193 and are overseen by the Department's Office of Pipeline Safety within the Research and Special Programs Administration.

The siting provisions in 49 C.F.R. § 193 incorporate by reference standard 59A from the National Fire Protection Association (NFPA).²³ NFPA 59A requires thermal exclusion zones and flammable vapor-gas dispersion zones around LNG terminals (§§ 193.2057, 193.2059). While it establishes these minimal siting requirements, DOT does not itself approve or deny specific siting proposals, with such authority instead vested in the Federal Energy Regulatory Commission. The DOT regulations also adopt many of NFPA's design and construction guidelines including requirements for LNG facilities to withstand fire, wind, hydraulic forces, and erosion from LNG spills (§§ 193.2067, 193.2155, 193.2301). Other provisions address operations (§§ 193.2501-2521), maintenance (§§ 193.2601-2639), employee qualification (§§ 193.2701-2719), and security (§§ 193.2901-2917).

Federal Energy Regulatory Commission (FERC)

Under the Natural Gas Act of 1938 (NGA),²⁴ FERC grants federal approval for the siting of new onshore LNG facilities.²⁵ Section 7 of the Act authorizes FERC to issue certificates of "public convenience and necessity" for "the construction or extension of any facilities ... for the transportation in interstate commerce of natural gas" (15 U.S.C. § 717f). Section 7 does not expressly cover LNG facilities, however, so recent agency policy has FERC exercising LNG siting regulation under its Section

²³ National Fire Protection Association (NFPA). *Standard for the Production, Storage, and Handling of Liquefied Natural Gas*, 1996 Edition. NFPA 59A. Quincy, MA. 1996.

²⁴ Act of June 21, 1938, ch. 556, 52 Stat. 812, (codified as amended at 15 U.S.C. §§ 717 *et seq.*)

²⁵ The Department of Energy Organization Act of 1977 (P.L. 95-91) transferred to the Energy Secretary the original NGA authority to approve siting, construction and operation of onshore LNG facilities (§ 301b). The Secretary, in turn, delegated this authority to FERC.

3 authority.^{26,27} Section 3 of the Act authorizes FERC to approve the import and export of natural gas (15 U.S.C. § 717b). Specifically, FERC asserts approval authority over the place of entry and exit, siting, construction, and operation of new LNG terminals as well as modifications or extensions of existing LNG terminals.²⁸

The FERC implements its authority over onshore LNG terminals through the agency's regulations at 18 C.F.R. § 153. These regulations detail the application process and requirements under Section 3 of the NGA. FERC's requirements include detailed site engineering and design information, evidence that a facility will safely receive or deliver LNG, and delineation of a facility's proposed location (18 C.F.R. § 153.8). Additional data are required if an LNG facility will be in an area with geological risk (18 C.F.R. § 153.8). The regulations also require LNG facility builders to notify landowners (18 C.F.R. § 157.6d) as is required with section 7 approvals (18 C.F.R. § 153.3). Facilities to be constructed at the Canadian or Mexican borders for import or export of natural gas also require a Presidential Permit. According to FERC officials, applications under their Section 3-based regulations are also sufficient for Presidential Permit purposes (18 C.F.R. §§ 153.15-153.17).²⁹

Under the National Environmental Policy Act of 1969 (P.L. 91-190), FERC must prepare an environmental impact statement in its review of an LNG terminal siting application (18 C.F.R. § 380). FERC's review requires 13 Environmental Resource Reports, five of which are applicable specifically to LNG facilities. These reports require analysis of, among other things, the socioeconomic impact of the LNG facility; geophysical characteristics of the site; safeguards against seismic risk; facility effects on air and noise quality; public safety issues in the event of accidents or malfunctions; and facility compliance with reliability standards and relevant safety standards (18 C.F.R. § 380.12). While FERC's above-mentioned environmental report provisions do not direct the outcome of final Commission action, they could have substantial impact on LNG siting decisions.

FERC-DOT Jurisdictional Issues. While FERC uses DOT standards, jurisdiction among the federal agencies with LNG oversight responsibilities has been

²⁶ California Energy Commission (CEC). *Liquefied Natural Gas in California: History, Risks and Siting*. No.700-03-005. Sacramento, CA. at 16; 94 FERC 61,188 at 61,663.

²⁷ In 1997, FERC reaffirmed its Section 3 authority despite changes to the Natural Gas Act in the Energy Policy Act of 1992 (P.L. 102-486). For details see 97 FERC 61,231 (2001). Also note that FERC's regulatory power regarding LNG importation under section 3 has been held to allow the Commission to impose requirements equivalent to any in section 7, so long as the Commission finds them necessary or appropriate to the public interest. *Distrigas Corp. v. FPC*, 495 F.2d 1057, 1066 (D.C. Cir. 1974).

²⁸ See 18 C.F.R. § 153; see also Foley, R. Federal Energy Regulatory Commission (FERC), Office of Energy Projects. "Liquefied Natural Gas Imports." Slide presentation. Jan. 2003 at 10.

²⁹ Federal Energy Regulatory Commission (FERC), Office of Energy Projects. Personal communication. Dec. 10, 2003.

a point of contention at times.³⁰ In practice, FERC requires compliance with DOT's siting and safety regulations as a starting point, but can regulate more strictly if it chooses. This working arrangement is not explicitly established under the relevant federal law. Neither do the statutes and regulations clearly define the roles of the agencies vis-a-vis one another. The revised Pipeline Safety Act, for example, states:

In a proceeding under section 3 or 7 of the Natural Gas Act (15 U.S.C. § 717b or 717f), each applicant ... shall certify that it will design, install, inspect, test, construct, operate, replace, and maintain a gas pipeline facility under ... section 60108 of this title. The certification is binding on the Secretary of Energy and the Commission... (49 U.S.C. § 60104(d)(2)).

Despite this provision, which might appear to give DOT full control of gas safety regulation (including LNG siting authority), the authors of the associated House committee report indicated their intention to preserve FERC jurisdiction over LNG.³¹ Accordingly, FERC has held that the Pipeline Safety Act does not remove its jurisdiction under the NGA to regulate LNG safety issues.³² In 1985, FERC and DOT executed a Memorandum of Understanding expressly acknowledging "DOT's exclusive authority to promulgate Federal safety standards for LNG facilities" but recognizing FERC's ability to issue more stringent safety requirements for LNG facilities when warranted. This agreement appears to have resolved any jurisdictional conflict between the agencies at that time.³³ FERC, DOT and the United States Coast Guard (USCG) are currently negotiating another MOU to coordinate activities associated with the spate of new terminal applications, but the details of this MOU are not yet public.³⁴

National Fire Protection Association (NFPA)

As noted above, LNG terminal safety regulations incorporate standards set by the NFPA. The NFPA is an international nonprofit organization which advocates fire prevention and serves as an authority on public safety practices. According to NFPA, its 300 safety codes and standards "influence every building, process, service, design, and installation in the United States."³⁵ The NFPA LNG Standards Committee includes volunteer experts with diverse representation from industry and government, including FERC, DOT, USCG, and state agencies. The NFPA standards for LNG safety were initially adopted in 1967, with nine subsequent revisions, most recently in 2001.³⁶ According to the Society of International Gas Tanker and Terminal

³⁰ S. REP. NO. 96-182 at 4 (1979).

³¹ See H.R. REP. NO. 1390 (1968), *reprinted in* 1968 U.S.C.C.A.N. 3223, 3251.

³² *Chatanooga Gas Co.*, 51 FPC 1278, 1279 (1974).

³³ See "Notice of Agreement Regarding Liquefied Natural Gas," 31 FERC 61,232 (1985).

³⁴ FERC. Personal communication. Dec. 10, 2003.

³⁵ National Fire Protection Assoc. (NFPA). *About NFPA*. Web site. Quincy, MA. 2003.

³⁶ National Fire Protection Association (NFPA). *Standard for the Production, Storage, and Handling of Liquefied Natural Gas*, 2001 Edition. NFPA 59A. Quincy, MA. 2001.

Operators (SIGTTO), although the NFPA standards originated in the United States, they were the first internationally recognized LNG standards and are widely used throughout the world today.³⁷

State Regulatory Roles

While the federal government is primarily responsible for LNG terminal safety and siting regulation, state and local laws, such as environmental, health and safety codes, can affect LNG facilities as well. Under the Pipeline Safety Act, a state may also regulate *intrastate* pipeline facilities if the state submits a certification under section 60105(a) or makes an agreement with the DOT under section 60106. Under these provisions, a state “may adopt additional or more stringent safety standards” for LNG facilities so long as they are compatible with DOT regulations. (49 U.S.C. 60104(c)). Of course, if a particular LNG facility would otherwise not fall under FERC and DOT jurisdiction, states may regulate without going through the certification or agreement process. Regulation of *interstate* facilities remains the primary responsibility of federal agencies. The Office of Pipeline Safety may, however, authorize a state to “act as its agent to inspect interstate pipelines” associated with LNG facilities while retaining its enforcement responsibility.³⁸ As of 2002, all states but three were participants in the natural gas pipeline safety program and fifteen were in the hazardous liquid pipeline safety program.³⁹

State regulation of LNG facility safety and siting runs the gamut from comprehensive to piecemeal. In California, for example, the state Energy Commission recently established the LNG Interagency Permitting Working Group to coordinate its LNG terminal permitting process. The Working Group seeks “to ensure that any LNG development is consistent with state energy policy that balances environmental protection, public safety, and local community concerns.”⁴⁰ Arizona sets out specific requirements for LNG storage facilities, including “peak shaving” plants used by regional gas utilities, consistent with DOT regulations for construction maintenance and safety standards (Ariz. Admin. Code R14-5-202, R14-5-203, 126-01-001). Colorado and Georgia have similarly comprehensive administrative systems for enforcing the federal standards (See 4 Co. Admin. Code 723-11; Ga. Admin. Code 515-9-3-.03).

Apart from state regulation aimed specifically at LNG facilities, generally applicable state and local laws, such as zoning laws and permit requirements for water, electricity, construction, and waste disposal, also may serve to impact the

³⁶ (...continued)

Note that federal laws still refer to the 1996 revision of this standard.

³⁷ Society of International Gas Tanker and Terminal Operators (SIGTTO). Personal communication. London, England. Dec. 19, 2003.

³⁸ Office of Pipeline Safety, programs website at <http://ops.dot.gov/partnership.htm>.

³⁹ Office of Pipeline Safety, CY 2002, States Participating in the Federal/State Cooperative Gas and Hazardous Liquid Pipeline Safety Programs (April 2002).

⁴⁰ California Energy Commission, 2003 Integrated Energy Policy Report, Docket #02-IEP-01, Publication Number 100-03-019F at 29.

planning and development of LNG facilities. However, with respect to LNG in particular, local laws have been overridden by state legislation in the past.⁴¹ It should also be noted that a federally authorized LNG project cannot be frustrated by contrary provisions found in state or local law.⁴²

Recent Safety Issues in LNG Terminal Siting

Proposals for new LNG terminal facilities have generated considerable public concern in many of the communities where the terminals would be built. Some community groups and local officials fear that LNG terminals may expose them to unacceptable safety hazards, and that these safety hazards may not be appropriately evaluated in the federal siting approval process. They question the adequacy of safety exclusion zones and the lack of “remote siting” requirements in federal regulations. They are also concerned that FERC does not adequately account for maritime safety hazards associated with LNG tankers that would service new terminals. These issues are complicated by apparent contradictions among recent LNG hazard studies, including those used by the federal government to evaluate LNG terminal hazards.

Safety Exclusion Zones

Federal safety regulations require LNG terminals to be surrounded by “exclusion zones” to protect neighboring communities in the event of a pool fire or flammable vapor cloud (49 C.F.R. §§ 193.2057, 2059). For FERC site approval, a prospective LNG terminal owner or a government agency must exercise “legal control” of activities within such zones.⁴³ Critics of these LNG safety provisions argue that the thermal and vapor exclusion zones they specify may be too small, in part because the “design spills” on which they are based are too small.⁴⁴ They argue that catastrophes such as terrorist attacks on storage tanks could release far more LNG far more quickly than assumed in siting plans — resulting in larger, hotter pool fires or larger vapor clouds closer to nearby populations. Critics also argue that federally allowable levels of thermal radiation from pool fires are too high, since radiation at these levels could still burn people in a relatively short period of time. One recent report commissioned by opponents of the proposed Harpswell terminal,

⁴¹ *New England LNG Co., Inc. v. City of Fall River*, 331 N.E.2d 536 (Mass. 1975); *see also* Tessa Meyer Santiago, Note, An Ounce of Preemption Is Worth a Pound of Cure: State Preemption of Local Siting Authority As a Means for Achieving Environmental Equity, 21 VA. ENVTL. L.J. 71, 104 (2002).

⁴² *ANR Pipeline Co. v. Iowa State Commerce Comm’n*, 828 F.2d 465, 466 (8th Cir. 1987); *Algonquin LNG v. Loqa*, 79 F. Supp. 2d 49, 49-50, 53 (D.R.I. 2000).

⁴³ Federal Energy Regulatory Commission (FERC). *Hackberry LNG Project: Final Environmental Impact Statement*. FERC/EIS-0156. Washington, DC. Aug. 14, 2003. p4-65.

⁴⁴ Raines, B. “Congress Wanted LNG Plants at ‘Remote’ Sites.” *Mobile Register*. Mobile, AL. Nov. 16, 2003.

for example, concludes that “the federal safety requirements ... will not prevent harm to humans outside the site boundary for the spill scenarios that FERC considers.”⁴⁵

NFPA Perspectives. The NFPA LNG standards committee believes the 59A exclusion zone provisions are adequate, striking an appropriate balance between public safety and the public need for LNG facilities. The NFPA maintains that, unlike some critics’ assertions, the LNG committee based its standards not only on deep technical expertise, but also on 30 years of practical experience with liquefied gas facilities around the world. The NFPA has said there is no reason to change the current design spill provisions, nor any evidence that the catastrophic failure of an onshore LNG tank is plausible.⁴⁶

According to the NFPA, the LNG safety zone standards in 59A are more stringent than NFPA’s comparable standards for liquefied petroleum gases (e.g., propane, butane) and liquefied hydrogen gas, which are more widespread in the United States and potentially more hazardous than LNG.⁴⁷ FERC and other experts also consider the NFPA safety zone standard to be more stringent in important ways than the European standard (EN 1473).⁴⁸ For example, the European standard sees no need to consider a fire scenario for certain “full containment” LNG tanks, so it sets no minimum distance to the property line for such tanks, as NFPA 59A requires.⁴⁹ Unlike NFPA 59A, however, EN 1473 uses a risk based, case-by-case standard rather than a prescriptive standard, so only limited general conclusions can be drawn by comparing their distinct safety zone provisions. The EN 1473 committee acknowledges, however, that its standard could “possibly be manipulated given a weak or ill informed national regulatory body.”⁵⁰

The NFPA also believes its thermal radiation limits are appropriate. According to federal regulation, thermal radiation from a design spill can be no more than 1,600 Btu/ft²-hr at a “property line that can be built upon” or at an “outdoor assembly area occupied by 50 or more persons” (NFPA 59A 2-2.3.1).⁵¹ This radiation level would burn an exposed person within approximately 30 seconds, but would not ignite a wooden structure.⁵² The NFPA LNG standards committee acknowledges that heat exposure at 1,600 Btu/ft²-hr “is fatal quite quickly” and that this specific limit is

⁴⁵ Fay, James A., Nov. 5, 2003. p5.

⁴⁶ National Fire Protection Assoc. (NFPA). Technical Committee on Liquefied Natural Gas. Personal communication. Quincy, MA. Dec. 15, 2003.

⁴⁷ NFPA. Personal communication. Dec. 15, 2003. See *NFPA 58: Liquefied Petroleum Gas Code*, and *NFPA 50B: Standard for Liquefied Hydrogen Systems*.

⁴⁸ British Standards Institute (BSI). *EN 1473: Design of Onshore LNG Terminals*. London, England. 1997.

⁴⁹ Federal Energy Regulatory Commission (FERC). *Freeport LNG Project: Draft Environmental Impact Statement*. FERC/EIS-0164D. Washington, DC. Nov. 2003. p4-113.

⁵⁰ SIGTTO. Personal communication. Jan. 5, 2004

⁵¹ NFPA 2001.

⁵² FERC. Nov. 2003. p4-120.

“somewhat arbitrary.”⁵³ Nonetheless, the NFPA believes there would be sufficient alarm or other warning in an LNG release to allow potentially exposed individuals time to seek shelter or move further away from the exclusion zone before injury. Based on the its field experience, the NFPA believes the current thermal limit is reasonable and has no plans to revise it.⁵⁴

FERC Perspectives. Like NFPA, FERC officials believe the design spill and exclusion zone requirements in the DOT regulations are adequate to ensure public safety. In its recent draft evaluation of the proposed Freeport LNG terminal, the Commission does calculate thermal exclusion zones based on a major storage tank design spill. This spill assumes the release of 46.5 million gallons of LNG from an onshore storage tank, approximately 110% of the total tank capacity, resulting in a thermal exclusion zone of 914 feet from the tank.⁵⁵ The largest flammable vapor exclusion zone FERC considers, however, is based on a spill of approximately 220,000 gallons in the process area drain, resulting in a vapor exclusion zone of 2,111 feet from the drain.⁵⁶ FERC’s report does not consider vapor dispersion from a larger tank spill because the NFPA does not view such an event to be a credible failure.⁵⁷

FERC officials acknowledge that the impact of potential terror attacks is unpredictable. Nonetheless, FERC maintains that the more extreme scenarios suggested by some LNG terminal opponents are too theoretical and do not realistically reflect the actual configuration and physical characteristics of LNG terminal infrastructure, including the comprehensive safety and security features required in terminal design. For example, FERC officials disagree with the proposition that the entire contents of an LNG storage tank can spill instantly in FERC’s view “like lifting an upside-down dixie cup” as suggested by some critics.⁵⁸

Marine Safety Hazards

In addition to concerns about the adequacy of mandated safety exclusion zones, communities near proposed LNG terminals fear that FERC does not adequately account for potential safety hazards from LNG tankers serving those terminals.⁵⁹ As noted earlier in this report, LNG spills on water are potentially more dangerous than spills on land because LNG may spread much more quickly over water and is not readily contained. Consequently, some experts believe an LNG tanker accident or attack resulting in a major spill could pose a hazard to coastal communities along the

⁵³ NFPA. Personal communication. Dec. 15, 2003.

⁵⁴ NFPA. Personal communication. Dec. 15, 2003.

⁵⁵ FERC. Nov. 2003. pp4-119,120.

⁵⁶ FERC. Nov. 2003. p4-121.

⁵⁷ NFPA. Personal communication. Jan. 8, 2004.

⁵⁸ Federal Energy Regulatory Commission (FERC). Office of Energy Projects. Personal communication. Dec. 10, 2003.

⁵⁹ Raines, B. and Finch, B. “Who Gauges Tanker Hazard?” *Mobile Register*. Mobile, AL. Oct. 26, 2003.

tanker's route. These concerns have led, for example, to (unsuccessful) attempts by the mayor of Boston to permanently suspend LNG shipments to the Everett terminal passing through Boston harbor.⁶⁰

FERC officials have stated that there are no federal requirements for marine exclusion zones around LNG tankers analogous to exclusion zones around onshore facilities — and that such requirements are unnecessary. The USCG has primary jurisdiction over LNG shipping and marine transfer facilities. Nonetheless, FERC believes “looking at marine risk in LNG siting applications is required under the founding principles of the National Environmental Policy Act.”⁶¹ In its LNG review of the Freeport LNG terminal application, for example, FERC does examine the potential effects of ship-to-ship and ship-to-shore collisions, accidental grounding, and certain “credible” terror attacks.⁶² Terminal opponents have criticized FERC's use of engineering models in marine hazard analysis, however, so the Commission's conclusions based on these models have been controversial.⁶³

In addition to FERC's onshore operations requirements, LNG marine operations would have to adhere to LNG vessel management procedures and emergency plans developed by the regional USCG marine safety unit. These procedures would contain requirements for pre-arrival notification, harbor transit, dock operations, cargo transfer, inspection, monitoring and emergency operations. FERC expects the key provisions would include a moving safety zone around LNG ships set by the USCG.⁶⁴ Security of hazardous cargoes such as LNG is already subject to extensive requirements such as security zones and harbor escorts under USCG maritime security regulations to mitigate the possibility of an accident or attack.⁶⁵

Remote Siting

As noted earlier in this report, the LNG safety provisions in the Pipeline Safety Act require the Secretary of Transportation to “consider the ... need to encourage remote siting” of new LNG facilities (49 U.S.C. § 60103). But federal regulations contain no remote siting requirements, relying instead on safety exclusion zones to protect the public. This regulatory alternative was criticized by the General Accounting Office (GAO) in 1979 testimony to Congress supporting remote siting in the Pipeline Safety Act:

⁶⁰ Fitzgerald, Jay. “Mayor: Ban LNG ships in Hub.” *Boston Herald*. Nov. 8, 2003. p19.

⁶¹ FERC. Office of Energy Projects. Personal communication. Dec. 10, 2003.

⁶² FERC. Nov. 2003. p4-132.

⁶³ Raines, B. and Finch, B. “Study Talks of Possible LNG Disaster as Result of Accident.” *Mobile Register*. Mobile, AL. Oct. 22, 2003.

⁶⁴ FERC. Nov. 2003. p4-129.

⁶⁵ Parfomak, P. *Liquefied Natural Gas (LNG) Infrastructure Security: Background and Issues for Congress*. RL32073. Congressional Research Service. Washington, DC. Sept. 9, 2003.

We believe remote siting is the primary factor in safety. Because of the inevitable uncertainties inherent in large-scale use of new technologies and the vulnerability of the facilities to natural phenomena and sabotage, the public can be best protected by placing these facilities away from densely populated areas.⁶⁶

More recently, Representative Edward Markey, an original sponsor of the Pipeline Safety Act, has expressed concern that DOT regulations do not go far enough in complying with the congressional intent of the remote siting provisions.⁶⁷

But industry and government officials maintain that exclusion zones do provide adequate public safety based on the current state of knowledge about LNG. They argue that LNG terminals are no longer a new technology and face far fewer operational uncertainties than in 1979. In particular, some experts believe that hazard models in the 1970's were too conservative. They believe that more recent models have led to a better understanding of the physical properties of LNG, and, consequently, a better basis for design decisions affecting public safety.⁶⁸ They point out that LNG terminals like those in Everett, Massachusetts (1971); Barcelona, Spain (1969); Fezzano, Italy (1969); and Pyongtaek, Korea (1986) have been operating for decades near populated areas without a serious accident affecting the public. Of the 40 existing LNG terminals in Japan, a seismically active country, 24 are near major cities such as Tokyo and Osaka.⁶⁹ While the recent Algerian terminal accident was quite serious, experts point out that it did not lead to the catastrophic failure of the main LNG storage tanks and did not cause injuries the general public.

LNG Hazard Models

A number of technical studies since the terror attacks of September 11, 2001, have been commissioned to reevaluate the safety hazards of LNG terminals and associated shipping (**Table 2**). These studies have caused controversy because some reach differing conclusions about the potential public hazard of LNG terminal accidents or terror attacks. Consequently, community groups fear that LNG hazards may be misrepresented by government agencies, or that certain LNG hazards may simply not be understood well enough to support a terminal siting approval.⁷⁰ For example, recent press articles suggest that federal agencies may have underestimated

⁶⁶ Peach, J.D. General Accounting Office (GAO), Director, Energy and Minerals Division. Testimony to the Senate Committee on Commerce, Science and Transportation. Washington, DC. April 25, 1979. p10.

⁶⁷ Raines, B. "Congress Wanted LNG Plants at 'Remote' Sites." *Mobile Register*. Mobile, AL. Nov. 16, 2003.

⁶⁸ Tobin, L.T. Remarks at a meeting of the City of Vallejo Seismic Safety Commission. Meeting minutes. Vallejo, CA. Sept. 11, 2003. p5. See also: Federal Register. Vol.62. No.37. Feb. 25, 1997. pp8402-8403.

⁶⁹ California Energy Commission (CEC). "LNG Worldwide." Commission website at [<http://www.energy.ca.gov/lng/international.html>]. Link active as of Jan. 28, 2004.

⁷⁰ Editorial. "An Independent LNG Study Urgently Needed." *Mobile Register*. Nov. 9, 2003.

the possibility of a catastrophic chain-reaction explosion arising from the breach of an LNG ship.⁷¹

Most hazard analyses for LNG terminals and shipping depend on computer models to approximate the effects of hypothetical accidents. Federal siting standards specifically require computer modeling of thermal radiation and flammable vapor cloud exclusion zones (49 C.F.R. §§ 193.2057, 2059).⁷² Such models are necessary because there have been no major LNG incidents of the type envisioned in LNG safety research and because historical LNG safety experiments have been limited in scale and scope. But LNG hazards models are extremely complex and inherently uncertain, relying on calculations and input assumptions about which fair-minded analysts may legitimately disagree. Even small differences in an LNG hazard model have led to significantly different conclusions. Referring to the recent LNG safety zone studies, for example, FERC notes that “distances have been estimated to range from 1,400 feet to more than 4,000 feet for [hazardous] thermal radiation.”⁷³

Table 2. Recent LNG Hazard Studies

Author	Sponsor	Subject
Lloyd’s Register of Shipping ⁷⁴	Distrigas (Tractebel)	Focused analysis models possible terror attacks on LNG ships serving Everett
Quest Consultants Inc. ⁷⁵	DOE (lead), FERC, DOT	Models catastrophic breach of an LNG ship tank
James Fay (MIT) ⁷⁶	Fair Play for Harpswell	Models fire and vapor hazards of proposed Harpswell LNG terminal
Tobin & Associates ⁷⁷	City of Vallejo	Reviews general safety of proposed Mare Island LNG terminal

⁷¹ Anonymous. “LNG Safety Questions.” *Long Beach Press-Telegram*. Long Beach, CA. Public forum section. Dec. 20, 2003.

⁷² Gas Research Institute (GRI). “LNGFIRE: A Thermal Radiation Model for LNG Fires” Version 3. GRI-89/0176. Washington, DC. June 29, 1990; “LNG Vapor Dispersion Prediction with the DEGADIS: Dense Gas Dispersion Model.” GRI-89/00242; “Evaluation of Mitigation Methods for Accidental LNG Releases. Vol. 5: Using FEM3A for LNG Accident Consequence Analyses.” GRI 96/0396.5. Washington, DC.

⁷³ FERC. Nov. 2003. p4-133.

⁷⁴ Waryas, Edward. Lloyd’s Register Americas, Inc. “Major Disaster Planning: Understanding and Managing Your Risk.” Fourth National Harbor Safety Committee Conference. Galveston, TX. March 4, 2002. Summary excerpts are in this presentation.

⁷⁵ Juckett, Don. U.S. Department of Energy (DOE). “Properties of LNG.” LNG Workshop. Solomons, MD. February 12, 2002. Quest study summary are in this presentation.

⁷⁶ Fay, James A. “Public Safety Issues at the Proposed Harpswell LNG Terminal.” FairPlay for Harpswell. Harpswell, ME. Nov. 5, 2003.

⁷⁷ Tobin & Assoc. “Liquefied Natural Gas in Vallejo: Heath and Safety Issues.” Final Report by the LNG Safety Committee of the Disaster Council, Vallejo, CA. Jan.16, 2003.

Lehr and Simecek-Beatty ⁷⁸	NOAA	Draft report compares hypothetical LNG and fuel oil fires on water
Sandia National Laboratory ⁷⁹	DOE	Will examine effect of large scale LNG spill on water
To be determined	FERC (lead), DOT, USCG	Will model LNG marine safety hazards

Source: Congressional Research Service.

The LNG hazard studies in **Table 2** have been sponsored by a range of stakeholders and have been performed by individuals with various expertises. It is beyond the scope of this report to make detailed comparisons of the methodologies and findings of these studies and FERC analysis. Furthermore, not all of these reports are publicly available, and two are yet to be completed. Nonetheless, each of the available studies (or its application) appears to have significant limitations, or has been questioned by critics. In its most recent LNG siting review, FERC acknowledges that “opportunity exists to refine ... assumptions and provide a more realistic assessment of the ‘worst case’ hazards.”⁸⁰ But the Commission also disagrees with the planning implications of “worst case” scenarios put forth by LNG terminal opponents. According to FERC,

The various approaches to estimate a ‘worst case’ scenario should not be misconstrued as defining an exclusionary zone. Rather the “worst case” scenarios provide guidance ... in establishing potential impact areas for emergency response and evacuation planning.⁸¹

Hazards vs. Risks. In reviewing the various LNG hazard studies becoming available, it is important to be clear about the distinction between *hazards* and *risks*. While theoretical models may try to quantify the effects of worst-case hazards, evaluating the risks associated with those hazards requires an estimate of the probability that they will occur. It is often argued that a significant *hazard* which is nonetheless highly unlikely does not represent an unacceptable *risk* to the public. In this view, worst-case hazard studies alone do not provide a sufficient basis for evaluating public safety. Unfortunately, few LNG safety studies comprehensively and convincingly address the probability of catastrophic accidents or attacks actually occurring. In part, this shortcoming arises from a lack of historical LNG incidents and detailed terrorist threat information on which to base such probabilities. Faced with this analytic uncertainty, decision makers are forced to draw the best information they can get and rely upon their own best judgment to reach conclusions about LNG safety.

⁷⁸ Lehr, W. and Simecek-Beatty, D. “Comparison of Hypothetical LNG and Fuel Oil Fires on Water” (Draft). National Oceanic and Atmospheric Administration (NOAA). Nov. 2003.

⁷⁹ Anonymous. “Author Claims Natural Gas Tanker Port Study Being Misused.” *Dow Jones Newswires*. Dec. 5, 2003.

⁸⁰ FERC. Nov. 2003. p4-133.

⁸¹ FERC. Nov. 2003. p4-134.

LNG Terminal Safety in Perspective

Other Hazardous Materials. LNG terminals and tankers have a high profile due to recent media coverage, although there are few of them relative to all the hazardous chemical plants and ships currently operating near U.S. cities. According to the U.S. Environmental Protection Agency, for example, over 500 toxic chemical facilities operate in “urban” areas at which worst-case accidents could affect 100,000 or more people.⁸² These include chlorine plants in city water systems and ammonia tanks in agricultural fertilizer production. There are also oil refineries and other liquefied petroleum gas (e.g., propane, butane) terminals operating in U.S. ports which pose safety hazards similar to those of LNG. Based on data from the U.S. Office of Hazardous Materials Safety, there are over 100,000 annual U.S. shipments of hazardous marine cargo such as ammonia, crude oil, liquefied petroleum gases, and other volatile chemicals.⁸³ Many of these cargoes pose a similar hazard to LNG and pass through the same harbors serving existing or proposed LNG terminals.

Terror Attractiveness. The attractiveness of LNG infrastructure to terrorists has been the subject of debate since September 11, 2001. Many experts believe that concerns about terrorist threats to LNG may be overstated and should not impede increased LNG imports. They argue that deliberately causing an LNG catastrophe to injure people would be extremely difficult and that LNG facilities are relatively secure compared to other hazardous chemical infrastructure. The head of one university research consortium remarked, for example, “from all the information we have ... we don’t see LNG as likely or credible terrorist targets.”⁸⁴ Likewise, based in part on consultations with the Federal Bureau of Investigation, NFPA’s LNG standards committee has not seen a need to update the 59A standard in light of the September 11, 2001, terror attacks.⁸⁵ On the other hand, the Department of Homeland Security specifically identified LNG assets among a list of potential terrorist targets in a security alert late in 2003.⁸⁶ According to a senior USCG marine safety officer responsible for LNG port security, “no one can guarantee that a terrorist incident can’t happen.”⁸⁷

⁸² Based on facilities submitting Risk Management Plans required under Section 112 of the Clean Air Act (42 U.S.C. § 7412) and classified in the December 1, 2003 update of the EPA National Database using EPA’s software RMP*Review (v2.1). EPA notes that an entire population is highly unlikely to be affected by any single chemical release, even in the worst case. In an actual release, effects on a population would depend on wind direction and many other factors. In addition, these worst-case scenarios do not account for emergency response measures facility operators or others might take to mitigate harm.

⁸³ Office of Hazardous Materials Safety, Department of Transportation. *Hazardous Materials Shipments*. Washington, DC. October, 1998. Table 2. p2.

⁸⁴ Behr, Peter. “Higher Gas Price Sets Stage for LNG.” *Washington Post*. Washington, D.C. July 5, 2003. pD10.

⁸⁵ National Fire Protection Assoc. (NFPA). Technical Committee on Liquefied Natural Gas. Personal communication. Quincy, MA. Dec. 15, 2003.

⁸⁶ Office of Congressman Edward J. Markey. Personal communication. Jan. 5, 2004.

⁸⁷ Resnick-Ault, Jessica. “Gas Industry Defends Safety of Sending Behemoth Tanker to New (continued...) ”

Civil and Criminal Liability. One reason LNG tanker and terminal operators seek to ensure public safety is to avoid civil and criminal liability from an LNG accident; there are no special provisions in U.S. law protecting the LNG industry from such liability. The 1989 Exxon Valdez oil spill, for example, cost Exxon over \$1 billion in criminal and civil settlements for violations of federal and state laws. In January 2003, the Justice Department announced over \$100 million in civil and criminal penalties against Olympic Pipeline and Shell Pipeline resolving claims from a fatal pipeline fire in Bellingham, Washington in 1999.⁸⁸ In March 2003, emphasizing the environmental aspects of homeland security, Attorney General Ashcroft announced a crackdown on companies failing to protect against possible terrorist attacks on storage tanks, transportation networks, industrial plants and pipelines. He pledged to increase prosecution of civil and criminal cases, where appropriate, to make companies comply with environmental and safety laws.⁸⁹ Not everyone believes, however, that Justice department scrutiny will ensure LNG infrastructure safety. Public scrutiny of gas and hazardous liquids pipeline safety after the Bellingham accident, for example, raised concerns about energy companies' commitment to safe operations and their often close relationships with safety enforcement agencies.⁹⁰

Even if no federal or state regulations are violated, LNG companies still face civil liability for personal injury or wrongful death in the event of an accident. In the Bellingham case, for example, the pipeline owner and associated defendants agreed to pay a \$75 million settlement to the families of two children killed in the accident.⁹¹ In 2002, El Paso Corporation settled wrongful death and personal injury lawsuits stemming from a natural gas pipeline explosion near Carlsbad, New Mexico which killed 12 campers.⁹² Although the terms of those settlements were not disclosed, two additional lawsuits sought a total of \$171 million in damages. The impact of these lawsuits on the company's business is unclear, however; El Paso's June 2003 quarterly financial report noted that "our costs and legal exposure... will be fully covered by insurance."⁹³

⁸⁷ (...continued)

England Waters." *Providence Journal*. Providence, RI. Jan. 4, 2004.

⁸⁸ Anonymous. "Shell, Olympic Socked for Pipeline Accident." *Energy Daily*. Jan. 22, 2003.

⁸⁹ Heilprin, John. "Ashcroft Promises Increased Enforcement of Environmental Laws for Homeland Security." Assoc. Press. *Washington Dateline*. Washington, DC. March 11, 2003.

⁹⁰ Nesmith, J. and Haurwitz, R.K.M. "Pipelines: The Invisible Danger." *Austin American-Statesman*. Austin, TX. July 22, 2001.

⁹¹ Business Editors. "Olympic Pipe Line, Others Pay Out Record \$75 Million in Pipeline Explosion Wrongful Death Settlement." *Business Wire*. April 10, 2002

⁹² National Transportation Safety Board (NTSB). *Pipeline Accident Report* PAR-03-01. Feb. 11, 2003.

⁹³ El Paso Corp. *Quarterly Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934*. Form 10-Q. For the period ending June 30, 2002. Houston, TX.

Policy Options for Congress

A key question for Congress, with respect to the siting of new LNG terminals, is whether the regulation of these terminals appropriately balances the risk to public safety with the need for new natural gas supplies. On one hand, some may view current federal LNG siting requirements and processes as sufficient. Holders of this view would continue to rely on the judgment of LNG experts in federal agencies and standards committees to appropriately balance public safety with public needs. While there have been some concerns about regulatory jurisdiction, marine safety and hazard models, some may believe that the responsible government agencies are actively and cooperatively addressing these concerns. On the other hand, policy makers may believe that some aspects of new LNG terminals do pose excessive public risks, or that there is still too much uncertainty about key risks to make final conclusions about public safety. In this case, Congress has several options to further address LNG terminal safety concerns.

Banning Onshore LNG Terminals. As some have suggested, Congress could ban the construction of any new LNG terminals onshore in the belief that, due to their hazards, such terminals simply should not be built anywhere near people.⁹⁴ Many “remote siting” advocates would likely support such a ban. Indeed, as **Table 1** shows, developers have already proposed numerous offshore LNG terminals — largely to avoid public safety concerns. Others say an onshore LNG terminal ban would have several potential disadvantages. They argue that offshore LNG terminals are generally more expensive than onshore terminals and further away from consumer markets, so an offshore requirement ultimately increases energy costs compared to a gas supply network with a mix of offshore and onshore facilities. No offshore LNG terminals have been built yet, so they may also need to overcome technical challenges associated with their floating designs.⁹⁵ Second, they argue, an onshore terminal ban might by implication ultimately lead to the closure of the existing onshore LNG terminals and LNG storage facilities used by regional gas companies. Such closures could increase natural gas prices and volatility, and could lead to immediate shortages in regions like New England with constrained pipeline supplies. Third, they say, such a ban could set a precedent affecting a host of other economically critical but locally undesirable facilities. If new LNG terminals must all be built offshore, they ask, will the same eventually be required of every other hazardous material terminal or storage facility? Some say a federal policy move in this direction could have unpredictable economic and environmental implications for all manner of trade and industrial production where public hazards exist.

Increasing State Siting Authorities. Since LNG terminal hazards primarily affect local communities, Congress could encourage a greater role for state and local safety regulation in new terminal siting. LNG terminals are unusual among hazardous chemical facilities in that the federal government plays the lead role in

⁹⁴ Editorial Board. “Move ExxonMobil’s LNG Plant Offshore.” *Mobile Register*. Nov. 30, 2003.

⁹⁵ Shook, Barbara. “Environmental, Safety, Security Issues Add to Cost of Offshore LNG.” *Oil Daily*. Energy Intelligence Group. August 5, 2003.

safety regulation and site approval. For most other types of facilities storing hazardous materials, like water treatment plants and industrial refrigeration plants, state and local authorities have greater safety and siting approval authority. If states or localities were given greater siting approval authority for LNG, they could individually adopt safety standards which might alleviate local community concerns. States are prohibited by law from setting safety standards for *interstate* pipeline facilities and LNG terminals, although they may adopt “additional or more stringent safety standards” for *intrastate* pipelines if those standards are compatible with the minimum federal standards (49 U.S.C. § 60103c).

Although devolving federal LNG siting authority to state and local agencies might alleviate local safety concerns, it might also create unintended and unacceptable barriers to LNG infrastructure development. State and local authority over electric transmission siting, for example, has been widely criticized for preventing or delaying new transmission projects critical to regional electric reliability due in many cases to local community opposition. For these reasons, legislative proposals have been made to increase, rather than decrease federal siting authority for new transmission. States would also likely require time to establish new LNG safety laws or regulations, unpredictably delaying new terminal development.

Setting More Stringent Standards. Congress could set more stringent provisions in safety standards for new LNG terminals to address perceived weaknesses in the existing standards. For example, provisions lowering allowable radiation thresholds for thermal exclusion zones, would effectively increase the size of those zones. Other provisions could mandate prescriptive hazard modeling for LNG tankers serving new terminals in the same way that onshore spill impacts must be modeled. But in setting more stringent safety provisions, technical justification for the alternative provisions might be needed, or the new standards might face greater criticism for arbitrariness than the current ones. Time would also be needed to fully understand the implications of these alternatives on future development of LNG infrastructure. Standards set too stringently, for example, might in effect equate to a ban on onshore facilities, with all the consequences of an explicit ban discussed above. Alternatively, policy makers could act to adopt less prescriptive safety standards like those in EN 1473, relying on facility-specific risk studies to evaluate safety hazards. There is, however, no evidence that such standards consistently lead to safer LNG facilities. Furthermore, the inherent subjectivity of such standards might do little to quell debate about hazard analysis in sensitive locations.

Encouraging More Safety Research. As some in Congress have suggested, Congress could call for additional LNG safety research to help reduce uncertainties about specific LNG terminal or shipping hazards.⁹⁶ A number of LNG terminal hazard reports have emerged in the last two years, and more are underway, but there appears to be widespread agreement among federal agencies, LNG developers and community groups that additional “objective” LNG safety research would be beneficial. For example, physical testing (as opposed to computer simulations) of impacts and explosions on LNG tanker hulls by the USCG could fill

⁹⁶ “Ala. Senator Cites Safety Fears Over LNG Plan.” *Gas Daily*. McGraw-Hill. Dec. 22, 2003. p1.

important gaps in engineering knowledge about the potential effects of terrorist attacks. Executing such a research program would have to be done within the next year, however, in order to influence pending applications for new LNG terminal construction. Such studies could also still be subject to the same types of technical limitations and criticisms facing existing analysis, so while they may reduce key uncertainties, they may not eliminate them altogether. These studies could also be costly, especially if they involve field experiments on the scale of credible LNG accidents.

Reducing LNG Demand. Congress could try to reduce the need for new LNG terminals by acting to curb growth in U.S. LNG demand, or growth in natural gas demand overall. For example, Congress could change public and industrial incentives for conservation, switching to other fuels, or developing renewable energy supplies. But other fuels like coal and nuclear power pose their own hazards to communities and the environment, so their expansion may not be preferable to additional LNG infrastructure. Conservation and renewable energy sources are less hazardous, although they face significant technological and cost barriers to more widespread public adoption. Federal investments in renewables research or conservation subsidies might have to be large, and might not have enough impact to alleviate the need for LNG expansion altogether. Various provisions in recent proposed energy legislation would encourage the development of conservation and other alternatives to natural gas, but critics believe they would not likely go far enough to significantly affect near-term natural gas consumption.

Another potential way to curb U.S. LNG demand would be to encourage greater North American production of natural gas. Several recent energy policy proposals seek to promote this objective, including proposals to encourage construction of an Alaskan gas pipeline and encourage production from marginal gas wells in North America. An Alaska gas pipeline would take years to build, say opponents, and would not on its own be able to meet the anticipated long-term growth in U.S. gas demand. Increased production from natural gas wells in the lower 48 states could help alleviate a possible near-term natural gas supply shortage, but may not offer a sustainable long-term supply solution since domestic gas reserves may not be able to keep pace with rising gas demand.

Conclusions

Proposals for new U.S. LNG import terminals are numerous, but LNG imports pose significant safety challenges. LNG is inherently hazardous and its infrastructure is potentially attractive to terrorists. The recent LNG terminal fire in Algeria demonstrates that, despite technological improvements since the 1940s, LNG facilities can still experience serious accidents. Many lawmakers and the general public are concerned about these hazards. The U.S. LNG industry is subject to more extensive siting and safety regulation than many other similarly hazardous facilities. Federal, state and local governments have also put in place security measures intended to safeguard LNG against newly perceived terrorist threats. Some community groups and other stakeholders fear that federal siting requirements for

LNG facilities are still not stringent enough, but the responsible federal agencies disagree.

The safety issues associated with LNG terminal siting are both important and familiar. Every major energy source poses some hazard to public safety. Similar public concerns have been raised around siting of other types of energy facilities such as nuclear power plants, oil import terminals, pipelines, and electric transmission lines. In the case of nuclear power, strict safety requirements and community siting opposition, along with high construction costs, have helped block new plant orders for over 25 years. In evaluating new LNG terminal proposals, therefore, policy makers face a full range of facilities and safety hazards associated with U.S. energy supplies, not only LNG needs and hazards on their own.

Although LNG terminal regulations are extensive, and the global industry has decades of experience operating LNG facilities, many stakeholders question LNG terminal safety. Some of these questions might be resolved through focused and objective research on key LNG topics. Rather than reaching potentially premature conclusions about a particular LNG terminal proposal (either for or against) based on incomplete engineering knowledge or press commentary, decision makers might seek clearer understanding of LNG hazards through research. LNG siting decisions are already underway, however, so any research efforts intended to affect the siting process would probably have to be completed quickly. Revisiting federal LNG siting decisions may disrupt the ongoing development of LNG infrastructure and associated energy supplies. The construction and subsequent closure of the Shoreham nuclear power plant in the 1980's due to new public safety requirements offers an example of the need to resolve safety concerns before capital is invested.

Both industry and government analysts project continued growth in the demand for natural gas — and a decreasing ability for domestic gas producers to meet that demand.⁹⁷ Greater LNG imports represent one way to address this growth in demand, along with increased North American gas production, conservation, fuel-switching, and the development of renewable energy sources. One way or another the fundamental gas supply and demand balance must be maintained. If policy makers encourage LNG imports, then the need to foster the other energy options may be diminished — and *vice versa*. Thus decisions about LNG infrastructure could have consequences for a broader array of natural gas supply policies.

⁹⁷ Energy Information Administration (EIA), U.S. Dept. Of Energy. *Annual Energy Outlook 2004 with Projections to 2025*. DOE/EIA-0383(2003). Washington, DC. Jan. 2004.

Appendix: Offshore LNG Terminal Regulation

Under the Deepwater Port Act of 1974 (P.L. 93-627) the Secretary of Transportation is directed to “authorize and regulate the location, ownership, construction, and operation of deepwater ports” (33 U.S.C. §§ 1501(a), 1503). The Secretary has delegated this authority to the Maritime Administration (MARAD) within the Department of Transportation, and to the Coast Guard (USCG), within the Department of Homeland Security.⁹⁸ Originally, P.L. 93-627 applied only to offshore oil ports and terminals and not LNG facilities. However, the Maritime Transportation Security Act of 2002 (P.L. 107-295) amended P.L. 93-627 to include natural gas facilities, including LNG terminals, developed offshore. As amended, “deepwater ports” are:

any fixed or floating manmade structure other than a vessel ... located beyond State seaward boundaries ... intended for use as a port or terminal for the transportation, storage, or further handling of oil *or natural gas* for transportation to any State . . . (33 U.S.C. § 1502(9a))⁹⁹

The Deepwater Port Act sets out a detailed process for offshore facility siting applications. The Act also authorizes regulations addressing potential threats to the environment or human welfare posed by development of offshore LNG facilities (33 U.S.C. §§ 1504, 1508; 33 C.F.R. § 148). The Act also requires regulations for the designation of safety zones around deepwater ports (33 U.S.C. § 1509(d)). Among the amendments to the Act is a provision exempting LNG terminals from the limitation on the number “deepwater ports” that can be located in a designated “application area,” a provision applicable to oil terminals (33 U.S.C. §§ 1504(d)(4), (i)(4)). Additionally, a preexisting provision of the Act allows the governor of a state adjacent to a proposed offshore LNG facility to have that facility license conform to state environmental protection, land and water use, or coastal zone management programs (33 U.S.C. § 1508(b)).

The USCG’s regulations regarding LNG facilities are codified throughout 33 C.F.R., with major provisions in part 127. These regulations detail the requirements for siting applications, which include information about the proposed location, design, construction, and operation (33 C.F.R. § 148.109). NEPA analysis is often instrumental in siting and safety-related decisions at specific, proposed facilities and is facilitated by the Mineral Management Service, the agency responsible for offshore minerals extraction and the Outer Continental Shelf leasing program.¹⁰⁰ Unlike onshore facilities, the Coast Guard does not appear to require generally applicable exclusion zones for offshore facilities, but relies instead on case-by-case designation

⁹⁸ For a recent LNG siting application, MARAD performed financial analysis and USCG evaluated environmental impacts; the agencies cooperated on all other aspects of the review. (“First Offshore Terminal in U.S. is About to Secure Federal License.” *Foster Natural Gas Report*. Bethesda, MD. Nov. 20, 2003. p21.

⁹⁹ The statute defines natural gas to include “liquefied natural gas.” 33 U.S.C. § 1502(14).

¹⁰⁰ Sierra B. Weaver, Note, Local Management of Natural Resources: Should Local Governments Be Able to Keep Oil Out?, 26 HARV. ENVTL. L. REV. 231, 246 (2002).

of safety zones.¹⁰¹ Additional USCG regulations include agency oversight of emergency procedures, security, fire protection, design and construction standards (33 C.F.R. §§ 127.109, 127.701-127.711, 127.601-127.617, 127.1101-127.1113, 149.205).

¹⁰¹ See 33 C.F.R. § 165, Regulated Navigation Areas and Limited Access Areas.