

CRS Report for Congress

Liquefied Natural Gas (LNG) Infrastructure Security: Issues for Congress

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**Prepared for Members and
Committees of Congress**

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Summary

Liquefied natural gas (LNG) is a hazardous fuel shipped in large tankers from overseas to U.S. ports. Because LNG infrastructure is highly visible and easily identified, it can be vulnerable to terrorist attack. Since September 11, 2001, the U.S. LNG industry and federal agencies have put new measures in place to respond to the possibility of terrorism. Nonetheless, public concerns about LNG risks continue to raise questions about LNG security. Faced with a perceived national need for greater LNG imports, and persistent public concerns about LNG risks, some in Congress are examining the adequacy of security provisions in federal LNG regulation.

LNG infrastructure consists primarily of tankers, import terminals, and inland storage plants. There are nine active U.S. terminals and proposals for many others. Although potentially catastrophic events could arise from a serious accident or attack on such facilities, LNG has a record of relative safety for the last 40 years, and no LNG tanker or land-based facility has been attacked by terrorists. The likelihood and possible impacts from LNG attacks continue to be debated among experts.

Several federal agencies oversee LNG infrastructure security. The Coast Guard has lead responsibility for LNG shipping and marine terminal security under the Maritime Transportation Security Act of 2002 (P.L. 107-295) and the Security and Accountability for Every Port Act of 2006 (P.L. 109-347). The Office of Pipeline Safety (OPS) and the Transportation Security Administration (TSA) both have security authority for LNG storage plants within gas utilities, as well as some security authority for LNG marine terminals. The Federal Energy Regulatory Commission (FERC) approves the siting, with some security oversight, of on-shore LNG marine terminals and certain utility LNG plants. The Coast Guard, OPS and FERC cooperate in the siting approval of new LNG facilities, inspection and operational review of existing facilities, informal communication, and dispute resolution.

Federal initiatives to secure LNG are still evolving, but a variety of industry and agency representatives suggest they are reducing the vulnerability of LNG to terrorism. S. 1594 would strengthen federal protection of vessels and infrastructure handling LNG and other especially hazardous cargoes through new international standards, new training requirements, vessel security cost-sharing, incident response and recovery plans, and other provisions. H.R. 2830, which passed in the House of Representatives on April 24, 2008, but which President Bush has threatened to veto, would require the Coast Guard to secure LNG tankers, and would limit the agency's reliance on state and local resources in doing so, among other provisions. As Congress continues its oversight of LNG, it may consider whether future LNG security requirements will be appropriately funded, whether these requirements will be balanced against evolving risks, and whether the LNG industry is carrying its fair share of the security burden. Congress may also act to improve its understanding of LNG security risks. Finally, Congress may initiate action to better understand the security and trade implications of efforts to promote U.S.-flagged LNG tankers and U.S. crews.

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Liquefied Natural Gas (LNG) Infrastructure Security: Issues for Congress

Introduction

Liquefied natural gas (LNG) facilities are receiving a great deal of public attention due to their increasingly important role in the nation's energy infrastructure and their potential vulnerability to terrorist attack. LNG has long been important to U.S. natural gas markets, although energy economics and public perceptions about LNG risks have limited the industry's growth. Concerns about rising natural gas prices and the possibility of domestic gas shortages have been driving up demand for LNG imports. But LNG is a hazardous¹ liquid transported and stored in large quantities. Consequently, LNG infrastructure may directly impact the security of communities where this infrastructure is located. Faced with the widely perceived national need for greater LNG imports, and persistent public concerns about LNG risks, some in Congress are examining the adequacy of security provisions in federal LNG regulation.²

S. 1594, which was introduced by Senator Frank Lautenberg and three cosponsors and referred to the Senate Committee on Commerce, Science, and Transportation on June 12, 2007, would strengthen federal protection of vessels and infrastructure handling LNG and other especially hazardous cargoes. H.R. 2830, which passed in the House of Representatives on April 24, 2008, would require the Coast Guard to enforce security zones around LNG tankers, would limit reliance on state and local government resources to provide LNG security, and would require the Coast Guard to certify it has adequate resources for LNG security before approving an LNG facility's security plan. H.R. 2830 would further require a comparative risk assessment of vessel-based and facility-based LNG regasification processes and a report on state and local augmentation of Coast Guard security resources, among other provisions.

This report provides an overview of industry and federal activities related to LNG security. The report describes U.S. LNG infrastructure, the industry's safety record and security risks, and the industry's security initiatives since September 11, 2001. It summarizes recent changes in federal LNG and maritime security law and related changes in the security roles of federal agencies. The report discusses several policy concerns related to federal LNG security efforts: 1) public costs of marine

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

² See, for example: U.S. Representative Tim Bishop, "Bishop Calls for Congressional Hearing on Coast Guard's Inability to Protect LNG Tankers," Press release, March 12, 2008.

security, 2) uncertainty regarding LNG terrorism risks, and 3) security implications of promoting U.S.-flagged LNG tankers and U.S. crews.

Scope and Limitations

This report focuses on industry and federal activities in LNG infrastructure security. The report includes some discussion of state and local agency activities as they relate to federal efforts, but does not address the full range of state and local issues of potential interest to policy makers. The report also focuses on shipping, marine terminals and land-based storage facilities within gas utilities; it does not address LNG trucking, special purpose LNG facilities, or LNG-fueled vehicles. The report discusses activities in LNG safety only as they relate to security. For further discussion of LNG terminal safety, including LNG safety-related legislative proposals, see CRS Report RL32205, *Liquefied Natural Gas (LNG) Terminals: Siting, Safety and Regulation*, by Paul Parfomak and Adam Vann.

Background

What is LNG?

When natural gas is cooled to temperatures below minus 260°F it condenses into *liquefied* natural gas, or “LNG.”³ 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 by ship or truck. 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 2007, LNG imports to the United States originated in Trinidad and Tobago (57.3%), Egypt (15.3%), Nigeria (12.7%), Algeria (9.9%), Qatar (2.4%), and Equatorial Guinea (2.4%).⁴ In recent years, some LNG shipments have also come from Malaysia, Oman, Australia, and other countries.⁵ Brunei, Indonesia, Libya, 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 Growth

The United States has used LNG commercially since the 1940s. Initially, LNG facilities stored domestically produced natural gas to supplement pipeline supplies

³ Natural gas typically consists of at least 80% methane, although LNG is usually over 90% methane. It may also contain other hydrocarbon gases (e.g., propane) and nitrogen.

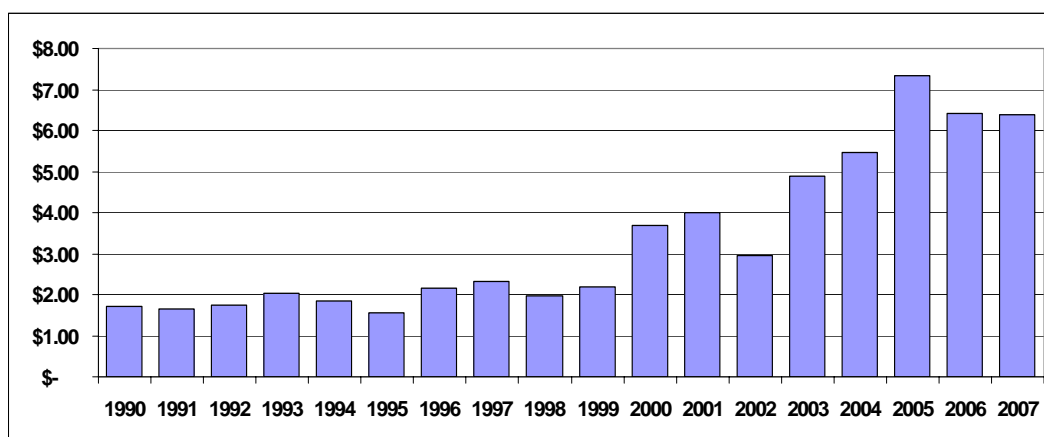
⁴ U.S. Dept. of Energy, Office of Fossil Energy. “Natural Gas Import/Export Reports.” Internal database. January 7, 2008. Excludes December 2007 imports.

⁵ Energy Information Administration (EIA). *Natural Gas Year-In-Review 2006*. Washington, DC, March 2007. p. 5.

during times of high gas demand. In the 1970s LNG imports began to supplement domestic production. Due primarily to low domestic gas prices, LNG imports stayed relatively small — accounting for only 1% of total U.S. gas consumption in 2002.⁶ In countries with limited domestic gas supplies, however, LNG imports grew dramatically over the same period. Japan, for example, imported 97% of its natural gas supply as LNG in 2002, over 11 times as much LNG as the United States.⁷ South Korea, France, Spain, and Taiwan also became heavy LNG importers.

Natural gas demand has accelerated in the United States over the last several years due to environmental concerns about other energy sources, growth in natural gas-fired electricity generation, and historically low gas prices. Supply has not been able to keep up with demand, however, so gas prices have recently become high and volatile. As **Figure 1** shows, average annual gas prices at the wellhead have risen from between \$1.50 and \$2.50/Mcf (“thousand cubic feet”) through most of the 1990s to above \$6.00/Mcf since 2005. At the same time, international prices for LNG have fallen because of increased supplies and lower production and transportation costs, making LNG more competitive with domestic natural gas. While cost estimation is speculative, some industry analysts believe that LNG can be economically delivered to U.S. pipelines for between \$2.25 to \$4.15/Mcf, depending upon the source.⁸

Figure 1. Average U.S. Natural Gas Wellhead Price (\$/Mcf)



Source: Energy Information Administration. “U.S. Natural Gas Wellhead Price.” Internet database. Updated Feb. 29, 2008. [<http://tonto.eia.doe.gov/dnav/ng/hist/n9190us3m.htm>]

In 2003 testimony before the House Energy and Commerce Committee, the Federal Reserve Chairman, Alan Greenspan, called for a sharp increase in LNG imports to help avert a potential barrier to U.S. economic growth. According to Mr. Greenspan’s testimony

⁶ Energy Information Administration (EIA). *Natural Gas Annual 2005*. Tables 1 and 9. November 16, 2006.

⁷ Energy Information Administration (EIA). “World LNG Imports by Origin, 2002.” Washington, DC. October 2003.

⁸ Donnelly, M. “LNG as Price Taker.” *Public Utilities Fortnightly*. November 1, 2006.

... notable cost reductions for both liquefaction and transportation of LNG ... and 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.⁹

If current natural gas trends continue, the Energy Information Administration (EIA) projects U.S. LNG imports to account for 13% of total U.S. gas supply in 2030.¹⁰

Overview of U.S. LNG Infrastructure

The physical infrastructure of LNG consists of interconnected transportation and storage facilities, each with distinct physical characteristics affecting operational risks and security needs. This overview focuses on the three major elements of this infrastructure: tanker ships, marine terminals, and storage facilities.

LNG Tanker Ships

LNG is transported to the United States in very large, specialized tanker ships. LNG tankers are double hulled, containing several massive tanks, each sealed and insulated to maintain safe LNG temperature and prevent leakage during transit. There are currently 200 tankers in service around the world, with a combined cargo capacity of over 24 million cubic meters of LNG, equivalent to over eight times the average daily U.S. natural gas consumption. More than 200 additional tankers are expected to enter service by 2013.¹¹ There are no U.S.-flagged LNG tankers.

LNG Marine Terminals

LNG tankers unload their cargo at dedicated marine terminals which store and regasify the LNG for distribution to domestic markets. Onshore terminals typically consist of docks, LNG handling equipment, storage tanks, and interconnections to regional gas pipelines. As discussed later in the report, the siting of onshore LNG import terminals is regulated by the Federal Energy Regulatory Commission (FERC). There are eight active onshore LNG terminals in the United States:

- **Everett, Massachusetts.** The Everett terminal is located across the Mystic River from Boston; tankers must pass through Boston harbor to reach it. The terminal serves gas utilities and electric power

⁹ Greenspan, Alan, Chairman, U.S. Federal Reserve Board. "Natural Gas Supply and Demand Issues." Testimony before the House Energy and Commerce Comm. June 10, 2003.

¹⁰ Energy Information Administration (EIA). *Annual Energy Outlook 2008* (Revised Early Release). DOE/EIA-0383(2008). Table A13. March 2008. p. 25.

¹¹ *Lloyd's List*. "US Demand for LNG Puts Pressure on Maritime Manpower." September 11, 2007. p. 10.

producers in New England, receiving approximately 65 LNG shipments annually.¹²

- **Cove Point, Maryland.** Cove Point is located on the Chesapeake Bay 60 miles southeast of Washington, DC. Under federally approved expansion plans, the terminal could be capable of receiving up to 200 shipments per year in 2008.¹³
- **Elba Island, Georgia.** The Elba Island terminal is located on an island five miles down the Savannah River from Savannah, Georgia and ten miles from the Atlantic coast. The terminal completed a major expansion in 2006, allowing it to receive approximately 118 shipments per year.¹⁴
- **Kenai, Alaska.** Built in 1969, this is the oldest LNG marine terminal in the United States and the only one built for export (to Japan). The Kenai terminal is located in Nikiski near the Cook Inlet gas fields. Since 1969 the terminal has exported an average of approximately 34 LNG shipments each year.¹⁵
- **Lake Charles, Louisiana.** The Lake Charles terminal is located approximately nine miles southwest of the city of Lake Charles near the Gulf of Mexico. The terminal completed a major expansion in 2006, allowing it to receive up to 175 shipments per year.¹⁶
- **Peñuelas, Puerto Rico.** The Peñuelas terminal, located on the southern coast of Puerto Rico, is dedicated to fueling an electric generation plant which supplies 20% of Puerto Rico's power.¹⁷ The terminal receives 10 to 15 LNG shipments annually.¹⁸
- **Quintana Island, Texas.** This terminal is located southeast of the city of Freeport, in Brazoria County. The terminal has the capability

¹² Department of Energy, Office of Fossil Energy (OFE). "Imports of Liquefied Natural Gas (LNG)." Unpublished data. Washington, D.C. January 11, 2007.

¹³ Federal Energy Regulatory Commission (FERC). "Order Issuing Certificates and Granting Section 3 Authority." Issued June 16, 2006. Docket No. CP05-130-000, *et al.* p. 71.

¹⁴ "El Paso Corporation Announces Start of Service From Elba II Expansion." PR Newswire. February 1, 2006; *Federal Register*, vol. 67, no. 181, September 18, 2002, p. 58784.

¹⁵ Marathon Oil Corporation. *2003 Annual Report*. Houston. March 8, 2004. p. 11.

¹⁶ "Second Trunkline LNG Terminal Expansion Up and Running." *Inside F.E.R.C.* July 31, 2006. p. 12; *Federal Register*, vol. 67, no. 34, February 20, 2002, p. 7684.

¹⁷ "Gas Natural Acquires Enron's 50% Stake in 540-MW Gas Plant in Puerto Rico." *Platt's Global Power Report*. McGraw-Hill. July 10, 2003. p. 11.

¹⁸ OFE. January 11, 2007.

of receiving approximately 200 ships per year.¹⁹ It received its first commercial cargo in April 2008.²⁰

- **Sabine Pass, Louisiana.** This terminal is located near the Sabine Pass Channel in Cameron Parish. The terminal has the capability of receiving approximately 300 ships per year.²¹ It also received its first commercial cargo in April 2008.²²

Offshore LNG terminals connect to land only by underwater pipelines. These offshore terminal designs seek to avoid community opposition, permitting, and operating obstacles which have hindered the construction of new on-shore LNG terminal facilities. Because offshore terminals would be located far from land, they also would present fewer security risks than on-shore LNG terminals. Offshore terminals may present environmental concerns, however, if they use seawater for regasification. Such a process cools the waters in a terminal's vicinity with potential impacts on the local ecosystem due to the lower water temperatures.²³ As discussed later in the report, offshore LNG terminals are regulated jointly by the Maritime Administration (MARAD) and the U.S. Coast Guard. There is currently one operating offshore LNG terminal in U.S. waters:

- **Gulf of Mexico, Louisiana.** The Gulf Gateways (Energy Bridge) terminal was completed in 2004 and received its first LNG shipment in March, 2005. The terminal consists of an offshore gas pipeline buoy system and is served by specialized tankers which regasify their LNG cargoes on board. The terminal expects up to be able to serve up to 60 LNG shipments per year.²⁴

A second offshore terminal near Boston, Massachusetts, is scheduled to begin operations in 2008.²⁵

In addition to these active terminals, some 28 LNG terminal proposals have been approved by regulators across North America to serve the U.S. market (**Figure 2**). A number of these proposals have been withdrawn, however, due to siting

¹⁹ Federal Energy Regulatory Commission. "Order Granting Authorization Under Section 3 of the Natural Gas Act." Docket No. CP03-75-000. June 18, 2004. p.2.

²⁰ Fowler, T. "Freeport Gets 1st LNG Cargo." *Houston Chronicle*. April 16, 2008.

²¹ Federal Energy Regulatory Commission. "Order Granting Authority under Section 3 of the Natural Gas Act and Issuing Certificates." Docket No. CP04-47-000. Dec. 21, 2004. p.2.

²² Gunter, F. "Cheniere Opens Sabine Pass LNG Terminal." *Houston Business Journal*. April 21, 2008.

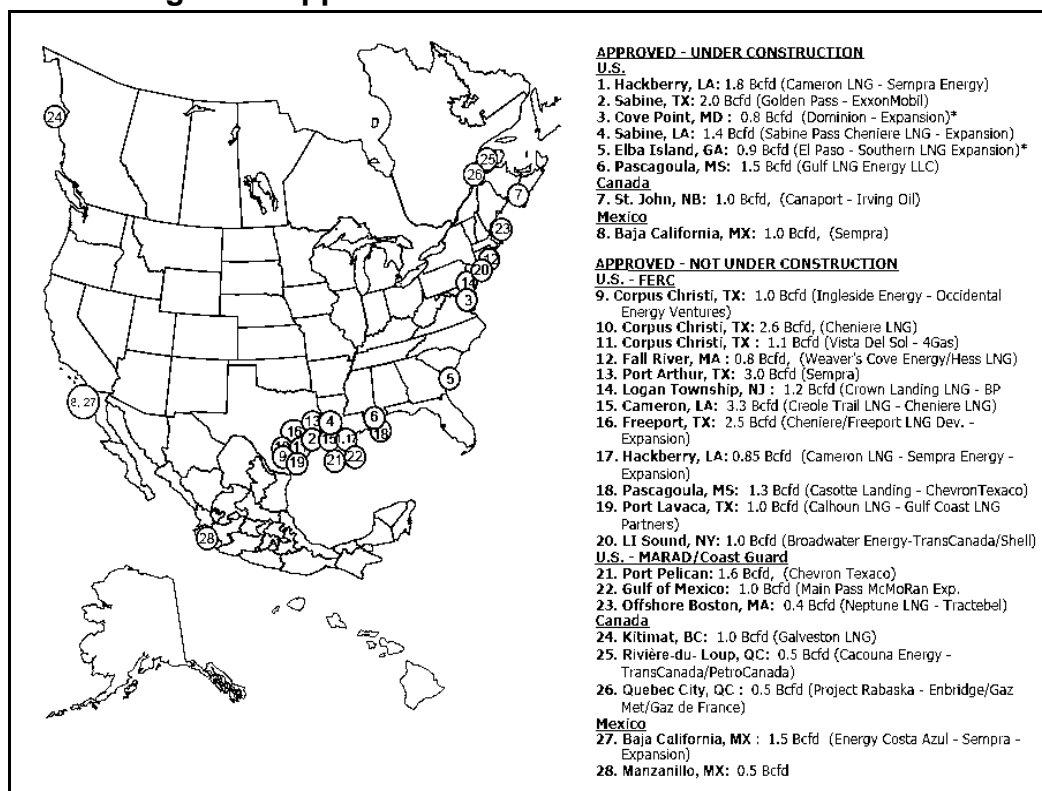
²³ O'Driscoll, M. "LNG: Shell's Gulf Landing Offshore Project Gets Green Light." *Greenwire*. E&E Publishing, LLC. Washington, D.C. Feb 18, 2005.

²⁴ *Natural Gas Intelligence*. "Energy Bridge Terminal Prepares for First 3 Bcf LNG Delivery This Month." Intelligence Press, Inc. March 7, 2005.

²⁵ "Boston Offshore LNG Port Nears Clearance to Open." *Reuter's*. January 9, 2008.

problems, financing problems, or other reasons. Developers have proposed another 13 U.S. terminals prior to filing formal siting applications.²⁶

Figure 2. Approved LNG Terminals in North America



Source: Federal Energy Regulatory Commission (FERC), "Approved North American LNG Import Terminals," Updated April 21, 2008. [<http://www.ferc.gov/industries/lng.asp>]

LNG Peak Shaving Plants

Many gas distribution utilities rely on "peak shaving" LNG plants to supplement pipeline gas supplies during periods of peak demand during winter cold snaps. The LNG is stored in large refrigerated tanks integrated with the local gas pipeline network. The largest facilities usually liquefy natural gas drawn directly from the interstate pipeline grid, although many smaller facilities without such liquefaction capabilities receive LNG by truck. LNG tanks are generally surrounded by containment impoundments which limit the spread of an LNG spill and the potential size of a resulting vapor cloud. LNG peak shaving plants are often located near the populations they serve, although many are in remote areas away from people. According to the Pipeline and Hazardous Materials Safety Administration (PHMSA) there are 103 active LNG storage facilities in the United States distributed across 31

²⁶ Federal Energy Regulatory Commission (FERC), "Proposed North American LNG Import Terminals," Updated April 21, 2008. [<http://www.ferc.gov/industries/lng.asp>]

states.²⁷ These facilities are mostly in the Northeast where pipeline capacity and underground gas storage have historically been constrained.

LNG Risks and Vulnerabilities

The safety hazards associated with LNG terminals have been debated for decades. A 1944 accident at one of the nation's first LNG facilities killed 128 people and initiated public fears about LNG hazards which persist today.²⁸ Technology improvements and standards since the 1940s have made LNG facilities much safer, but serious hazards remain since LNG is inherently volatile and is shipped and stored in large quantities. A January 2004 accident at Algeria's Skikda LNG terminal which killed or injured over 100 workers added to the ongoing controversy over LNG facility safety.²⁹ LNG infrastructure is also potentially vulnerable to terrorist attack.

Physical Hazards of LNG

Natural gas is combustible, so an uncontrolled release of LNG poses a serious hazard of explosion or fire. LNG also poses hazards because it is extremely cold. Experts have identified several potentially catastrophic events that could arise from an LNG release. The likelihood and severity of these events have been the subject of considerable research and analysis. While open questions remain about the impacts of specific hazards in an actual accident, there appears to be consensus as to what the greatest LNG 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.³⁰ The resulting "pool fire" would spread as the LNG pool expanded away from its source and continued evaporating. Such pool fires are intense, burning far more hotly and rapidly than oil or gasoline fires.³¹ They cannot be extinguished — all the LNG must be consumed before they go out. Because LNG pool fires are so hot, their thermal radiation may injure people and damage property a considerable distance from the fire itself. Many experts agree that a pool fire, especially on water, is the most serious LNG hazard.³²

²⁷ Pipeline and Hazardous Materials Safety Administration. "Liquefied Natural Gas (LNG) in the U.S." Web page. March 2008. [<http://primis.phmsa.dot.gov/comm/LNG.htm>]

²⁸ 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.

²⁹ Junnola, J., et al. "Fatal Explosion Rocks Algeria's Skikda LNG Complex." *Oil Daily*. January 21, 2004. p. 6.

³⁰ Methane, the main component of LNG, burns in gas-to-air ratios between 5% and 15%.

³¹ Havens, J. "Ready to Blow?" *Bulletin of the Atomic Scientists*. July/August 2003. p. 17.

³² Havens. 2003. p. 17.

- **Flammable vapor clouds.** If LNG spills but does not immediately ignite, the evaporating natural gas will form a vapor cloud that may drift some distance from the spill site. If the cloud subsequently encounters an ignition source, those portions of the cloud with a combustible gas-air concentration will burn. Because only a fraction of such a cloud would have a combustible gas-air concentration, the cloud would not likely explode all at once, but the fire could still cause considerable damage. An LNG vapor cloud fire would gradually burn its way back to the LNG spill where the vapors originated and would continue to burn as a pool fire.³³ If an LNG tank failed due to a collision or terror attack, experts believe the failure event itself would likely ignite the LNG pool before a large vapor cloud could form.³⁴ Consequently, they conclude that large vapor cloud fires are less likely than instantaneous pool fires.
- **Flameless explosion.** If LNG spills on water, it could theoretically heat up and regasify almost instantly in a “flameless explosion” (also called a “rapid phase transition”). While the effects of tanker-scale spills have not been studied extensively, Shell Corporation experiments with smaller LNG spills in 1980 did not cause flameless explosions. Even if there were a flameless explosion of LNG, experts believe the hazard zones around such an event “would not be as large as either vapor cloud or pool fire hazard zones.”³⁵

In addition to these catastrophic hazards, an LNG spill poses hazards on a smaller scale. An LNG vapor cloud is not toxic, but could cause asphyxiation by displacing breathable air. Such clouds rise in air as they warm, however, diminishing the threat to people on the ground. Alternatively, extremely cold LNG could injure people or damage equipment through direct contact. 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 (as crude oil does).³⁶

Safety Record of LNG

The LNG tanker industry claims a record of relative safety over the last 45 years; since international LNG shipping began in 1959, tankers reportedly have carried over 47,000 LNG cargoes without a serious accident at sea or in port.³⁷ LNG

³³ Quillen, D. ChevronTexaco Corp. “LNG Safety Myths and Legends.” Presentation to the Natural Gas Technology Conference. Houston, TX. May 14-15, 2002. p. 18.

³⁴ Havens. 2003. p. 17.

³⁵ Havens. 2003. p. 17.

³⁶ Quillen. 2002. p. 28.

³⁷ Society of International Gas Tanker and Terminal Operators Ltd. (SIGTTO). “Worth Repeating.” *SIGTTO News*. Vol. 17. March 2007. p. 10.

tankers have experienced groundings and collisions during this period, but none has resulted in a major spill.³⁸ 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 and fuel tankers like the *Exxon Valdez*, which caused a major Alaskan oil spill after grounding in 1989.³⁹ 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.

The safety record of onshore LNG terminals is more mixed. There are more than 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 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 a 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.⁴⁰ 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.⁴¹ According to press reports, the accident resulted from poor maintenance rather than a facility design flaw.⁴² 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.⁴³

LNG Security Risks

LNG tankers and land-based facilities may be vulnerable to terrorism. Tankers could be physically attacked to destroy their cargo — or commandeered for use as weapons against coastal targets. Land-based LNG facilities could also be physically attacked with explosives or through other means. Alternatively, computer control systems could be “cyber-attacked,” or both physical and cyber attack could happen at the same time. Some LNG facilities could also be indirectly disrupted by other types of terror strikes, such as attacks on regional electricity grids or communications networks, which could in turn affect dependent LNG control and safety systems. Since LNG is fuel for power plants, heating, military bases, and other uses, disruption

³⁸ SIGGTO 2007; CH-IV International. *Safety History of International LNG Operations*. TD-02109. Millersville, MD. July, 2004. pp. 13-18.

³⁹ Society of International Gas Tanker & Terminal Operators Ltd. (SIGTTO). “Safe Havens for Disabled Gas Carriers.” Third Edition. London. February 2003. pp. 1-2.

⁴⁰ Junnola, J., et al. January 21, 2004. p. 6.

⁴¹ Hunter, C. “Algerian LNG Plant Explosion Sets Back Industry Development.” *World Markets Analysis*. January 21, 2004. p. 1.

⁴² Antosh, N. “Vast Site Devastated.” *Houston Chronicle*. January 21, 2004. p. B1.

⁴³ CH-IV International. pp. 6-12.

of LNG shipping or storage poses additional “downstream” risks, especially in more LNG-dependent regions like New England.

LNG Tanker Vulnerability. LNG tankers cause the most concern among security analysts because they are potentially more accessible than fixed terminal facilities, because they may transit nearer to populated areas, and because LNG spills from tankers could be more difficult to control. According to a 2004 report by Sandia National Laboratories, an intentional LNG spill and resulting fire could cause “major” injuries to people and “significant” damage to structures within approximately 500 meters (0.3 mile) of the spill site, more moderate injuries and structural damage up to 1,600 meters (1.0 mile) from the spill site, and lower impacts out to 2,500 meters (1.5 miles).⁴⁴ These results are used by federal agencies in reviewing LNG terminal siting applications.

Other LNG hazard studies have reached somewhat different conclusions about LNG tanker vulnerability. A report by the Government Accountability Office (GAO) released in 2007 reviewed six unclassified studies of LNG tanker hazards, including the Sandia study. The GAO report concluded that⁴⁵

Because there have been no large-scale LNG spills or spill experiments, past studies have developed modeling assumptions based on small-scale spill data. While there is general agreement on the types of effects from an LNG spill, the results of these models have created what appears to be conflicting assessments of the specific consequences of an LNG spill, creating uncertainty for regulators and the public.

Following the GAO report, Members of Congress have expressed continuing concern about the uncertainty associated with LNG tanker vulnerability and hazard analysis.⁴⁶ In 2008, Congress appropriated \$8 million to fund large-scale LNG fire experiments by the Department of Energy addressing some of the hazard modeling uncertainties identified in the GAO report.⁴⁷ It remains to be seen to what degree this research will increase policy makers’ confidence in LNG tanker vulnerability analyses.

⁴⁴ Sandia National Laboratories (SNL). *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*. SAND2004-6258. Albuquerque, NM. December 2004. p. 54.

⁴⁵ Government Accountability Office (GAO). *Maritime Security: Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification*. GAO-07-316. February 2007. p. 22.

⁴⁶ See, for example Senator Barbara A. Mikulski, testimony before the House Transportation and Infrastructure Committee, Coast Guard and Maritime Transportation Subcommittee field hearing on the Safety and Security of Liquefied Natural Gas and the Impact on Port Operations. Baltimore, MD. April 23, 2007.

⁴⁷ Consolidated Appropriations Act, 2008 (P.L. 110-161), Division C — Energy and Water Development and Related Agencies Appropriations Act, 2008, Title III, Explanatory Statement, p. 570.

The *Gaz Fountain* Attack

Although there have been no terrorist attacks on LNG tankers, there is at least one documented case of a gas tanker of similar construction being attacked in wartime. During the Iran-Iraq War in the 1990s, the double-hulled LPG tanker *Gaz Fountain* was fired upon by an Iranian aircraft using three air-to-ground, armor-piercing Maverick missiles. Two of the missiles exploded on or above the ship's deck, causing relatively minor damage. The third missile penetrated the deck and exploded above a butane storage tank, opening a 6 square-meter (65 square-foot) hole in the roof of the tank. The escaping gas ignited, establishing a large fire on deck above the missile entry hole. The fire aboard the *Gaz Fountain* was successfully extinguished by a salvage ship, her remaining cargo was successfully unloaded to another tanker, and she was eventually repaired.⁴⁸

The *Gaz Fountain* attack and salvage provides some evidence as to the robustness of double-hulled gas tankers like those that carry LNG. But the relatively benign outcome in the *Gaz Fountain* attack does not necessarily demonstrate that attacks on LNG tankers would have similarly limited impacts. The *Gaz Fountain* was fortunate that its storage tank was breached only at the top. If missiles had been targeted at the hull of the ship rather than its deck, one might have penetrated the side of a storage tank, causing a major spill on water and an inextinguishable pool fire. Furthermore, if the gas involved had been LNG rather than butane, the *Gaz Fountain* might have been subject to cryogenic damage since LNG is transported at a much lower temperature than butane (-260°F vs. +25°F). According to the Sandia report, such a combination could lead to cascading failure of adjacent storage tanks and, presumably, an even larger fire.⁴⁹

Federal LNG Security Initiatives

Operators of LNG infrastructure had security programs in place prior to September 11, 2001, but these programs mostly focused on personnel safety and preventing vandalism. The terror attacks of September 11 focused attention on the vulnerability of LNG infrastructure to different threats, such as systematic attacks on LNG facilities by foreign terrorists. Consequently, both government and industry have taken new initiatives to secure LNG infrastructure in response to new threats.

Several federal agencies oversee the security of LNG infrastructure. The Coast Guard has lead responsibility for LNG shipping and marine terminal security. The Department of Transportation's Office of Pipeline Safety and the Department of Homeland Security's Transportation Security Administration have security authority for peak-shaving plants within gas utilities, as well as some security authority for LNG marine terminals. FERC has siting approval responsibility, with some security oversight, for land-based LNG marine terminals and certain peak-shaving plants. In

⁴⁸ Carter, J.A. "Salvage of Cargo from the War-Damaged *Gaz Fountain*." Proceedings of the Gastech 85 LNG/LPG Conference. Nice, France. November 12-15, 1985.

⁴⁹ SNL. December 2004. p. 151.

addition to federal agencies, state and local authorities, like police and fire departments, also help to secure LNG.

Security Activities of Federal Maritime Agencies

The two federal agencies with the most significant roles in maritime security as it relates to LNG are the U.S. Coast Guard and the Maritime Administration.

U.S. Coast Guard. The Coast Guard is the lead federal agency for U.S. maritime security, including port security. Among other duties, the Coast Guard tracks, boards, and inspects commercial ships approaching U.S. waters. A senior Coast Guard officer in each port oversees the security and safety of vessels, waterways, and many shore facilities in his geographic area. The Coast Guard derives its security responsibilities under the Ports and Waterways Safety Act of 1972 (P.L. 92-340) and the Maritime Transportation Security Act of 2002 (P.L. 107-295). Maritime security regulations mandated by P.L. 107-295 are discussed below. Under P.L. 107-295 the Coast Guard and the Maritime Administration share siting approval authority for offshore LNG terminals.

Shortly after September 11, 2001, the Coast Guard began to systematically prioritize protection of ships and facilities, including those handling LNG, based on vulnerability assessments and the potential consequences of security incidents. The Coast Guard evaluated the overall susceptibility of marine targets, their use to transport terrorists or terror materials, and their use as potential weapons. In particular, the Coast Guard evaluated the vulnerability of tankers to “a boat loaded with explosives” or “being commandeered and intentionally damaged.”⁵⁰ While the assessments focused on Coast Guard jurisdictional vessels and facilities, some scenarios involved other vital port infrastructure like bridges, channels, and tunnels.⁵¹ The Coast Guard used these assessments in augmenting security of key maritime assets and in developing the agency’s new maritime security standards.

The Coast Guard began increasing LNG tanker and port security immediately after September 11, 2001. For example, the Coast Guard suspended LNG shipments to Everett for several weeks after the terror attacks to conduct a security review and revise security plans.⁵² The Coast Guard also worked with state, environmental and police marine units to establish 24-hour patrols in Boston harbor.⁵³ In July 2002, the Coast Guard imposed a 1,000-yard security zone around the Kenai LNG terminal — and subsequently imposed similar zones around other U.S. LNG terminals.⁵⁴ The Coast Guard also reassessed security at the Cove Point terminal before allowing LNG

⁵⁰ 68FR126. July 1, 2003. p. 39244.

⁵¹ Ibid., p. 39246.

⁵² McElhenny, J. “Coast Guard Lifts Ban of Natural Gas Tankers in Boston Harbor.” Associated Press. October 16, 2001.

⁵³ Crittenden, J. “Vigilance: Holiday Puts Spotlight on Harbor Security.” *Boston Herald*. Boston, MA. June 30, 2002. p. 1.

⁵⁴ “LNG Security in Boston to Be Permanent.” *Platt’s Oilgram News*. New York, NY. August 1, 2002.

shipments to resume there for the first time since 1980.⁵⁵ As new LNG terminals have been proposed and approved by federal agencies, the Coast Guard has continued its involvement in LNG security.

The most heavily secured LNG shipments are those bound for the Everett terminal because they pass through Boston harbor. Depending upon the level of alert, the Coast Guard and local law enforcement agencies may put in place numerous security provisions for these shipments, including:

- Inspection of security and tanker loading at the port of origin.
- On-board escort to Boston by Coast Guard “sea marshals.”
- 96-hour advanced notice of arrival of an LNG tanker.
- Advance notification of local police, fire, and emergency agencies, as well as the Federal Aviation Administration and the U.S. Navy.
- Boarding LNG tankers for inspection prior to Boston harbor entry.
- Harbor escort by armed patrol boats, cutters, or auxiliary vessels.
- Enforcement of a security zone closed to other vessels two miles ahead and one mile to each side of the LNG tanker.
- Suspension of overflights by commercial aircraft at Logan airport.
- Inspection of adjacent piers for bombs by police divers.
- Posting of sharpshooters on nearby rooftops.
- Additional security measures which cannot be disclosed publicly.⁵⁶

According to the Coast Guard, such security provisions have been in place for the other U.S. LNG terminals as well, depending upon local assessments of security risk and the unique characteristics of each marine area.⁵⁷

On October 22, 2003, the Coast Guard issued final rules to implement the new security requirements mandated by P.L. 107-295. The rules are codified in Title 33 of the Code of Federal Regulations, Chapter 1, Subchapter H. Among other provisions, the rules establish Coast Guard port officers as maritime security coordinators and set requirements for maritime area security plans and committees. The rules require certain owners or operators of marine assets to designate security officers, perform security assessments, develop and implement security plans, and comply with maritime security alert levels. The vessel rules apply to all LNG tankers entering U.S. ports. Facility rules apply to all land-based U.S. LNG terminals or proposed offshore LNG terminals. Finally, the rules require certain vessels, including LNG tankers, to carry an automatic identification system.

⁵⁵ “Coast Guard, Mikulski Clear Plan to Reactivate Cove Point LNG Plant.” *Platt’s Inside FERC*. Washington, DC. January 6, 2003. p. 5.

⁵⁶ Greenway, H.D.S. “Is it Safe?” *The Boston Globe Magazine*. July, 27, 2003; Lin, J. and Fifield, A. “Risky Business?” *The Philadelphia Enquirer*. February 20, 2005. p. 1.

⁵⁷ O’Malley, Mark, Chief, Ports and Facilities Activities, U.S. Coast Guard. Testimony before the House Committee on Transportation and Infrastructure, Subcommittee on Coast Guard and Maritime Transportation hearing on the Safety and Security of Liquid Natural Gas. May 7, 2007; U.S. Coast Guard, Boston, MA, Captain of the Port. Personal communication. March 22, 2007.

The Coast Guard also has authority to review, approve, and verify security plans for marine traffic around proposed LNG marine terminals as part of the overall siting approval process led by FERC. The Coast Guard is responsible for issuing a Letter of Recommendation regarding the suitability of waterways for LNG vessels serving proposed terminals. The Coast Guard acts as a cooperating agency in the evaluation of LNG terminal siting applications.⁵⁸

The Coast Guard also led the International Maritime Organization (IMO) in developing maritime security standards outside U.S. jurisdiction.⁵⁹ These standards, the International Ship and Port Facility Security Code (ISPS Code) contain detailed mandatory security requirements for governments, port authorities and shipping companies, as well as recommended guidelines for meeting those requirements. The ISPS Code is intended to provide a standardized, consistent framework for governments to evaluate risk and to “offset changes in threat with changes in vulnerability.”⁶⁰

On October 13, 2006, President Bush signed the Security and Accountability for Every Port Act of 2006 (P.L. 109-347). While not addressing LNG security specifically, the act includes general maritime security provisions which could apply to LNG vessels and facilities. These provisions include, among others, requirements relating to maritime facility security plans (Sec. 102); unannounced inspections of maritime facilities (Sec. 103); long-range vessel tracking (Sec. 107); operational centers for port security (Sec. 108); port security grants (Sec. 112); and training and exercise programs (Sec. 112-113). The Coast Guard is the federal agency primarily responsible for implementing these provisions.

Maritime Administration. The Maritime Administration (MARAD) within the Department of Transportation has as its stated mission “to strengthen the U.S. maritime transportation system - including infrastructure, industry and labor - to meet the economic and security needs of the Nation.”⁶¹ As noted above, under P.L. 107-295, MARAD shares siting approval authority for offshore LNG terminals with the Coast Guard. Among other activities, the agency also administers its Maritime Security Program “to maintain an active, privately owned, U.S.-flag, and U.S.-crewed liner fleet in international trade.”⁶² Consistent with this mission, Congress passed the Coast Guard and Maritime Transportation Act of 2006 (P. L. 109 — 241) directing

⁵⁸ U.S. Coast Guard. *U.S. Coast Guard Captain of the Port Long Island Sound Waterways Suitability Report for the Proposed Broadwater Liquefied Natural Gas Facility*. September 21, 2006. p.2. [<http://www.uscg.mil/d1/units/seclis/broadwater/wsrpt/WSR%20Master%20Final.pdf>]

⁵⁹ 68FR126. July 1, 2003. p. 39241.

⁶⁰ International Maritime Organization (IMO). “IMO Adopts Comprehensive Maritime Security Measures.” Press release. London. December 17, 2002.

⁶¹ Maritime Administration (MARAD). “MARAD Mission, Goals and Vision.” Web page. March 16, 2008. [<http://www.marad.dot.gov/welcome/mission.html>]

⁶² Maritime Administration (MARAD). “MARAD Fact Sheet.” March 16, 2008. p. 2. [<http://www.marad.dot.gov/Headlines/factsheets/PDF%20Versions/Mission%20Fact%20Sheet.pdf>]

MARAD to implement a program to promote the transportation of LNG to domestic terminals in U.S. flag vessels (Sec. 304(a)). The act also directs the agency to give top priority to the processing of offshore LNG siting applications that will be supplied by U.S. flag vessels (Sec. 304(b)). The act also requires the agency to consider the nation of registry for, and the nationality or citizenship of, officers and crew serving on board LNG tankers when reviewing an LNG terminal siting application (Sec. 304(c)).

Federal Pipeline and Chemical Security Agencies

Office of Pipeline Safety. The Office of Pipeline Safety (OPS) within the Pipeline and Hazardous Materials Safety Administration (PHMSA) of the Department of Transportation has statutory authority to regulate the safety and security of LNG peak-shaving plants. The agency derives this authority under the Natural Gas Pipeline Safety Act of 1968 (P.L. 90-481). The OPS security regulations for LNG peak-shaving facilities are found in 49 C.F.R. 193, *Liquefied Natural Gas Facilities: Federal Safety Standards* (Subpart J-Security). These regulations govern security procedures, protective enclosures, communications, monitoring, lighting, power sources, and warning signs. Federal LNG *safety* regulations (33 C.F.R. 127) and National Fire Protection Association standards for LNG also include provisions addressing security, such as requirements for monitoring facilities and preparing emergency response plans.⁶³

On December, 28, 2006, the OPS published in the *Federal Register* a security advisory for LNG facility operators after an August, 2006 security breach at an LNG peak-shaving plant in Lynn, MA.⁶⁴ Although not a terrorist incident, the security breach involved the penetration of intruders through several security barriers and alert systems, permitting them to access the main LNG storage tank at the facility. The OPS advisory recommends that LNG facility operators ensure alarms and monitoring devices are functioning; ensure security personnel are properly trained; determine whether security personnel can respond to security breaches in a timely manner; update security procedures to incorporate the most relevant threat information; confirm that personnel properly coordinate their security activities; and independently audit facility security or conduct.⁶⁵

Transportation Security Administration. The Transportation Security Administration (TSA) is the lead federal authority for the security of the interstate gas pipeline network under the Natural Gas Pipeline Safety Act of 1968 (P.L. 90-481). This security authority was transferred to TSA from the Transportation Department's Office of Pipeline Safety (OPS) under the Aviation and Transportation Security Act of 2001 (P.L. 107-71). The TSA has asserted its security authority over

⁶³ National Fire Protection Association (NFPA). *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*. NFPA 59A. Quincy, MA. 2006.

⁶⁴ Pipeline and Hazardous Materials Safety Administration (PHMSA). "Pipeline Safety: Lessons Learned From a Security Breach at a Liquefied Natural Gas Facility." Docket No. PHMSA-04-19856. *Federal Register*. Vol. 71. No. 249. December 28, 2006. p. 78269.

⁶⁵ *Ibid.*

land-based LNG facilities that are considered an integral part of the interstate pipeline network.⁶⁶ The TSA exercises its pipeline and LNG security oversight through the Pipeline Security Division (PSD) within the agency's Office of Transportation Sector Network Management.⁶⁷ The mission of TSA's Pipeline Security Division currently includes developing security standards; implementing measures to mitigate security risk; building and maintaining stakeholder relations, coordination, education and outreach; and monitoring compliance with security standards, requirements, and regulations.

Since 2003, TSA has put in place a number of initiatives related to pipeline security. These initiatives include the coordination, development, implementation, and monitoring of pipeline security plans; on-site reviews of pipeline operator security; United States and Canadian security assessment and planning for critical cross-border pipelines; regional supply studies for key natural gas markets; and pipelines security training, among other initiatives.⁶⁸ As of February 2008, TSA had completed 73 CSR reviews.⁶⁹ According to TSA, virtually all of the companies reviewed have developed security plans, identified critical assets, and conducted background checks on new employees. Most have also implemented employee security training programs and raised local community and law enforcement awareness of pipeline security as part of their emergency response obligations.⁷⁰ In 2005, TSA issued an overview of recommended security practices for pipeline operators "for informational purposes only ... not intended to replace security measures already implemented by individual companies."⁷¹ The agency released revised guidance on security best practices at the end of 2006 and plans to release a second revision in 2008.⁷²

Federal Energy Regulatory Commission (FERC). The FERC is responsible for permitting new land-based LNG facilities, and for ensuring the safe operation of these facilities through subsequent inspections.⁷³ The initial permitting process requires approval of safety and security provisions in facility design, such as hazard detectors, security cameras, and vapor cloud exclusion zones. Every two years, FERC staff inspect LNG facilities to monitor the condition of the physical

⁶⁶ TSA, Intermodal Security Program Office. Personal communication. August 18, 2003.

⁶⁷ These offices were formerly known as the Pipeline Security Program Office and the Intermodal Security Program Office, respectively.

⁶⁸ Transportation Security Administration, *Pipeline Modal Annex*, June 2007, pp. 10-11. [http://www.dhs.gov/xlibrary/assets/Transportation_Pipeline_Modal_Annex_5_21_07.pdf]

⁶⁹ TSA, Intermodal Security Program Office, personal communication, February 27, 2008.

⁷⁰ Mike Gillenwater, TSA, "Pipeline Security Overview," Presentation to the Alabama Public Service Commission Gas Pipeline Safety Seminar, Montgomery, AL, December 11, 2007; TSA, Pipeline Security Division, personal communication, July 6, 2007.

⁷¹ TSA, Intermodal Security Program Office, *Pipeline Security Best Practices*, October 19, 2005, p. 1.

⁷² TSA, February 27, 2008.

⁷³ U.S. Code of Federal Regulations. 18 C.F.R. 157.

plant and inspect changes from the originally approved facility design or operations.⁷⁴ The FERC derives its LNG siting authority under the Natural Gas Act of 1938 (15 U.S.C. 717). The agency has jurisdiction over all on-shore LNG marine terminals and 12 peak-shaving plants involved in interstate gas trade.⁷⁵

In response to public concern about LNG plant security since September 11, 2001, FERC has emphasized the importance of security at LNG facilities. According to the commission, FERC staff played key roles at inter-agency technical conferences regarding security at the Everett and Cove Point LNG terminals. According FERC staff, the commission has added a security chapter to its LNG site inspection manuals which consolidates previous requirements and adds new ones.⁷⁶ As part of its biennial inspection program, FERC also inspected 11 jurisdictional LNG sites in 2005 “placing increased emphasis on plant security measures and improvements.”⁷⁷ FERC’s FY2006 annual report states that “the Commission continues to give the highest priority to deciding any requests made for the recovery of extraordinary expenditures to safeguard the reliability and security of the Nation’s energy transportation systems and energy supply infrastructure.”⁷⁸

Department of Homeland Security. The Department of Homeland Security (DHS) Appropriations Act of 2007 (P.L. 109-295) grants DHS the authority to regulate chemical facilities that “present high levels of security risk” (Sec. 550). In November, 2007, DHS finalized its chemical facility security regulations under the act, requiring that facilities with certain hazardous chemicals, including LNG, at or above screening threshold quantities submit information to DHS through an on-line screening tool. Based on these evaluations, DHS will identify high risk facilities required to conduct a security vulnerability assessments and prepare site security plans to address identified vulnerabilities and meet risk-based performance standards.⁷⁹ These regulations may apply to inland LNG peak-shaving plants, although they exempt LNG facilities in ports which are subject to security regulations under the Maritime Transportation Security Act of 2002 (P.L. 107-295), as amended.

⁷⁴ Foley, R. Federal Energy Regulatory Commission (FERC), Office of Energy Projects. “Liquefied Natural Gas Imports.” Slide presentation. January 2003. p. 17.

⁷⁵ Robinson, J.M, Federal Energy Regulatory Commission (FERC). Testimony before the Senate Energy and Natural Resources Committee, Subcommittee on Energy. February 15, 2005.

⁷⁶ FERC. Personal communication. August 13, 2003.

⁷⁷ Federal Energy Regulatory Commission (FERC). 2005 Annual Report. Washington, DC. 2006. p. 18.

⁷⁸ Federal Energy Regulatory Commission (FERC). *Federal Energy Regulatory Commission Annual Report FY2006*. 2007. p. 23.

⁷⁹ 72 Fed. Reg. 17688. “Chemical Facility Anti-Terrorism Standards.” April 9, 2007; 72 Fed. Reg. 65396. “Appendix to Chemical Facility Anti-Terrorism Standards.” November 20, 2007.

Federal Interagency Cooperation in LNG Security

The Coast Guard, TSA, and FERC all have potentially overlapping security jurisdiction over certain facilities at onshore LNG terminals. For example, FERC's biennial LNG site visits explicitly include security inspections, and TSA oversees onsite pipeline security — but the Coast Guard asserts lead security authority over the entire terminal in its maritime security regulations. Under current authority, both the Coast Guard and TSA could both require their own facility security assessments for pipelines and LNG storage at LNG marine terminals.

To avoid jurisdictional confusion, the Coast Guard, OPS and FERC have entered into an interagency agreement to ensure that they

work in a coordinated manner to address issues regarding safety and security at waterfront LNG facilities, including the terminal facilities and tanker operations, to avoid duplication of effort, and to maximize the exchange of relevant information related to the safety and security aspects of LNG facilities and the related marine concerns.⁸⁰

The agreement requires the agencies to cooperate in the siting approval of new LNG facilities, inspection and operational review of existing facilities, informal communication, and dispute resolution.⁸¹ According to FERC, in FY2006, the commission the “performed detailed reviews of [LNG] safety and security issues, in coordination with the U.S. Coast Guard and the U.S. Department of Transportation.”⁸²

The FERC's security review for new LNG terminal applications is conducted in consultation with the US Coast Guard. Security assessments of individual terminal proposals are conducted by Coast Guard field units through security workshops involving federal, state and local law enforcement officials as well as port stakeholders. FERC engineers provide technical assistance on marine spill issues. FERC and the Coast Guard require LNG terminal applicants to also submit a navigational suitability review under 33 C.F.R. 127, and begin a security assessment of their proposal in accordance with 33 C.F.R. 105. According to FERC, where site-specific security concerns have been raised, the agencies have conducted non-public technical workshops with “all relevant stakeholders and federal, state and local expert agencies” to resolve those security concerns.⁸³

⁸⁰ Federal Energy Regulatory Commission (FERC). “Interagency Agreement Among the Federal Energy Regulatory Commission United States Coast Guard and Research and Special Programs Administration for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities.” February 11, 2004. p. 1.

⁸¹ FERC. February 11, 2004. pp. 2-4.

⁸² Federal Energy Regulatory Commission (FERC). 2006 Annual Report. Washington, DC. 2007. p. 25.

⁸³ Robinson, J.M., Federal Energy Regulatory Commission (FERC). Testimony before the Senate Energy and Natural Resources Committee, Subcommittee on Energy. February 15, 2005.

Industry Initiatives for Land-Based LNG Security

After the September 11 attacks, gas infrastructure operators, many with LNG facilities, immediately increased security against the newly perceived terrorist threat. The operators strengthened emergency plans; increased liaison with law enforcement; increased monitoring of visitors and vehicles on utility property; increased employee security awareness; and deployed more security guards.⁸⁴ In cooperation with the OPS, the Interstate Natural Gas Association of America (INGAA) formed a task force to develop and oversee industry-wide security standards “for critical onshore and offshore pipelines and related facilities, as well as liquefied natural gas (LNG) facilities.”⁸⁵ The task force also included representatives from the Department of Energy (DOE), the American Gas Association (AGA), and non-member pipeline operators. With the endorsement of the OPS, the INGAA task force issued security guidelines for natural gas infrastructure, including LNG facilities, in September 2002.⁸⁶ The task force also worked with federal agencies, including the Department of Homeland Security, on a common government threat notification system.⁸⁷

Key Policy Issues in LNG Security

Government and industry have taken significant steps to secure the nation’s LNG infrastructure. But continued progress in implementing and sustaining LNG infrastructure protection activities may face several challenges. As discussed in detail in the following sections, members of Congress and federal officials are concerned about the growing public costs of LNG security, the uncertainty of terrorist threats against LNG, and security differences between foreign and U.S. LNG vessels and crews.

Public Costs of LNG Marine Security

Some policymakers are concerned about the public cost and sustainability of securing LNG shipments. Overall cost data for LNG security are unavailable, but estimates have been made for Everett shipments. In 2003, the Coast Guard Program Office estimated that it cost the Coast Guard approximately \$40,000 to \$50,000 to “shepherd” an LNG tanker through a delivery to the Everett terminal, depending on

⁸⁴ American Gas Association (AGA) *Natural Gas Distribution Industry Critical Infrastructure Security*, 2002, and AGA, *Natural Gas Infrastructure Security — Frequently Asked Questions*. April 30, 2003.

⁸⁵ Haener, W.J., CMS Energy Corp. Testimony on behalf of the Interstate Natural Gas Association of America (INGAA) before the House Transportation and Infrastructure Subcommittee on Highways and Transit. February 13, 2002. p. 4.

⁸⁶ Interstate Natural Gas Association of America (INGAA) et al., *Security Guidelines Natural Gas Industry Transmission and Distribution*. Washington, DC. September 6, 2002.

⁸⁷ Haener. February 13, 2002. p. 4.

the duration of the delivery, the nature of the security escort, and other factors.⁸⁸ A 2007 update from the Coast Guard Boston Sector estimates an average direct cost to the Coast Guard of an LNG delivery to Everett of approximately \$62,000.⁸⁹ State and local authorities also incur costs for overtime police, fire and security personnel overseeing LNG tanker deliveries. The state of Massachusetts and the cities of Boston and Chelsea estimated they spent a combined \$37,500 to safeguard the first LNG shipment to Everett after September 11, 2001.⁹⁰ Based on these figures, the public cost of security for an LNG tanker shipment to Everett is on the order of \$100,000, excluding costs incurred by the terminal owner.

Marine security costs at other active LNG terminals could be lower than for Everett to the extent they are farther from dense populations and face fewer vulnerabilities. But these terminals expect more shipments. Altogether, the nine active onshore U.S. LNG terminals, including Everett, expect to have enough capacity for over 1,100 shipments per year in 2009. Increasing LNG imports to meet 13% of total U.S. gas supply by 2030 as projected by the EIA could require some 2,300 LNG shipments to LNG terminals serving the United States. Assuming an average security cost only half that for Everett, or \$50,000 per shipment, annual costs to the public for marine LNG security could exceed \$55 million by 2009 if active terminals were operating at full capacity. Security costs could exceed \$115 million by 2030 based on the EIA projections.⁹¹ At least over the next several years, however, analysts predict that U.S. LNG terminals will operate well below capacity, so actual marine security costs will likely be lower.⁹²

The potential increase in security costs from growing U.S. LNG imports, and the potential diversion of Coast Guard and safety agency resources from other activities have been a persistent concern to policy makers.⁹³ According to Coast Guard officials, the service's LNG security expenditures are not all incremental, since they are part of the Coast Guard's general mission to protect the nation's waters and coasts. Nonetheless, Coast Guard staff have acknowledged that resources dedicated to securing maritime LNG might be otherwise deployed for boating safety, search and rescue, drug interdiction, or other security missions. LNG security is funded from the Coast Guard's general maritime security budget, so it is not a line

⁸⁸ U.S. Coast Guard, Program Office. Personal communication. August 12, 2003. This estimate is based on boat, staff and administrative costs for an assumed 20-hour mission.

⁸⁹ Cdr. Mark Meservey, House Liaison, U.S. Coast Guard. "Sector Boston LNG Security Approximate Costs." Unpublished memorandum. May 4, 2007.

⁹⁰ McElhenny, J. "State Says LNG Tanker Security Cost \$20,500." Associated Press. November 2, 2001. p. 1.

⁹¹ Note that security costs associated with any LNG terminals in Canada, Mexico and the Bahamas (built primarily to serve U.S. markets) would not be a direct U.S. responsibility, although such costs might still be priced into LNG supplied from those terminals.

⁹² "Liquified Natural Gas Markets in U.S. Emerge in Uncertain Times, Panelists Agree." *Foster Natural Gas Report*. April 11, 2008. p. 5.

⁹³ See, for example, Representative Peter Defazio, remarks before the House Homeland Security Committee hearing on Securing Liquid Natural Gas Tankers to Protect the Homeland. March 21, 2007.

item in the FY2009 Department of Homeland Security budget request. However, the Coast Guard's FY2006 budget did include an additional \$11 million in funding over FY2005 levels for "Increased Port Presence and LNG Transport Security," specifically including "additional boat crews and screening personnel at key LNG hubs."⁹⁴

In a December 2007 report, the GAO recommended that the Coast Guard develop a national resource allocation plan to address growing LNG security requirements.⁹⁵ In subsequent testimony before Congress, Coast Guard Commandant Admiral Thad Allen expressed concern about the costs to the Coast Guard of securing dangerous cargoes such as LNG and called for a "national dialogue" on the issue.⁹⁶ During questioning, Admiral Allen acknowledged that the Coast Guard did not currently possess sufficient resources to secure future LNG deliveries to a proposed LNG terminal in Long Island Sound which has subsequently been authorized by FERC.⁹⁷

State and local agencies are also seeking more funding to offset the costs of LNG security. Otherwise, they believe that LNG security needs may force them to divert limited local resources from other important public services. Addressing these concerns, the Energy Policy Act of 2005 requires private and public sector cost-sharing for LNG tanker security (Section 311d). In compliance with the act and prior FERC policy, FERC officials require new LNG terminal operators to pay the costs of any additional security or safety needed for their facilities.⁹⁸ The FERC has also recommended that LNG terminal operators provide private security staff to supplement Coast Guard and local government security forces.⁹⁹

The public costs of LNG security may decline as federally mandated security systems and plans are implemented. New security technology, more specific threat intelligence, and changing threat assessments may all help to lower LNG security costs in the future. Nonetheless, the potential increase in security costs from growing

⁹⁴ Department of Homeland Security (DHS). *Budget-in-Brief, Fiscal Year 2006*.

⁹⁵ Government Accountability Office. *Maritime Security: Federal Efforts Needed to Address Challenges in Responding to Terrorist Attacks on Energy Commodity Tankers*. GAO-08-141. December 10, 2007. p. 79.

⁹⁶ Admiral Thad Allen, Commandant, U.S. Coast Guard. Testimony before the House Committee on Appropriations, Subcommittee on Homeland Security hearing, "Coast Guard Budget: Impact on Maritime Safety, Security, and Environmental Protection." March 5, 2008.

⁹⁷ Admiral Thad Allen, March 5, 2008; Federal Energy Regulatory Commission. "Order Granting Authority Under Section 3 of the Natural Gas Act and Issuing Certificates." Docket No. CP06-54-0000. March 20, 2008.

⁹⁸ Baldor, L.C. "Federal Agency, R.I. Officials Meet over LNG Terminal." *Associated Press*. March 17, 2005.

⁹⁹ Federal Energy Regulatory Commission (FERC). "Response to Senator Jack Reed's 2/1/05 letter regarding the proposed Weaver's Cove LNG Project in Fall River, MA & the proposed KeySpan LNG Facility Upgrade Project in Providence, RI under CP04-293 et al." March 3, 2005. p. 2.

U.S. LNG shipments may warrant a review of these costs and associated recovery mechanisms. S. 1594 would allow the DHS to establish a security cost-sharing plan to assist the USCG in securing LNG tankers and other vessels carrying especially hazardous cargo (Sec. 6). H.R. 2830 would prohibit LNG facility security plans based upon the provision of security by a state or local government unless that government has an LNG security arrangement with the facility operator (Sec. 720(b)). H.R. 2830 would also require the Coast Guard to enforce LNG tanker security zones (Sec. 720(a)), and would require the Coast Guard to certify that it has adequate security resources in the sector where a terminal would be located before facility security plans for a new LNG terminal are approved (Sec. 720(c)).

The Commandant of the Coast Guard reportedly opposes the requirement in H.R. 2830 for the Coast Guard to provide LNG tanker security on the grounds that it undermines “the necessary discretion and flexibility to meet ... mission demands in an often-changing, dangerous operating environment.”¹⁰⁰ In prior testimony before Congress, the Commandant stated that such a requirement would not appropriately balance LNG risks against the risks of other dangerous cargoes in marine transportation, and would amount to a subsidy for private LNG companies.¹⁰¹ The Commandant also reportedly opposes H.R. 2830 because he believes it does not adequately distribute the LNG security burden among the Coast and state and local agencies involved in LNG projects.¹⁰² Echoing the Commandant’s objections, President Bush reportedly has threatened to veto H.R. 2830 because of these LNG security provisions.¹⁰³ H.R. 2830 passed the House by a margin (395-7) large enough to override a veto, however, and has yet to pass in the Senate, so it remains to be seen whether these provisions will ultimately change in response to the Commandant’s or President’s objections.

Uncertainty About LNG Threats

The likelihood of a terrorist attack on U.S. LNG infrastructure has been the subject of debate since September 11, 2001. To date, no LNG tanker or land-based LNG facility in the world has been attacked by terrorists. However, similar natural gas and oil facilities have been favored terror targets internationally. For example, since 2001, gas and oil pipelines have been attacked in at least half a dozen countries.¹⁰⁴ In October 2002, the French oil tanker *Limburg* was attacked off the Yemeni coast by a bomb-laden fishing boat.¹⁰⁵ In June 2003, U.S. intelligence

¹⁰⁰ Joshi, R. “Allen Slams USCG Funding Bill.” *Lloyd’s List*. May 1, 2008.

¹⁰¹ Thad Allen, Commandant, U.S. Coast Guard. Testimony before the House Appropriations Committee, Homeland Security Subcommittee hearing on the Coast Guard Budget: Impact on Maritime Safety, Security, and Environmental Protection. March 5, 2008.

¹⁰² Joshi, R. 2008.

¹⁰³ “Bush Warns on LNG Safety Bill.” *International Oil Daily*, April 29, 2008.

¹⁰⁴ For specific examples, see CRS Report RL31990, *Pipeline Security: An Overview of Federal Activities and Current Policy Issues*, by Paul Parfomak.

¹⁰⁵ “Ships as Terrorist Targets.” *American Shipper*. November, 2002. p. 59.

agencies warned about possible Al Qaeda attacks on energy facilities in Texas.¹⁰⁶ The Homeland Security Council included terrorist attacks on “cargo ships” carrying “flammable liquids” among the fifteen hazards scenarios it developed in 2004 as the basis for U.S. homeland security “national preparedness standards.”¹⁰⁷

In addition to warnings of a terrorist threat to energy facilities in general, federal agencies have identified LNG infrastructure in particular as a potential terrorist target. The Department of Homeland Security (DHS) specifically included LNG assets among a list of potential terrorist targets in a security alert late in 2003.¹⁰⁸ The DHS also reported that “in early 2001 there was some suspicion of possible associations between stowaways on Algerian flagged LNG tankers arriving in Boston and persons connected with the so-called ‘Millennium Plot’” to bomb targets in the United States. While these suspicions could not be proved, DHS stated that “the risks associated with LNG shipments are real, and they can never be entirely eliminated.”¹⁰⁹ The 2004 report by Sandia National Laboratories concluded that potential terrorist attacks on LNG tankers, could be considered “credible and possible.”¹¹⁰ The Sandia report identified LNG tankers as vulnerable to ramming, pre-placed explosives, insider takeover, hijacking, or external terrorist actions (such as a *Limburg*-type, missile or airplane attack).¹¹¹ Others further assert that terrorists have demonstrated both the desire and capability to attack such shipping with the intention of harming the general population.¹¹²

Although they acknowledge the security information put forth by federal agencies, many experts believe that concern about threats to LNG tankers is overstated.¹¹³ In 2003, 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.”¹¹⁴ Industry representatives argue that deliberately causing an LNG catastrophe to injure people might be possible in theory, but would be extremely difficult to accomplish. Likewise, the Federal Energy Regulatory Commission

¹⁰⁶ Hedges, M. “Terrorists Possibly Targeting Texas.” *Houston Chronicle*. June 24, 2003.

¹⁰⁷ Homeland Security Council. *Planning Scenarios: Executive Summaries*. July 2004. p. 6-1.

¹⁰⁸ Office of Congressman Edward J. Markey. Personal communication with staff. January 5, 2004.

¹⁰⁹ Turner, P.J., Assistant Secretary for Legislative Affairs, Department of Homeland Security (DHS). Letter to U.S. Representative Edward Markey. April 15, 2004. p. 1.

¹¹⁰ Sandia National Laboratories (SNL). *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*. SAND2004-6258. Albuquerque, NM. December 2004. pp. 49-50.

¹¹¹ SNL. December 2004. pp. 61-62.

¹¹² Clarke, R.A., et al. *LNG Facilities in Urban Areas*. Good Harbor Consulting, LLC. Prepared for the Rhode Island Office of Attorney General. GHC-RI-0505A. May 2005.

¹¹³ McLaughlin, J. “LNG is Nowhere Near as Dangerous as People Are Making it Out to Be.” *Lloyd’s List*. February 8, 2005. p5.

¹¹⁴ Behr, Peter. “Higher Gas Price Sets Stage for LNG.” *Washington Post*. July 5, 2003. p. D10.

(FERC) and other experts believe that LNG facilities are relatively secure compared to other hazardous chemical infrastructures which receives less public attention. In a 2004 report, the FERC stated that

for a new LNG terminal proposal ... the perceived threat of a terrorist attack may be considered as highly probable to the local population. However, at the national level, potential terrorist targets are plentiful.... Many of these pose a similar or greater hazard to that of LNG.¹¹⁵

The FERC also has remarked, however, that “unlike accidental causes, historical experience provides little guidance in estimating the probability of a terrorist attack on an LNG vessel or onshore storage facility.”¹¹⁶

Former Director of Central Intelligence, James Woolsey, has stated his belief that a terrorist attack on an LNG tanker in U.S. waters would be unlikely because its potential impacts would not be great enough compared to other potential targets.¹¹⁷ LNG terminal operators which have conducted proprietary assessments of potential terrorist attacks against LNG tankers, have expressed similar views.¹¹⁸ In a September 2006 evaluation of a proposed LNG terminal in Long Island Sound, the Coast Guard stated that there were “currently no specific, credible threats against” the proposed LNG facility or tankers serving the facility.¹¹⁹ The evaluation also noted, however, that the threat environment is dynamic and that some threats may be unknown.¹²⁰ Because the probability of a terrorist attack on LNG cannot be known with certainty, policy makers and community leaders must, to some extent, rely on their own judgment to decide whether LNG security measures for a specific facility will adequately protect the public. S. 1594 would increase federal protection of vessels and infrastructure handling LNG through new international standards (Sec. 2); safety and security assistance for foreign ports (Sec. 4-5), incident response and recovery plans (Sec. 7); and other provisions.

¹¹⁵ Federal Energy Regulatory Commission (FERC). *Vista del Sol LNG Terminal Project, Draft Environmental Impact Statement*. FERC/EIS-0176D. December 2004. p. 4-162; For example, based on data from the U.S. Office of Hazardous Materials Safety, 600 LNG tanker shipments would account for less than 1% of total annual U.S. shipments of hazardous marine cargo such as ammonia, crude oil, liquefied petroleum gases, and other volatile chemicals.

¹¹⁶ FERC. FERC/EIS-0176D. December 2004. p4-162. Notwithstanding this assertion, in its subsequent draft review of the Long Beach LNG terminal proposal, the FERC states that “the historical probability of a successful terrorist event would be less than seven chances in a million per year...” See FERC. October 7, 2005. p. ES-14.

¹¹⁷ Woolsey, James. Remarks before the National Commission on Energy, LNG Forum, Washington, D.C., June 21, 2006.

¹¹⁸ Grant, Richard, President, Distrigas. Testimony before the Senate Committee on Energy and Natural Resources, Subcommittee on Energy hearing on “The Future of Liquefied Natural Gas: Siting and Safety.” February 15, 2005.

¹¹⁹ U.S. Coast Guard. *U.S. Coast Guard Captain of the Port Long Island Sound Waterways Suitability Report for the Proposed Broadwater Liquefied Natural Gas Facility*. September 21, 2006. p. 146.

¹²⁰ Ibid.

Foreign vs. U.S. LNG Tankers and Crews

There are currently no U.S.-flagged LNG tankers and few, if any, U.S. citizens among LNG tanker crews. Some policy makers are concerned that, compared to U.S. vessels and crews, foreign-flagged LNG tankers may not face the same security requirements or may not face the same level of security oversight and verification.¹²¹ This rationale underlies the provisions in P.L. 109-241 that promote LNG shipping to the United States on U.S.-flagged vessels with U.S. crews. Prompted by these provisions, at least four LNG developers have committed to using U.S. crews in their LNG terminal siting proposals.¹²² Some stakeholders have called for similar measures to promote U.S. flags and crews for tankers serving onshore LNG terminals regulated by FERC.

Notwithstanding the LNG tanker provisions in P.L. 109-241, Coast Guard officials have stated that existing security provisions for foreign-flagged LNG tankers and foreign place them on an equal security footing with potential U.S. counterparts.¹²³

Our domestic maritime security regime is closely aligned with the International Ship and Port Facility Security (ISPS) Code.... Under the ISPS Code, vessels in international service, including LNG vessels, must have an International Ship Security Certificate (ISSC). To be issued an ISSC by its flag state, the vessel must develop and implement a threat-scalable security plan that, among other things, establishes access control measures, security measures for cargo handling and delivery of ships stores, surveillance and monitoring, security communications, security incident procedures, and training and drill requirements. The plan must also identify a Ship Security Officer who is responsible for ensuring compliance with the ship's security plan. The Coast Guard rigorously enforces this international requirement by evaluating security compliance as part of our ongoing port state control program.

Others have questioned preferential treatment of U.S. LNG tankers and crews on the grounds that it may impinge on free trade principles by discriminating against foreign LNG tanker operators fully adhering to international standards.¹²⁴ Given the potential maritime treaty and trade implications, federal efforts to promote U.S. flags and crews on LNG tankers may require careful consideration of potential benefits and costs.

¹²¹ See, for example: Senator Barbara A. Mikulski. Testimony before the House of Transportation and Infrastructure Committee, Coast Guard and Maritime Transportation Subcommittee field hearing on Safety and Security of Liquefied Natural Gas and the Impact on Port Operations. Baltimore, MD. April 23, 2007.

¹²² States News Service. "Agreement Means New Jobs for U.S. Mariners on LNG Tankers." February 8, 2008.

¹²³ O'Malley. May 7, 2007.

¹²⁴ "LNG Must Uphold US Free Trade, Warns ICS." *Lloyd's List*. February 21, 2007. p. 3.

Conclusions

The U.S. LNG industry is growing quickly. While rising LNG imports may offer economic benefits, they also pose risks. LNG infrastructure is inherently hazardous and it is potentially attractive to terrorists. Both lawmakers and the general public are concerned about these risks, although the LNG industry has a long history of relatively safe operations and has taken steps to secure its assets against terrorist attack. No LNG tanker or land-based facility has been attacked by terrorists, and federal, state and local governments have put in place security measures intended to safeguard LNG against newly perceived terrorist threats. These measures are evolving, but a variety of industry and agency representatives suggest that these federal initiatives are reducing the vulnerability of U.S. LNG to terrorism.

The ongoing debate about LNG infrastructure security in the United States has often been contentious. Local officials and community groups have challenged numerous LNG infrastructure proposals on the grounds that they may represent an unacceptable risk to the public. Heightened public scrutiny of LNG facilities has made it difficult to site new LNG terminals near major gas markets and has increased the cost and complexity of LNG terminal siting approval. Nonetheless, both industry and government officials acknowledge that enough new LNG infrastructure will likely be approved to meet long-term U.S. import requirements. Indeed, federal agencies have approved the construction of a number of new U.S. import terminals, several of them onshore. Numerous additional terminal proposals await federal approval. Together with the expansion of the existing U.S. import terminals and the construction of new LNG terminals in Canada and Mexico, the approved U.S. facilities would provide enough added capacity to meet the bulk of U.S. LNG demand for the next 20 years.

New U.S. LNG terminals may not be ideally located so as to minimize the cost of natural gas, but building them in these locations may be better than not building them at all. Furthermore, because their security has been subject to intense public scrutiny, new LNG terminal and tanker operations may be safer than they might have been without such scrutiny and their siting may be less likely to be challenged at a later time when construction is already underway. The construction and subsequent closure of the Shoreham nuclear power plant in the 1980's due to new public opposition offers an example of the need to resolve safety and security concerns before capital is invested. From a purely economic perspective, therefore, the added costs of building more heavily protected LNG terminals potentially farther from their primary markets may represent the U.S. public's willingness to pay for LNG security. Whether this implicit price of LNG security is reasonable is an open question, but the continued interest of private companies to invest billions of dollars in U.S. LNG terminals suggests that it will not prevent needed LNG development.

As Congress continues its oversight of LNG infrastructure development, it may decide to examine the public costs and resource requirements of LNG security, especially in light of dramatically increasing LNG imports. In particular, Congress may consider whether future LNG security requirements will be appropriately funded, whether these requirements will be balanced against evolving risks, and whether the LNG industry is carrying its fair share of the security burden. Congress

may also act to improve its understanding of LNG security risks. Costly “blanket” investments in LNG security might be avoided if more refined terror threat information were available to focus security spending on a narrower set of infrastructure vulnerabilities. Finally, Congress may initiate action to better understand the security and trade implications of efforts to promote U.S.-flagged LNG tankers.

In addition to these specific issues, Congress might consider how the various elements of U.S. LNG security activity fit together in the nation’s overall strategy to protect critical infrastructure. Maintaining high levels of security around LNG tankers, for example, may be of limited benefit if other hazardous marine cargoes are less well-protected. U.S. LNG security also requires coordination among many groups: international treaty organizations, federal agencies, state and local agencies, trade associations and LNG infrastructure operators. Reviewing how these groups work together to achieve common security goals could be an oversight challenge for Congress.