

Siting LNG Terminals in the Californias - What is a Good Project from Safety and Environmental Viewpoint?

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What is California's History with Onshore LNG Terminals?

- California LNG Terminal Act of 1977 (later rescinded):
 - *Transfers authority to permit one LNG terminal from CA Coastal Commission (CCC) to CPUC*
 - *CCC directed to survey and rank terminal sites*
 - *Maximum population density 10 people per sq. mi to one mile from fence line, 60 people per sq. mi to four miles from fence line*
 - *Same density standard for LNG shipping lanes*
 - *Power of eminent domain granted to terminal operator to maintain low population densities*

What was Rationale for Population Density Restrictions?

"The Legislature's 4-mile restriction was apparently based on estimates of the skin burn radiation limits from a major fire resulting from a large LNG spill at the terminal. This 4-mile criterion does not specifically address the possible travel of an unignited LNG vapor cloud beyond four miles."

Spills of 25,000 m³ and 125,000 m³ of LNG were evaluated.

Source: CCC, Final Report Ranking LNG Terminal Sites, May 24, 1978, p. 68.

Have Proposed California LNG Terminal Sites Been Considered Before?

- 1978 California Coastal Commission report, "Final Ranking of LNG Terminal Sites," 82 sites evaluated, all but 4 sites rejected.
- Evaluation criteria: population density, land and water site characteristics, maritime conditions, seismic activity, and coastal resources
 - *L.A. Harbor site was rejected, due to population density and seismic concerns*
 - *Humbolt Bay site rejected due to population density*

Have Offshore LNG Terminals Been Considered Before?

- CCC Resolution - WHEREAS, it is possible that one or more offshore sites and terminal types could prove more appropriate than the best onshore site and terminal type, considering safety, cost, timing and the policies of the (1976) Coastal Act
- Most appropriate offshore site - international waters (Ventura Flats) off the coast of Ventura County.
- Minimal adverse impacts on sensitive marine resources and public recreation along the coast.
- Offshore Long Beach identified as good potential site.

CCC, Final Report Evaluating and Ranking LNG Terminal Sites, May 24, 1978, p. 57.

CCC, Offshore LNG Terminal Study, September 15, 1978

Is There a Cost Difference Between Onshore and Offshore LNG Terminals?

Project	Sendout (bcfd)	Capital Cost (\$ millions)
Shell/Sempra	1.3	600
ChevronTex (offshore)	1.0	650
Marathon/Golar	0.75	550
Mitsubishi	0.75	400
BHP Billiton (offshore)	1.5	600

How Does U.S. Law Address LNG Terminal Safety?

- Pipeline Safety Act Amendments of 1979:
 - *Government Accounting Office (GAO), investigative arm of Congress, states before Senate "We believe remote siting is the primary factor in safety" (for LNG and LPG terminals)*
 - *GAO recommendation incorporated in 1979 Act*

Source: Mobile Register article, Nov. 16, 2003

Is Remote Siting of LNG Terminals Required by Law?

- Pipeline Safety Act Amendments of 1979:
 - *Final bill states "Secretary of Transportation shall prescribe minimum safety standards for deciding on the location of a new LNG facility"*
 - *The law lists six factors the Secretary must consider in setting these minimum standards*
 - *Factor No. 6 states "the need to encourage remote siting"*
 - *Factor No. 6 not incorporated into implementing regulations, according to author of legislation*

What is Intent of Legislation Regarding Terminal Safety?

Federal officials appear to be ignoring a congressional mandate designed to discourage construction of liquefied natural gas terminals in populated areas, according to U.S. Rep. Ed Markey, D-Mass., author of the 1979 House bill outlining minimum safety standards for such facilities.

Source: Mobile Register article, Nov. 16, 2003

How Does FERC Define Worst Case Accident Scenario?

- A break in one LNG transfer arm that last for 10 minutes. Total spill is ~550,000 gallons. This represents less than 1.5% of the capacity of one LNG storage tank.
- The LNG tanker, often considered the most vulnerable element at the terminal, is not included in the risk analysis.
- The LNG terminal owner must demonstrate via approved model that the distance to significant radiation impact is within the terminal property line.

What is a Worst Case LNG Tanker Accident Scenario?

- Scientific consensus is that rupture of a single 25,000 m³ LNG tanker sphere would create a fire at least 1/2 mile wide, with significant radiation impact another 1/2 mile out from the fire's edge.
- There are five 25,000 m³ LNG spheres on a typical LNG tanker- a fire involving all five tanks would be considerably larger than the single sphere example.

Source: Union of Atomic Scientists Bulletin article, LNG: Safety in Science, Jan/Feb 2004, pg. 30.

Test of LNG Spill



Combustion of 40 m³ of LNG



Form of LNG Vapor Cloud/Fire



What is Vulnerability of Sites with LNG Storage Tanks and Propane/Ethane Spheres?

- *"A moderately sized commercial aircraft would penetrate the three-foot thick concrete secondary LNG storage tank containment shell. The tanks could also be vulnerable to attack from land- or ship-borne weapons."*
- *"Two 12-million gallon propane tanks near Sacramento were identified for attack in 1998. The perpetrators were caught in the planning stages."*

Source: City of Vallejo, LNG in Vallejo: Health and Safety Issues, Draft 6 Final Report, Jan. 8, 2003, pg. 45.

What is Homeland Security's View on LNG Terminal Vulnerability?

Dept. of Homeland Security Nov. 21, 2003
warning of increased risk of terrorist attacks:

Of particular concern is "al-Queda's continued interest in aviation, including using cargo jets" to attack infrastructure such as bridges and dams "as well as targeting liquid natural gas, chemical and other hazardous materials facilities," the Department said in a statement.

Are FERC LNG Accident Modeling Scenarios Conservative?

- *"The author of a study (Quest) used by federal officials to demonstrate that LNG facilities pose few hazards for cities like Mobile has now written those officials to warn that his study cannot be used in that way."*
- *"Federal officials have used the Quest study in public hearings, federal documents and in letters to members of Congress to suggest that fires stemming from an LNG tanker accident would endanger only a small area around the ship."*

Recent Federal Developments - LNG Terminal Risk Evaluation

- December 2003 - DOE Sec. Abraham instructs DOE's Sandia National Laboratory (SNL) to conduct review of LNG safety studies amid controversy that federal officials had misused several LNG studies to open LNG import terminals in populated areas. Original SNL study narrowly focused.
- January 23, 2004 - DOE announces the SNL LNG safety study will be greatly expanded, *"to err on the side of inclusion rather than speed."*

Recent State and International Siting Developments

- Jan. 14, 2004 - Gov. Bob Riley (AL) states intention to block sale of Mobile Bay port site to ExxonMobil until independent safety study conducted. Urges FERC to consider "*most credible worst case scenario.*" [Alternative - offshore].
- Jan. 20, 2004 - Explosion/fire at LNG complex in Algeria, three liquefaction trains destroyed
- Jan. 27, 2004 - Incident will generate misinformed perceptions, doubts incident will influence FERC actions (Oil & Gas Journal).

Sources: Mobile Register article, January 15, 2004; Oil & Gas Journal article, January 27, 2004.

How are LNG Projects in the Region Being Designed?

Project	Location	Regas method	Distance to pop. density > 60 sq. mi.
Shell/Bechtel	onshore	SCV	1 <i>-withdrawn-</i>
Calpine Humbolt Bay	onshore	unknown	1 <i>-controversial-</i>
BHP Billiton 20 mi. off Oxnard	floating offshore	SCV	20+
Mitsubishi Long Beach Harbor	onshore	process water	<2 <i>-controversial-</i>

How are LNG Projects in the Region Being Designed?

Project	Miles to border	Location	Distance to pop. density > 60 sq. mi.
Sempra	40	onshore	2.5 <i>-permit on hold-</i>
Shell	40	onshore	3 <i>-permit on hold-</i>
Conoco/El Paso	15	onshore	<1 <i>-permit denied-</i>
ChevronTexaco	10	offshore	6 <i>-sanctuary issue-</i>
Marathon/Golar	3	onshore	<1 <i>-controversial-</i> ²¹

Have There Been Any LNG Storage Accidents?

Source: Vallejo LNG Safety Study (draft), January 8, 2003

Date	Place	Description
1988	Boston	~30,000 gallons of LNG spilled during interruption in LNG transfer. Blown flange gaskets caused by "water hammer," spill contained. Still air conditions prevented movement of vapor cloud.
1978	Das Is., UAE	Failed bottom connection, LNG drains into containment. Vapor cloud, no fire.
1944	Cleveland	LNG tank rupture, no containment, fire. 128 dead, hundreds injured. Tank metallurgy problem caused rupture.

Have There Been Any LNG Shipping Accidents?

Date	Place	Description
2000	Elba Island, GA	Cargo ship loses control and hits LNG unloading pier. Not operational at time. Five 16-inch unloading arms replaced.
1999	Trinidad/Tobago	Engine failure during approach to LNG jetty. Ship struck and damaged pier.
1989	Algeria	Wind blows ship from pier. All transfer arms sheared, piping on ship heavily damaged. LNG released, no fire.
1983	Japan	Prior to unloading, ship suddenly moves astern under own power. All transfer arms sheared and LNG spilled, no fire.

Are Double-Hulled LNG Tankers Impregnable?

A double-hulled french oil tanker was attacked off Yemen in late 2002:

- Explosion rips large hole in French crude oil supertanker Limburg
- Small boat loaded with explosives caused damage
- Both hulls breached, vessel set on fire

Source: BBC News Online article, Oct. 6, 2002

Long Beach Harbor Site: Supply Flexibility vs. Increased Hazard Potential at Terminal Site

- Processing plant included onsite to remove “hot gas” components, propane and ethane, so LNG can meet SoCalGas, ARB CNG specs.
- Hazard - propane (explosive) and ethane stored onsite in 85-foot diameter spheres near LNG storage tanks.
- Hazard - up to 140 tractor-trailer trucks required to move propane/ethane offsite.

What is “Hot” (High Btu) LNG?

- Characteristics of available Pacific Rim LNG - high Btu ($>1,100$ Btu/ft³), high ethane.
- Far Eastern LNG customers want high Btu content, these customers drive LNG business.
- SoCal Rule 30: heat content $\leq 1,150$ Btu/ft³
- ARB CNG fuel spec: ethane ≤ 6 percent
- Investment risk issue - Who will pay to “cool” the hot gas to meet CA specs? Liquefaction plant? Receiving terminal?

What is Air Emissions Impact of “Hot” Natural Gas?

- Millions of space heaters, hot water heaters, stoves with no controls to adjust for increase in natural gas Btu content.
- For these units, NO_x increase roughly proportionate to Btu content increase.
- SCAQMD test program - increased Btu content from 1,000 to 1,150 Btu/ft³, NO_x increased 20%.
- Not a major issue for combustion systems with adjustable controls (GTs, boilers, engines).

Possible Upstream Source(s) of LNG and Environmental Issues

Project	LNG Source	Environmental Issues
Shell or Mitsubishi	Sakhalin (Russia) or Australia	600 km. long pipeline along length of Sakhalin, offshore gas field in area considered key habitat for critically endangered Pacific Gray Whale
Sempra	Peru or Bolivia	Ex-Im Bank denied loan guarantee request (8/29/03) citing damage to Peruvian rainforest, Bolivia opposes Chile as LNG shipping point – War of Pacific
Marathon/Golar	Sulawesi, Indonesia	MOU with Pertamina to receive LNG from new plant on Sulawesi

Gaseous Fuel Accidents and Mexico - Population Sensitized to Fuel Storage Site Hazards

Site	Year	Fuel	Dead	Injured
Mexico City <i>Fire/explosion (same site)</i>	1984	LPG	650	6,400
	1996	LPG	4	unknown
Guadalajara <i>Tank leakage – fire</i>	1992	mixed	170	500
Chiapas <i>Cactus gas plant - gas leakage – explosion/fire</i>	1996	natural gas	6	30

Use of Large Amounts of Seawater for Regas Controversial

- All 4 existing continental U.S. regas terminals use portion of LNG for regas (1 - 1.5% of throughput)
- New coastal/river power plants prohibited from using once-through cooling. EPA 316(b) rule. Oil/gas production facilities, including LNG terminals, will be brought into program.
- SEMARNAT denied license to proposed 450 MW power plant at Baja Shell/Sempra LNG site in 2000 - impacts of seawater cooling on marine life cited.
- ChevronTexaco and Shell/Sempra proposing seawater regas in Baja.

California Natural Gas Demand Issues

- SoCalGas/SDGE Dec. 2003 projection: decline through ~2010, rebound to 2002 level in 2016.
- Backbone of California power generation is fleet of aging, inefficient utility boilers. Accelerated replacement with combined-cycle plants could reduce demand by 400 to 500 mmcf/d in short- and mid-term.
- Policy question: Spend \$4 billion for one LNG supply chain or \$4 billion to repower fleet, and potentially eliminate need for terminal?

LNG - Bridge to Renewable Energy Future? Do We Need the Bridge?

- California renewables generation target of 20% by 2017.
- Interest in accelerating 20% target to 2010.
- Little short- or mid-term potential demand for greenfield (other than replacement) gas-fired power plants if state chooses ambitious renewables track.

Conclusions

- Major ongoing controversy over appropriate worst case accident/event to use for siting onshore LNG regas terminals.
- All onshore regas projects encountering resistance in the Californias
- Offshore terminal with no seawater regas minimizes safety and marine impact concerns.
- Significant distance from coast (> 10 miles) minimizes visual impact concerns.