The Realities of Certifying LNG Terminals in North America

Bill Westcott

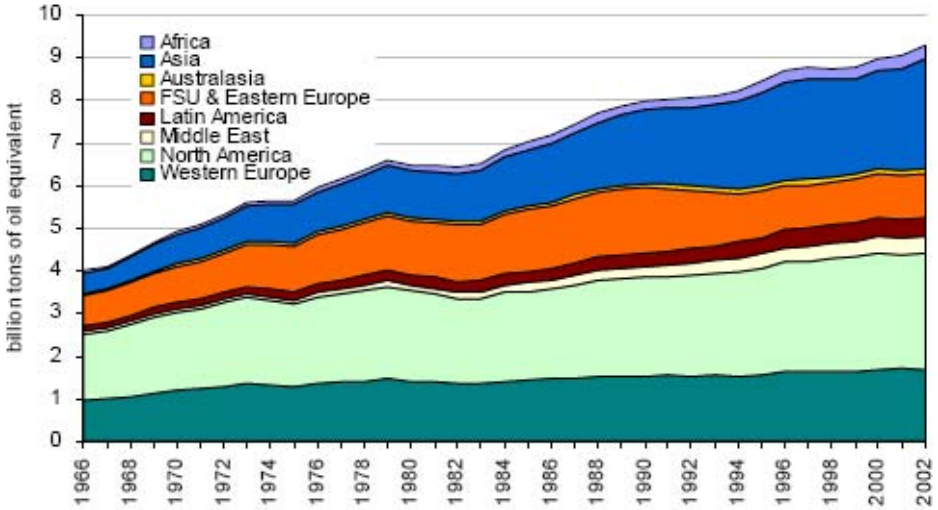
December 9, 2005

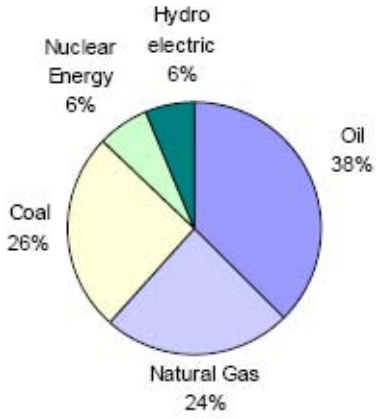
Rice Global E&C Forum

Overview

I. Current Energy Picture
II. North American LNG Import Terminals
III. “Certification” Background
IV. Public Safety Concerns
V. Reality

Main driver – strong growth in world energy demand

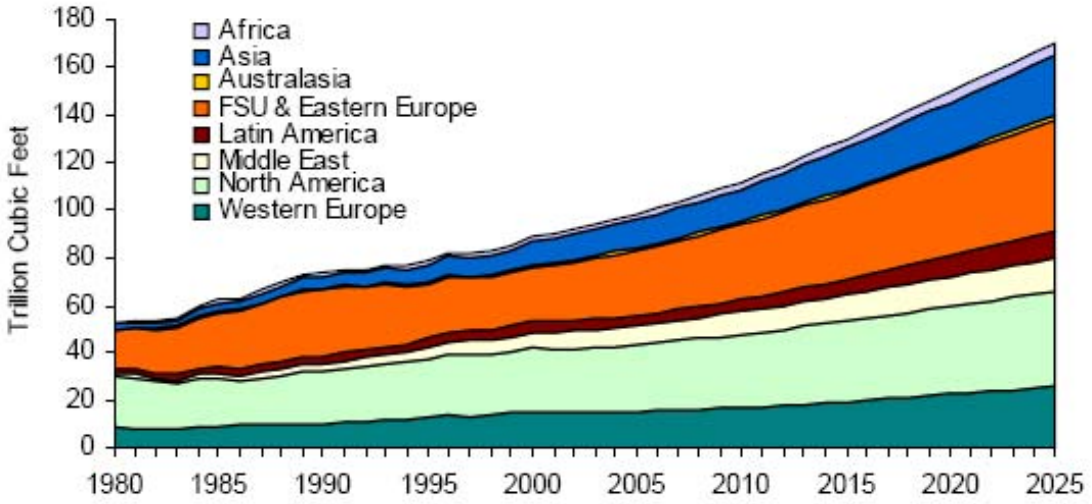




Source: BP

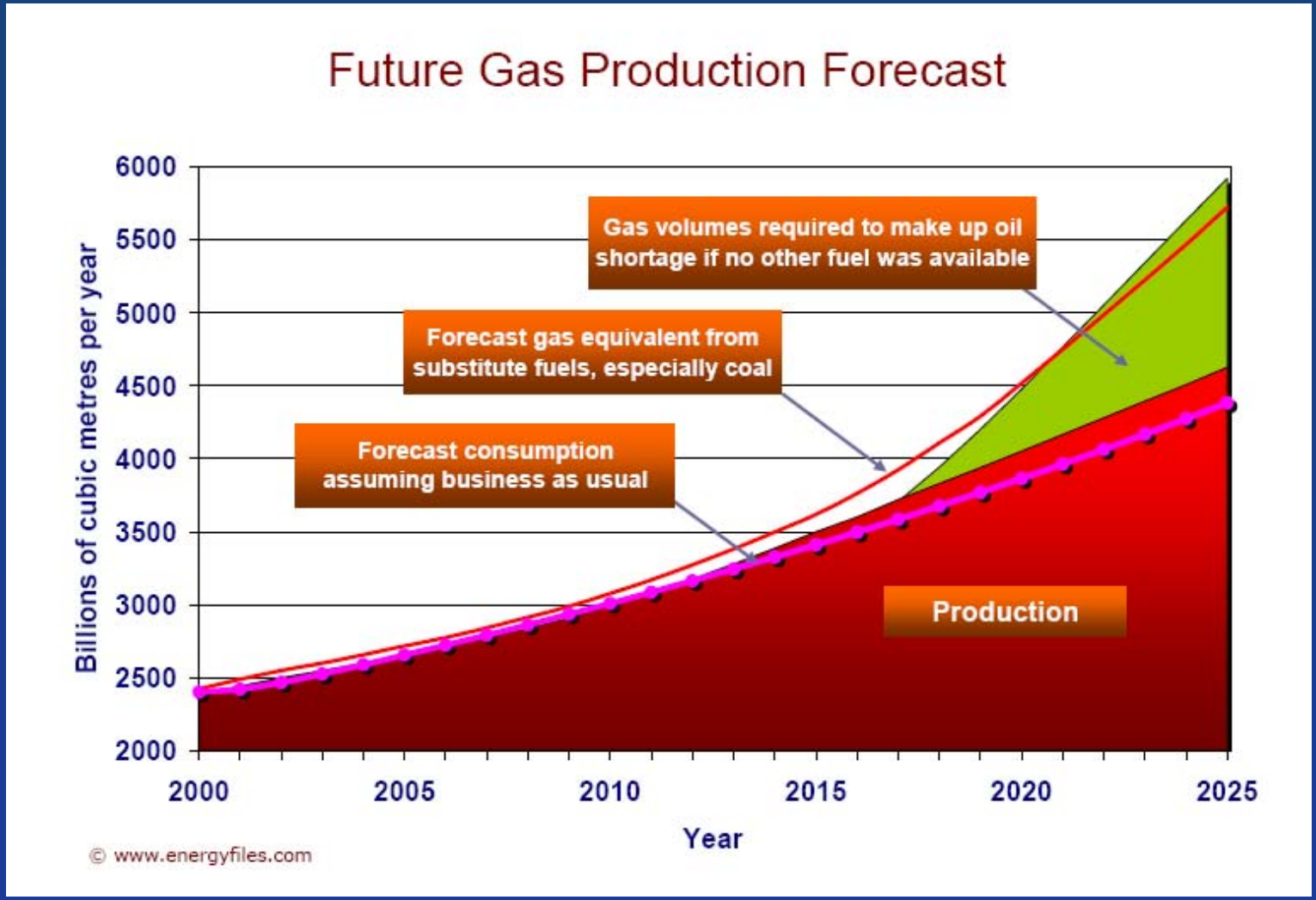
- Natural gas provides 24% of global energy demand
- This share is expected to increase

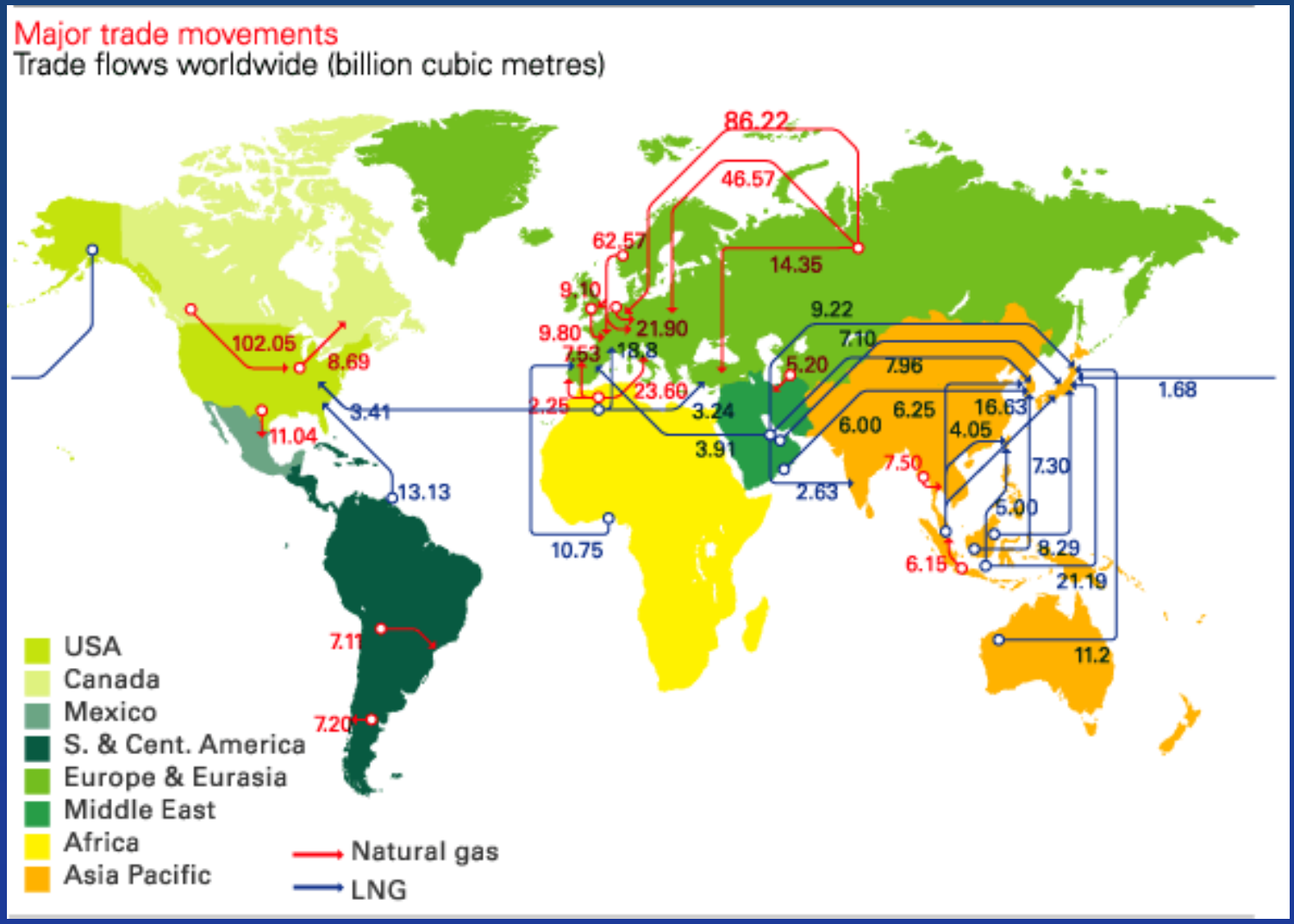
Strong growth in world natural gas demand



Source: EIA

- Gas demand to grow at 2.8% (compared with oil at 1.8%)
- Problems of meeting local shortages (e.g. UK & USA)
- Power cuts in prospect if severe winters
- UK wholesale gas prices up 32% in 2003





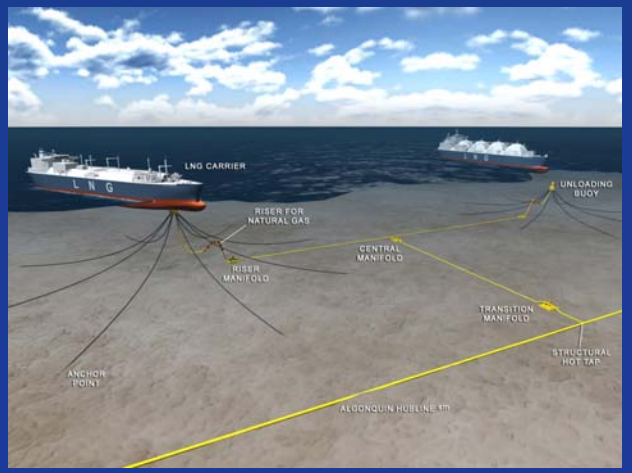
BP for 2004

Types of Import Terminals

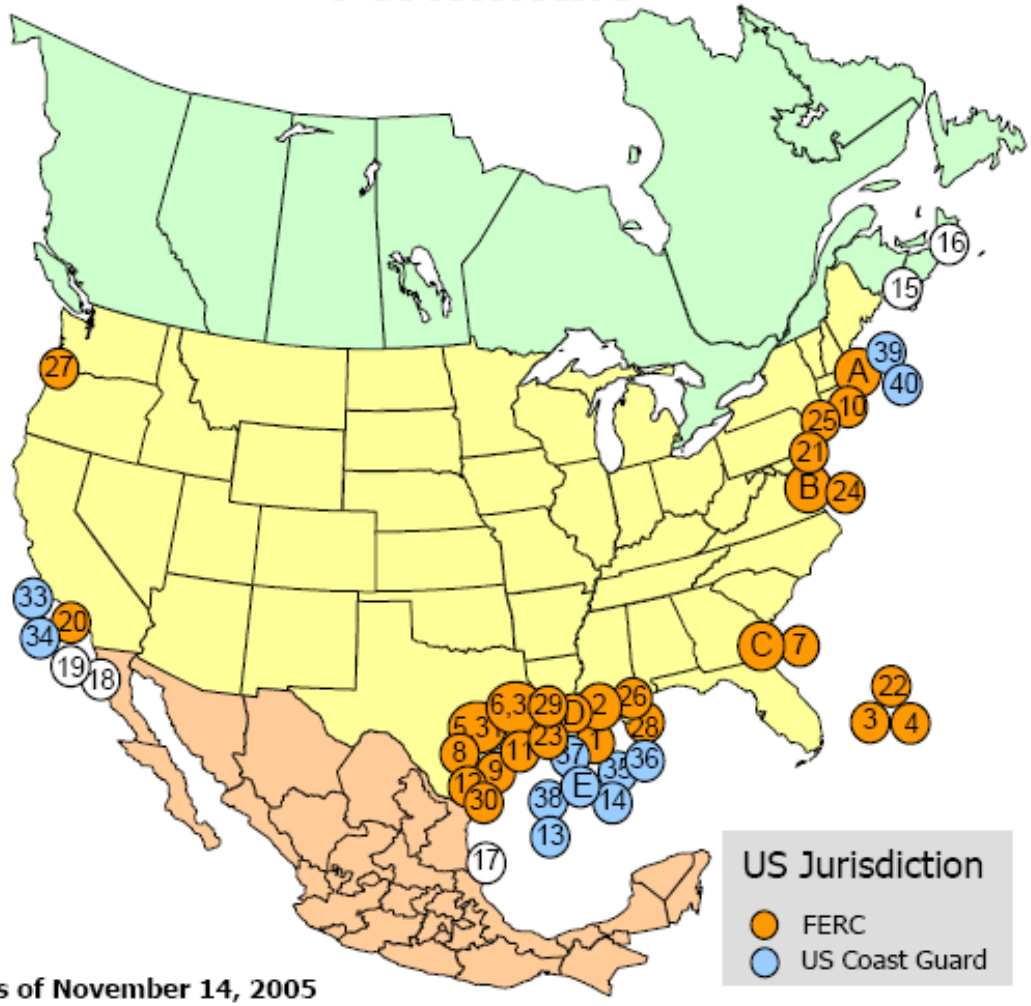
Coastal Liquefied Gas Terminals

Offshore GBS Terminals

Floating Offshore Terminals



Existing and Proposed North American LNG Terminals



As of November 14, 2005

* *US pipeline approved; LNG terminal pending in Bahamas*

CONSTRUCTED

A. Everett, MA : 1.035 Bcfd (Tractebel - DOMAC)
B. Cove Point, MD : 1.0 Bcfd (Dominion - Cove Point LNG)
C. Elba Island, GA : 0.68 Bcfd (El Paso - Southern LNG)
D. Lake Charles, LA : 1.0 Bcfd (Southern Union - Trunkline LNG)
E. Gulf of Mexico: 0.5 Bcfd, (Gulf Gateway Energy Bridge - Excelerate Energy)

APPROVED BY FERC

1. Lake Charles, LA: 0.8 Bcfd (Southern Union - Trunkline LNG)
2. Hackberry, LA : 1.5 Bcfd, (Sempra Energy)
3. Bahamas : 0.84 Bcfd, (AES Ocean Express)*
4. Bahamas : 0.83 Bcfd, (Calypso Tractebel)*
5. Freeport, TX : 1.5 Bcfd, (Cheniere/Freeport LNG Dev.)
6. Sabine, LA : 2.6 Bcfd (Cheniere LNG)
7. Elba Island, GA: 0.54 Bcfd (El Paso - Southern LNG)
8. Corpus Christi, TX: 2.6 Bcfd, (Cheniere LNG)
9. Corpus Christi, TX : 1.0 Bcfd (Vista Del Sol - ExxonMobil)
10. Fall River, MA : 0.8 Bcfd, (Weaver's Cove Energy/Hess LNG)
11. Sabine, TX : 1.0 Bcfd (Golden Pass - ExxonMobil)
12. Corpus Christi, TX: 1.0 Bcfd (Ingleside Energy - Occidental Energy Ventures)

APPROVED BY MARAD/COAST GUARD

13. Port Pelican: 1.6 Bcfd, (Chevron Texaco)
14. Louisiana Offshore : 1.0 Bcfd (Gulf Landing - Shell)

CANADIAN APPROVED TERMINALS

15. St. John, NB : 1.0 Bcfd, (Canaport - Irving Oil)
16. Point Tupper, NS 1.0 Bcf/d (Bear Head LNG - Anadarko)

MEXICAN APPROVED TERMINALS

17. Altamira, Tamulipas : 0.7 Bcfd, (Shell/Total/Mitsui)
18. Baja California, MX : 1.0 Bcfd, (Sempra)
19. Baja California - Offshore : 1.4 Bcfd, (Chevron Texaco)

PROPOSED TO FERC

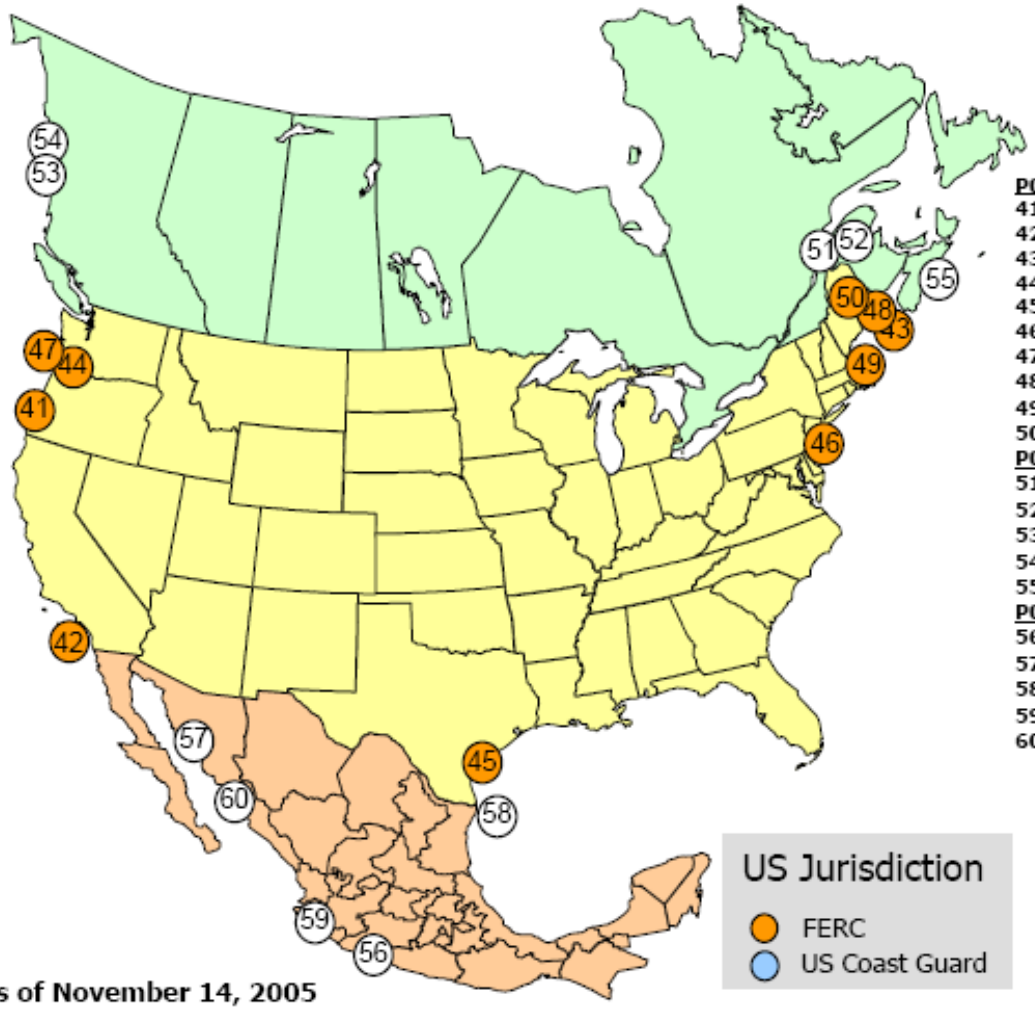
20. Long Beach, CA : 0.7 Bcfd, (Mitsubishi/ConocoPhillips - Sound Energy Solution
21. Logan Township, NJ : 1.2 Bcfd (Crown Landing LNG - BP)
22. Bahamas : 0.5 Bcfd, (Seafarer - El Paso/FPL)
23. Port Arthur, TX: 1.5 Bcfd (Sempra)
24. Cove Point, MD : 0.8 Bcfd (Dominion)
25. LI Sound, NY: 1.0 Bcfd (Broadwater Energy - TransCanada/Shell)
26. Pascagoula, MS: 1.0 Bcfd (Gulf LNG Energy LLC)
27. Bradwood, OR: 1.0 Bcfd (Northern Star LNG - Northern Star Natural Gas LLC)
28. Pascagoula, MS: 1.3 Bcfd (Casotte Landing - ChevronTexaco)
29. Cameron, LA: 3.3 Bcfd (Creole Trail LNG - Cheniere LNG)
30. Port Lavaca, TX: 1.0 Bcfd (Calhoun LNG - Gulf Coast LNG Partners)
31. Freeport, TX: 2.5 Bcfd (Cheniere/Freeport LNG Dev. - Expansion)
32. Sabine, LA: 1.4 Bcfd (Cheniere LNG - Expansion)

PROPOSED TO MARAD/COAST GUARD

33. California Offshore: 1.5 Bcfd (Cabrillo Port - BHP Billiton)
34. So. California Offshore : 0.5 Bcfd, (Crystal Energy)
35. Louisiana Offshore : 1.0 Bcfd (Main Pass McMoRan Exp.)
36. Gulf of Mexico: 1.0 Bcfd (Compass Port - ConocoPhillips)
37. Gulf of Mexico: 2.8 Bcfd (Pearl Crossing - ExxonMobil)
38. Gulf of Mexico: 1.5 Bcfd (Beacon Port Clean Energy Terminal - ConocoPhillips)
39. Offshore Boston, MA: 0.4 Bcfd (Neptune LNG - Tractebel)
40. Offshore Boston, MA: 0.8 Bcfd (Northeast Gateway - Excelerate Energy)

FERC

Potential North American LNG Terminals



POTENTIAL U.S. SITES IDENTIFIED BY PROJECT SPONSORS

41. Coos Bay, OR: 0.13 Bcfd, (Energy Projects Development)
42. California - Offshore: 0.75 Bcfd, (Chevron Texaco)
43. Pleasant Point, ME : 0.5 Bcfd (Quoddy Bay, LLC)
44. St. Helens, OR: 0.7 Bcfd (Port Westward LNG LLC)
45. Galveston, TX: 1.2 Bcfd (Pelican Island - BP)
46. Philadelphia, PA: 0.6 Bcfd (Freedom Energy Center - PGW)
47. Astoria, OR: 1.0 Bcfd (Skipanon LNG - Calpine)
48. Robbinston, ME: 0.5 Bcfd (Downeast LNG - Kestrel Energy/Dean Girdis)
49. Boston, MA: 0.8 Bcfd (AES Battery Rock LLC - AES Corp.)
50. Calais, ME: ? Bcfd (BP Consulting LLC)

POTENTIAL CANADIAN SITES IDENTIFIED BY PROJECT SPONSORS

51. Quebec City, QC : 0.5 Bcfd (Project Rabaska - Enbridge/Gaz Met/Gaz de France)
52. Rivière-du- Loup, QC: 0.5 Bcfd (Cacouna Energy - TransCanada/PetroCanada)
53. Kitimat, BC: 0.61 Bcfd (Galveston LNG)
54. Prince Rupert, BC: 0.30 Bcfd (WestPac Terminals)
55. Goldboro, NS 1.0 Bcfd (Keltic Petrochemicals)

POTENTIAL MEXICAN SITES IDENTIFIED BY PROJECT SPONSORS

56. Lázaro Cárdenas, MX : 0.5 Bcfd (Tractebel/Repsol)
57. Puerto Libertad, MX: 1.3 Bcfd (Sonora Pacific LNG)
58. Offshore Gulf, MX: 1.0 Bcfd (Dorado - Tidelands)
59. Manzanillo, MX: 0.5 Bcfd
60. Topolobampo, MX: 0.5 Bcfd

As of November 14, 2005

Office of Energy Projects

Cleveland, Ohio

Oct. 20, 1944

Skikda, Algeria

January 19, 2004

Other LNG Incidents

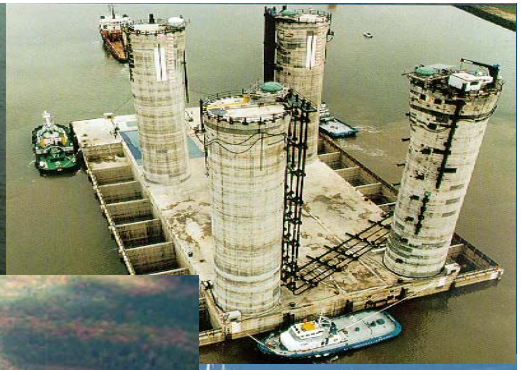
- *Methane Princess* Spill, 1965.
- *Jules Verne* Spill, May 1965.
- La Spezia, Italy, 1971.
- **Montreal East, Quebec, Canada LNG Plant Explosion, 1972.**
- **Staten Island Tank Fire, USA, 1973.**
- **Massachusetts Barge Spill, July 1974.**
- *Aquarius* Spill, September 1977.
- Das Island, United Arab Emirates Spill, March 1978.
- **Cove Point, Maryland LNG Spill, 1979.**
- *Mostafa Ben Bouliad* Spill, April 1979.
- *Pollenger* Spill, April 1979.
- Bontang, Indonesia LNG Plant Explosion, 1983.
- *Bachir Chihani,* Hull Cracking, 1990.
- Mediterranean Off Gibralter LNG Carrier Collision, November 13, 2002.
- **Trinidad Tobago LNG Turbine Explosion, June 13, 2004.**
- Belgium LNG Pipeline Explosion, July 31, 2004.
- Norway LNG Tanker Adrift, September 20, 2004.
- **Maryland House Explosion March 2005**
- Nigeria 28 in. LNG Pipeline Explosion, August, 2005.
- India Tugs Collided with LNG Terminal, September 17, 2005.

Lloyd's Register

Is there a role for Independent Assessment?


CAPTAIN FRIO


L N G




L N G

Principles of Certification

- **Work Independently**

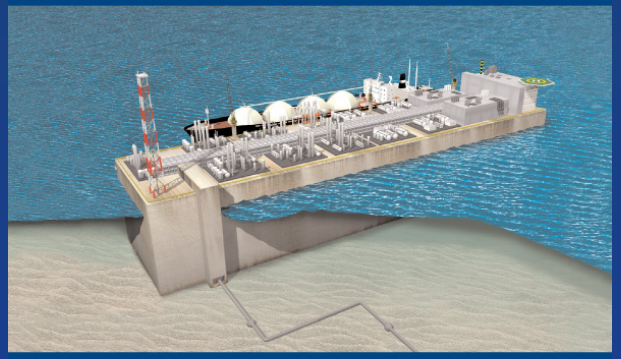
  - Design reviews and inspections are carried out independently from those carried out by contractors and owner.

- **Transparent Process**

  - Certification process is documented and available for review by Regulatory Body as necessary.

LNG Guidance Notes

Classification and certification of offshore gravity based liquefied gas terminals



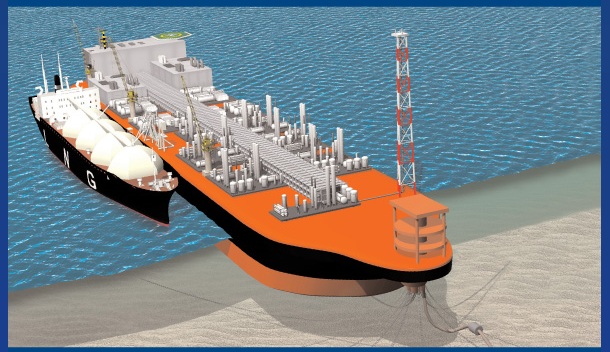
Guidance notes

April 2004
Revision 1

Safely optimising business performance

Lloyd's Register

Classification and certification of floating offshore liquefied gas installations



Guidance notes

April 2004
Revision 2

Safely optimising business performance

Lloyd's Register

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Challenges Faced

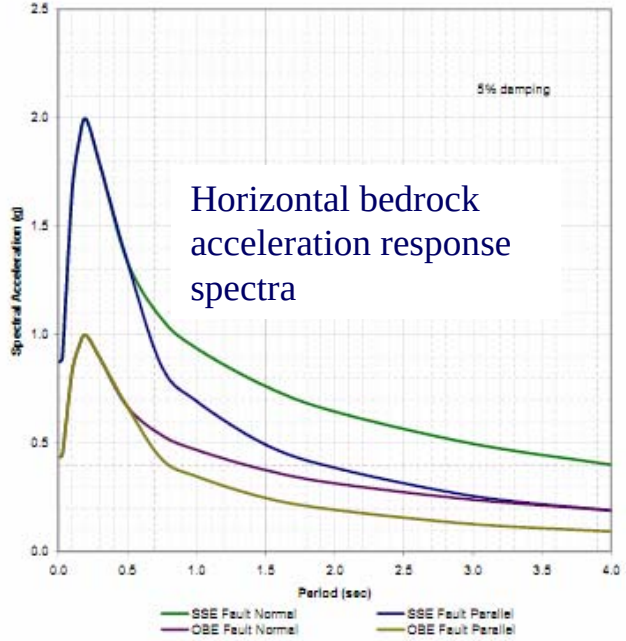
- **Technological**
  - **Seismicity**
  - **Transfer Systems**
  - **Novel Concepts and Materials**
- **Safety & Environmental**

Seismic environment

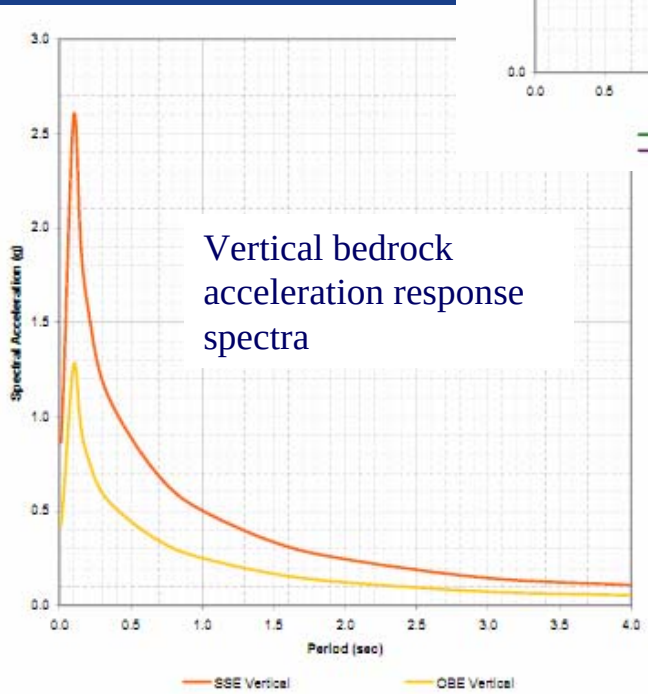
Analyses are performed for two earthquake events:

(OBE) Operating Basis Earthquake
1 in 475 years

(SSE) Safe Shutdown Earthquake
1 in 2500 years



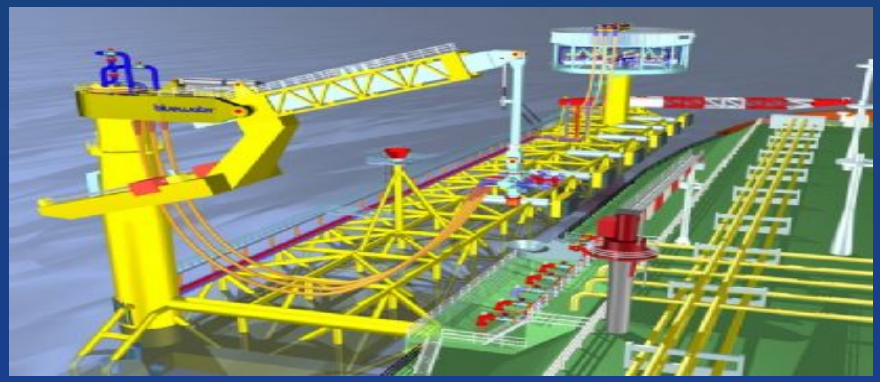
Horizontal bedrock acceleration response spectra



Vertical bedrock acceleration response spectra

Transfer systems

Bluewater



SBM

FMC

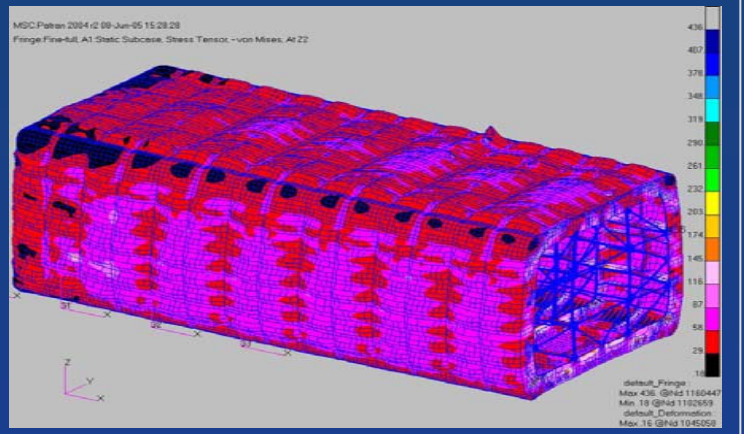
Novel LNG Concepts

- **Containment**
- **Pipe-in-pipe**

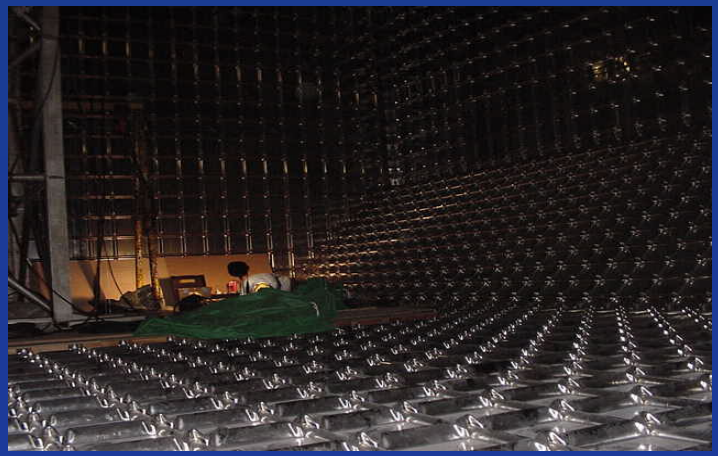
Containment

GT No.96

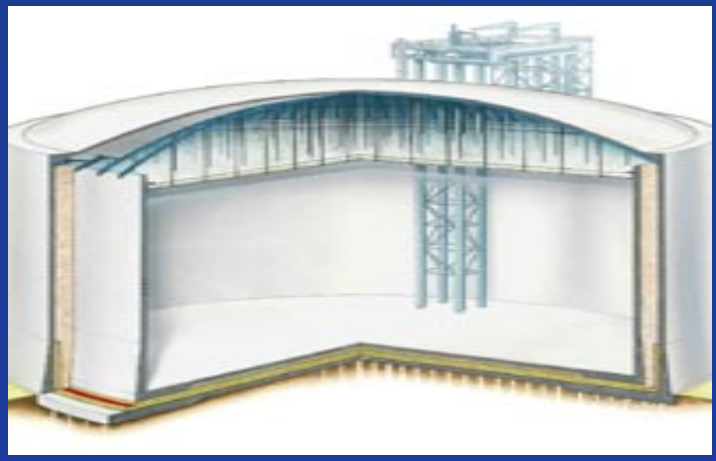
Exxon Mobil - Modular Tank



Technigaz MkIII

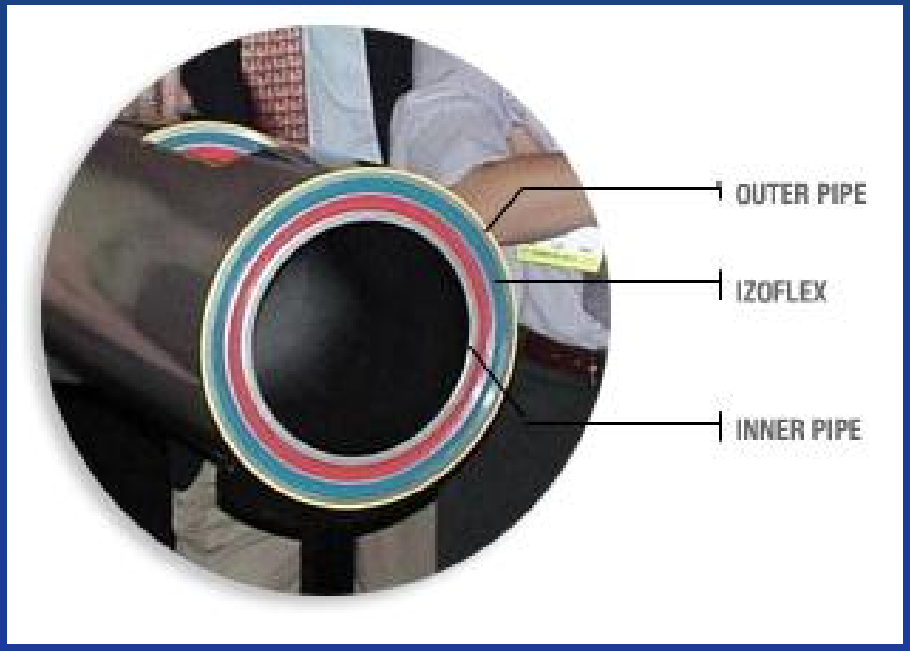


All-Concrete Storage Tanks

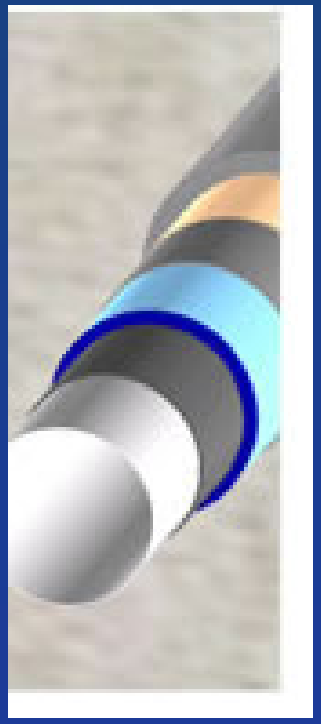


Pipe-in-pipe

ITP InTerPipe



Technip Cryogenic Pipe-in-Pipe



Challenges Faced

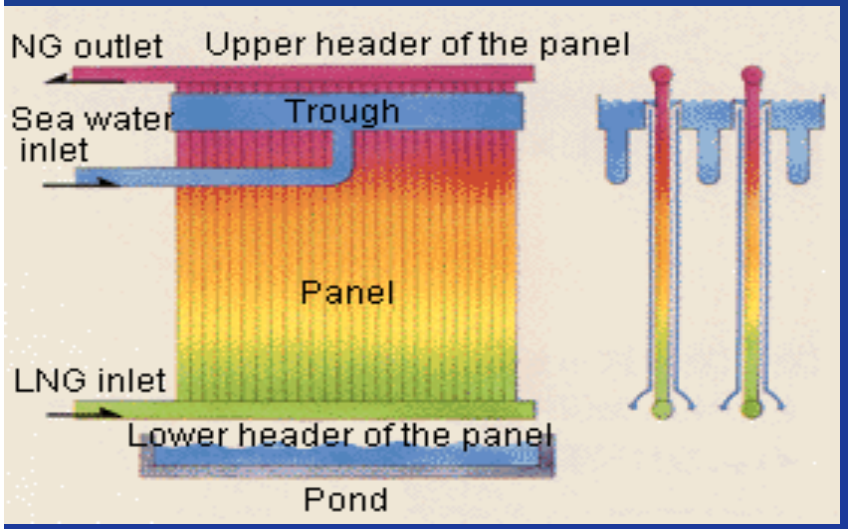
- **Technological**
  - **Seismicity**
  - **Transfer Systems**
  - **Novel Concepts and Materials**
- **Safety & Environmental**
  - **Siting**
  - **Vaporizers**
  - **Location of accommodation for offshore terminals**
  - **Security**

Siting

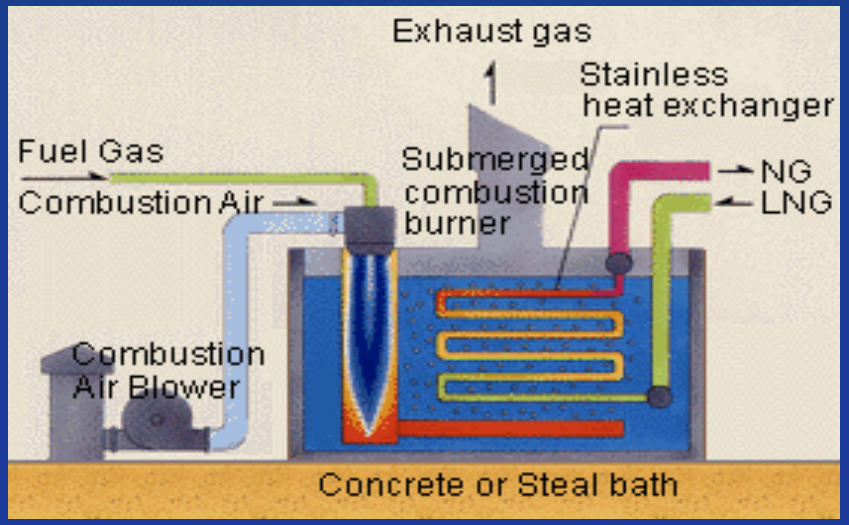
NIMBY **BANANA**

- **Is LNG safe?**
- **What about the explosions?**
- **What about terrorists?**

Open Rack Vaporizers (ORVs)



Submerged Combustion Vaporizers (SCVs)



Offshore Accommodations

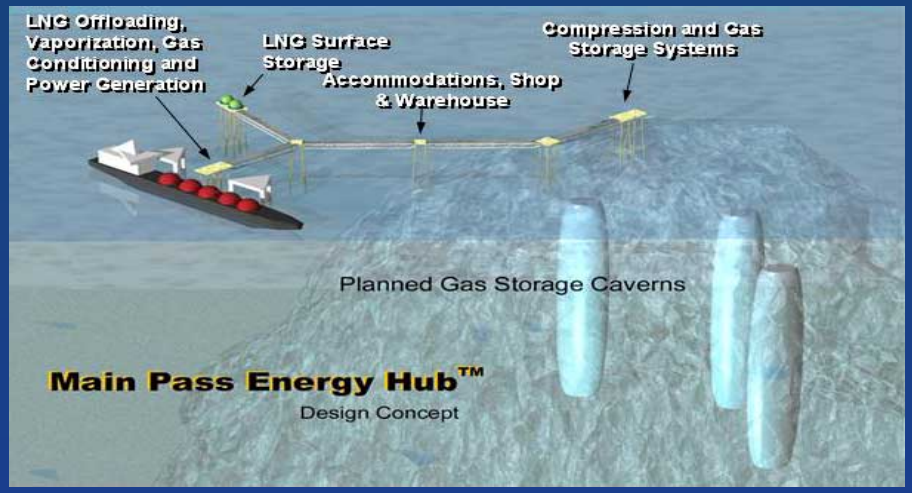
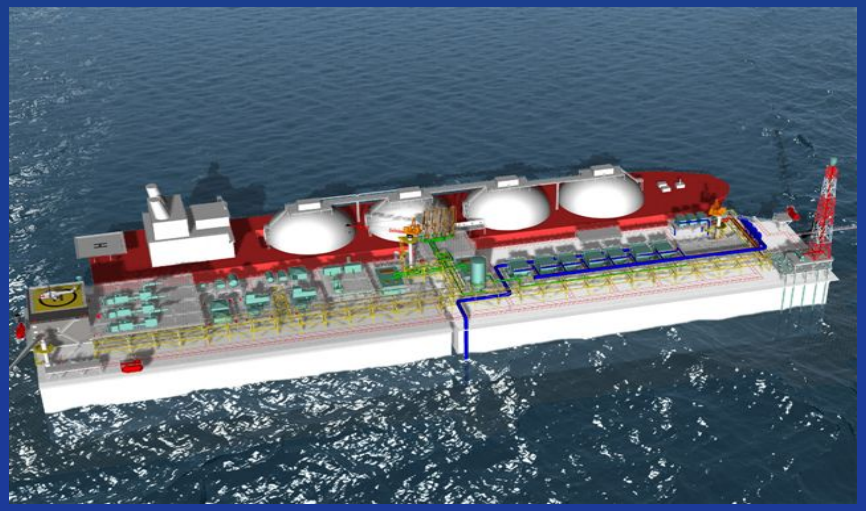


Figure 1: Terminal Layout



Security

At Boston we now see:

- **LNG tankers now inspected at point of origin**
- **Occasional on-board escort by coastguard “Sea marshals”**
- **96 hour advance notice of tanker**
- **Advance notice to local emergency services, Federal Aviation authority and US Navy**
- **Boarding of tankers prior for inspection before entrance to harbor**
- **Armed Escort during entrance**
- **Security zone 2 miles ahead, and 1 mile either side**
- **Suspension of overhead flights from Logan airport**

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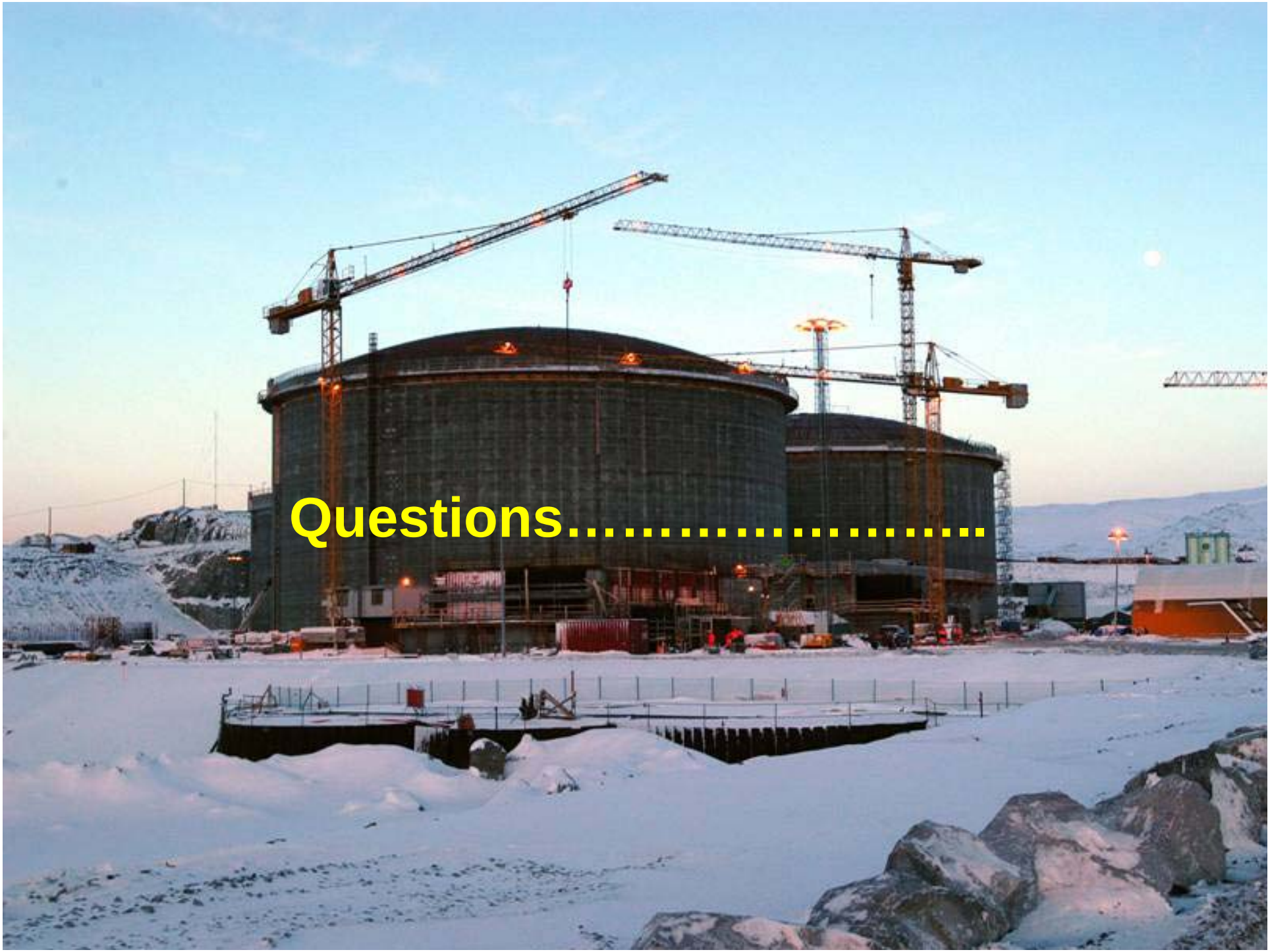
Lessons Learned on Previous Projects

- **All stages of design should consider how the facility is to be built, commissioned and operated, to ensure that unforeseen conditions do not occur.**

- **The CA should be involved as early as possible in the design and decision making process to be able to influence safety critical issues while they are relatively easy to change.**

- **The CA should be involved in the 'Change Control' process in order to be able to assess critical issues.**


Questions……..

Got LNG?.... Get Lloyd's Register