Criteria for LNG Siting from a Shipping Point of View

Captain Charlie O'Brien
BP Shipping

2005 EIA Midterm Energy Outlook
and Modeling Conference
Washington, DC
April 12, 2005

This presentation will address

- Hazards of LNG Operations
- Risk Assessment
- Terminal Site Selection
- LNG Carrier transits
- LNG transfer Operations
- Relationships with Stakeholders

Based on SIGTTO publication – “LNG Operations in Port Areas”

Hazards of LNG Operations

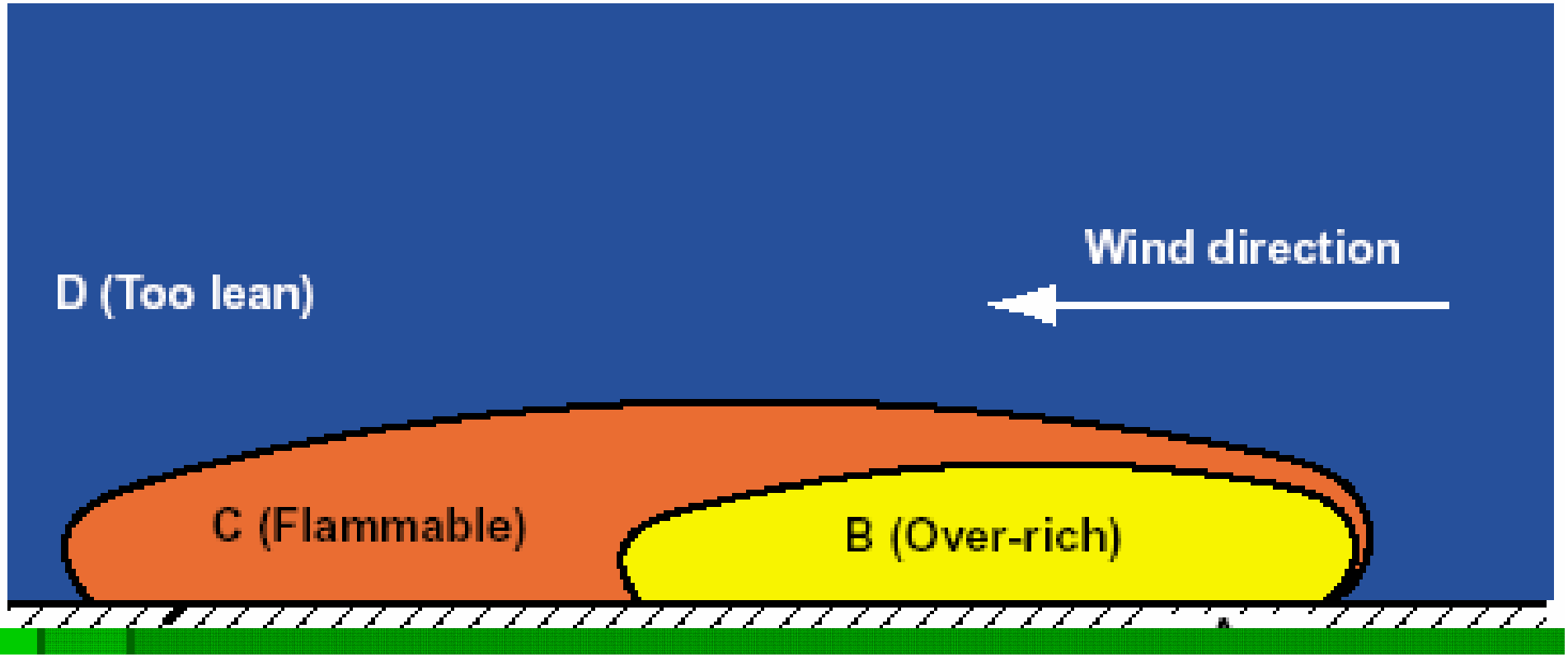
- Safety Aspects of the transportation of LNG
- Storage systems of LNG carriers
- Vulnerability to collision and grounding
  - Both underway and at berth
- Protection from failure of the transfer system
- Location of site in relation to others

Hazards of LNG Operations

- LNG carried at -160^{o} C (-260^{o} F)
- At this Temperature it is a liquid and reduces it's volume by 600 to 1
- In this condition there is virtually no pressure
- If liquid released then a large volume of vapour will emanate, leading to a risk of fire
- Could lead to structural damage to the ship due to brittle fracture

In case of a release

The loss of containment of LNG has never occurred, despite nearly 40,000 cargoes. It is known that if a release did occur and was not ignited then a cloud would form



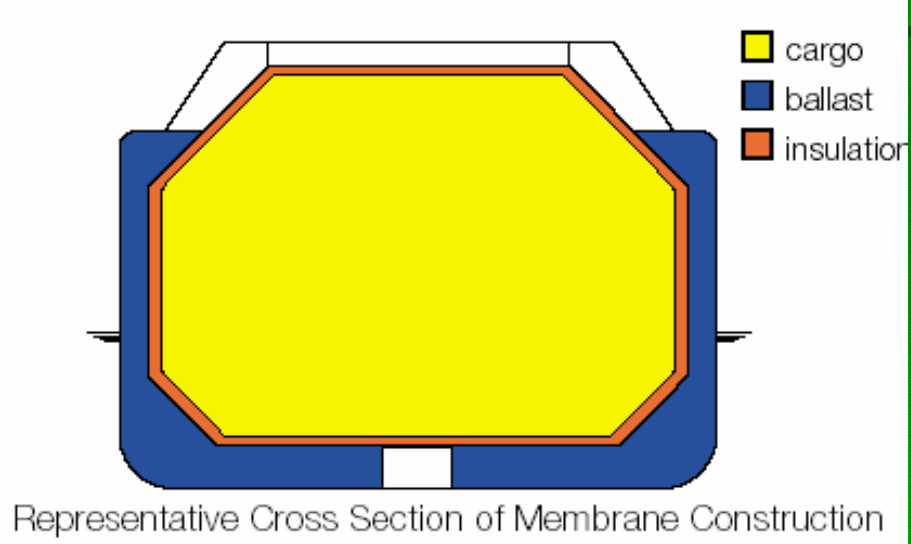
What happens if there is a release

- Most causes of release, either accidental or intentional, have a source of ignition
- If the containment is breached then the liquid natural gas will spill onto water, rapid vaporization, leading to a large quantity of flammable gas
  - In the case of immediate ignition would burn at the side of the ship
  - In the case of a plume then would travel down wind until ignition source is found and then burn slowly back to the ship

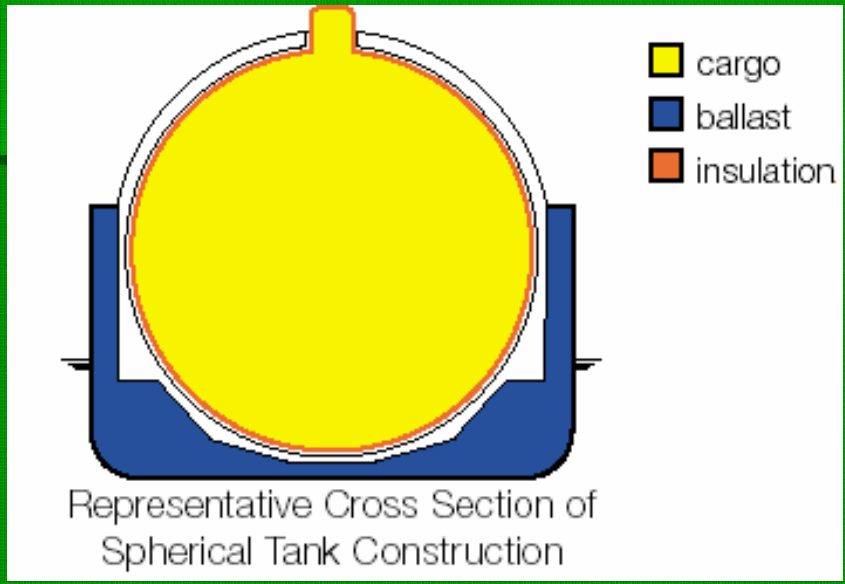
Hazards of LNG Operations

- When siting terminals the safety aspects of the carriage and storage of LNG on board the carriers need to be addressed
- Especially with a view to the vulnerability from side impact from large vessels
- And the release of LNG during transfer

Typical Containment Systems



Representative Cross Section of Membrane Construction



Representative Cross Section of Spherical Tank Construction

Membrane Carrier

Moss Rosenberg Carrier

Risk Assessment

- Formalized Risk Assessment is required during the detailed work on progressing an LNG Terminal
- When initially considering a site an “informal” assessment is carried out to ensure the site meets minimum criteria

Risk-based Approach

- Risk = Threat x System Failure x Consequences
- Threat and system failure require *Prevention*
- Consequences entail *Mitigation*
- Decrease risk by reducing the threat and the system failure
- Mitigate consequences through aggressive action and appropriate response measures

Risk Assessment

- Scope of operations
- Identification of hazards
- Probability of an event occurring
  - Potential for consequence escalating
- Consequence
  - Capability of an effective response
- Rank Identified risks
- Specify the mitigation

Protect from side collision and grounding

- When considering locating a site the following have to be considered
- In Transit
  - By procedure (traffic control) (safety / security zones)
  - Channel width and depth
- At Berth
  - By procedure (safety / security zones)
  - Location and orientation of berth

Grounding El Paso Paul Kayser

Containment systems are robust

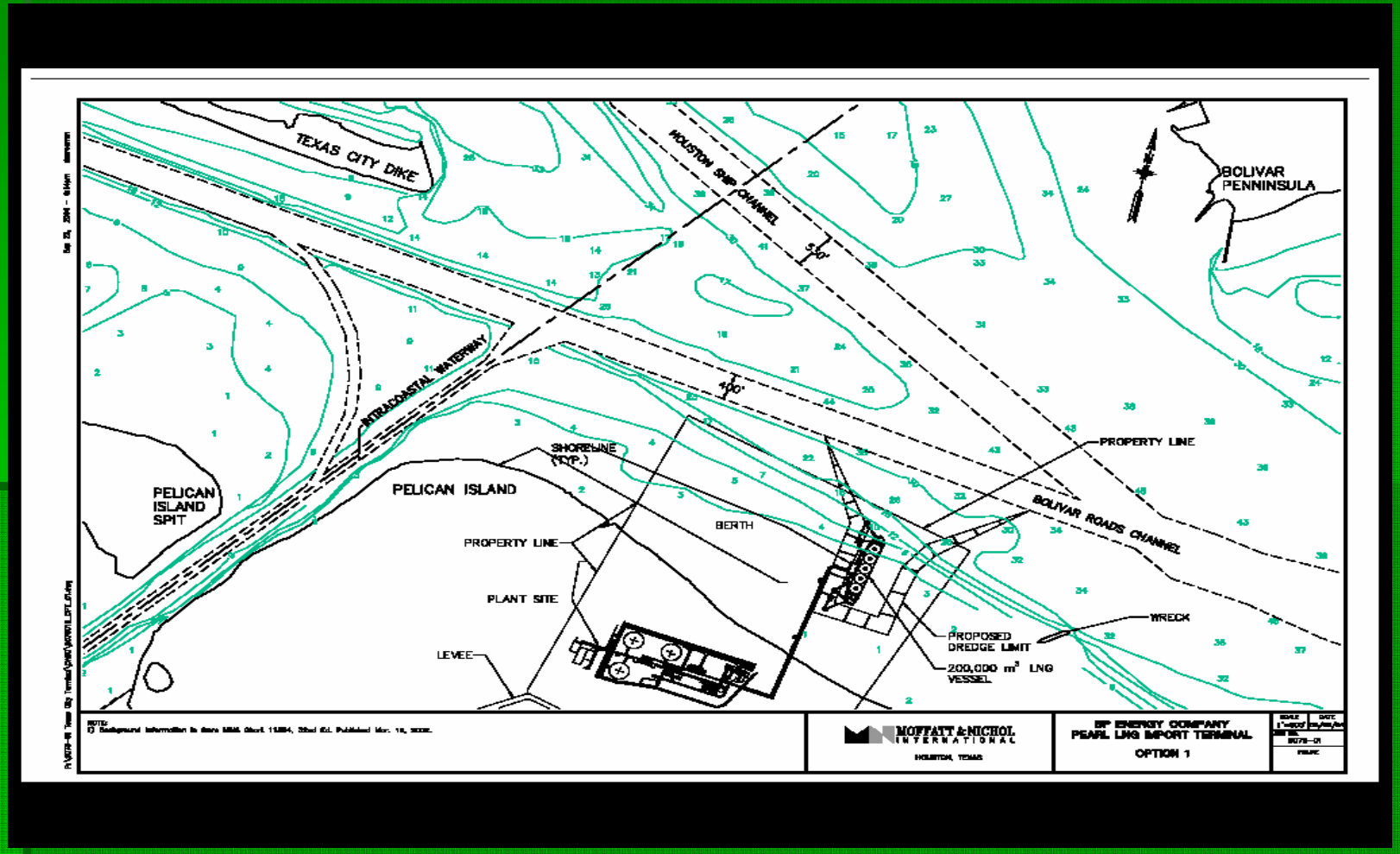
Avoidance of critical collision angles of impact during transit

Example

- BP Crown Landing Project
  - Relatively narrow channel thus collision can only be end on or nearly end on (collision with VLCC @ combined speed of 18 knots does not breach containment)
  - Procedures for transit
    - where side impact can occur
    - “Convoy” system where large ships upstream of site lead the way

Protection of vessel at berth

- Example of LNG Carrier protection when at berth



Safe Berth

A Safe Berth for a LNG Carrier can be defined as

- An adequate depth of water
- Not affected by hydraulic action of passing ships causing movement outside the operating envelope of arms
- Protected from allision from large ships
- Can sail, in an emergency, preferably, unassisted
- Protected from excessive waves wind and current
- Can effectively moor and meet OCIMF recommended criteria

Maneuvering on and off the berth

- There should be sufficient depth of water to enable the LNG carrier to berth and unberth at all times of the tide and in any current conditions
- Weather limits need to be established to ensure that all maneuvers can be conducted safely
- Becoming standard practice to use powerful Tractor Tugs
- All limitations and requirements need to be established on a Full Mission Bridge Simulator
- Pilots and Tug Masters need to be trained before first ship – so operation is not “new” to them

Security

- Security measures need to be addressed for the Transit and Alongside
- Company Security Vulnerability Assessment (SVA) – to be shared with USCG and used to formulate Security Plan for the terminal
- Terminal needs to be designed with security in mind
- “Novel” approaches to security need to be considered

Safety Alongside

- Linked Emergency Shut Down System (ESD)
- Most vulnerable part of transfer is the hard arms – in case of movement
- First step is effective mooring
- In addition to OCIMF – mooring tension monitoring
- Second step is Powered Emergency Release Couplings – PERCs

Emergency Response

- Close and early relationship with the Emergency responders
- Sometimes little in the way of emergency response capabilities for other ships in port areas – but proposed LNG shipping is the instigator of discussions
- Use of fire fighting capability of tugs – generally FiFi 1 tugs now being specified

Fire Fighting Tug (FiFi 1)

Training of Emergency Responders

- In the specific fire fighting skills for LNG fires
  - Characteristics are different from other hydrocarbon fires
- Awareness of LNG carriers and their firefighting capabilities.

Other Stakeholders

- Its is vital that ALL stakeholders in the community and in the Waterway and Port areas are aware of LNG carriers
- Including Federal, State, towns and industry
- A lot of misinformation around and once there is awareness then and more likely understanding ensues

Other Stakeholders

- Objective is to produce an informed public
- that is involved
- interested
- reasonable
- thoughtful
- solution-oriented and collaborative

Other Stakeholders

- Important that studies are conducted that can be released to explain any impact that the transportation of LNG will have on a waterway – if any
- Also a need to understand why LNG is treated differently
- A relatively new industry that has been and is very proactive
- To date no major incidents and the industry has to keep it that way to have acceptance.

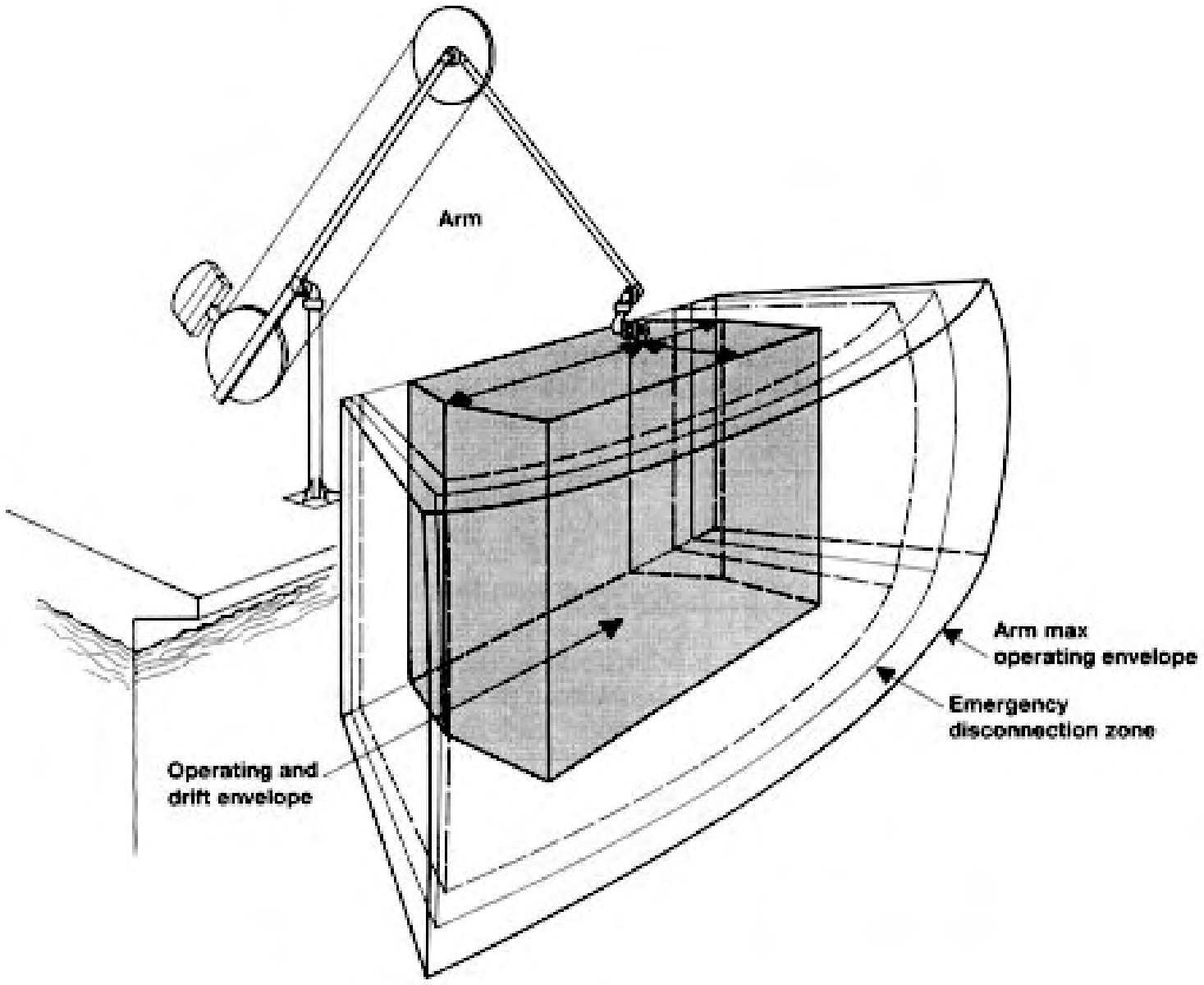
Summary

- For new terminals all International and National regulations, recommendations and practices have to be considered.
- Safety and security of the ship is paramount at all times – both in transit and at the berth
- Excellent safety record to date and has to be kept that way.
- The safety record is not by accident but by a proactive approach by the industry

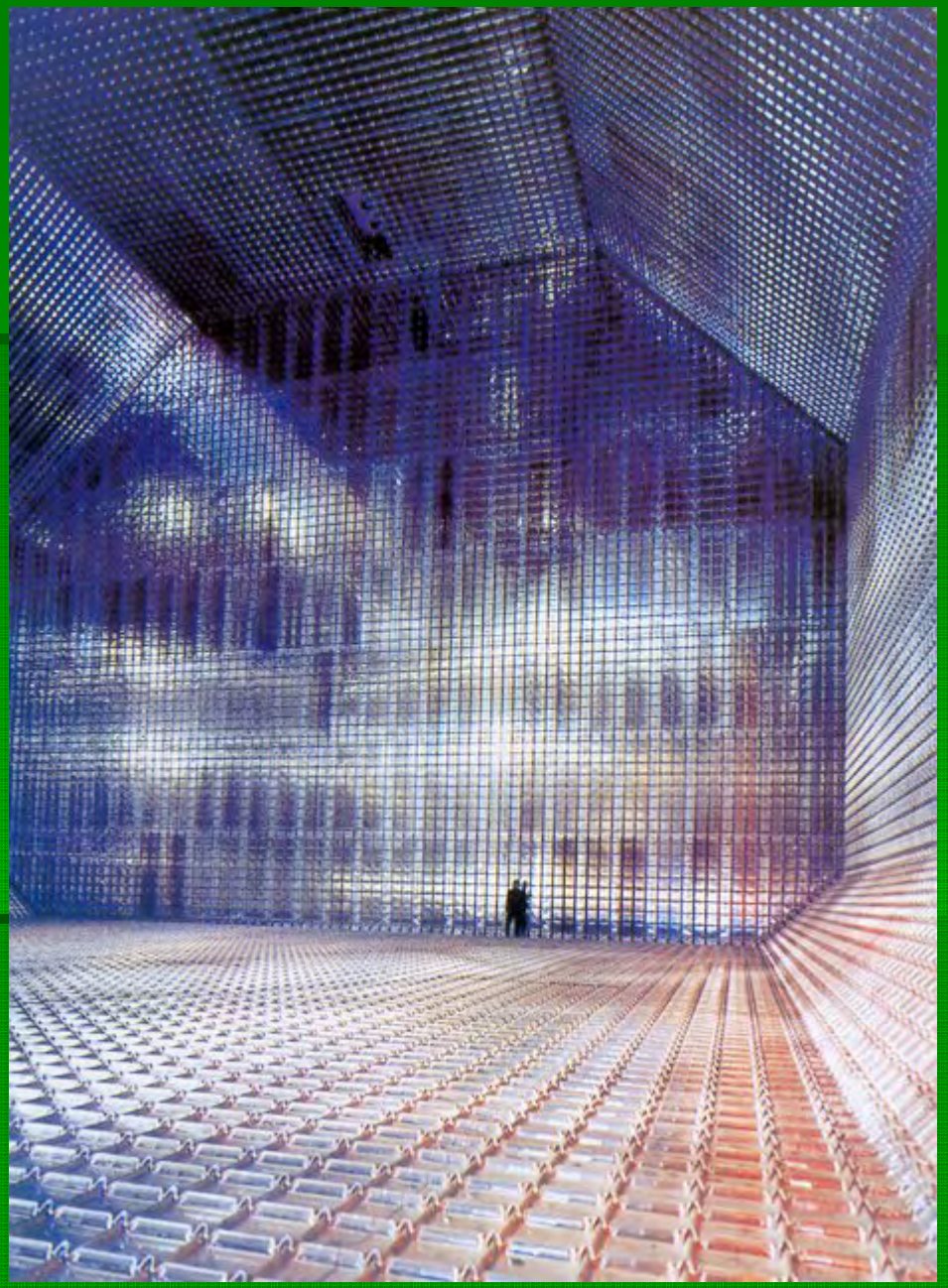
END

Back up slides

Loading Arm Envelope and ESD Limits

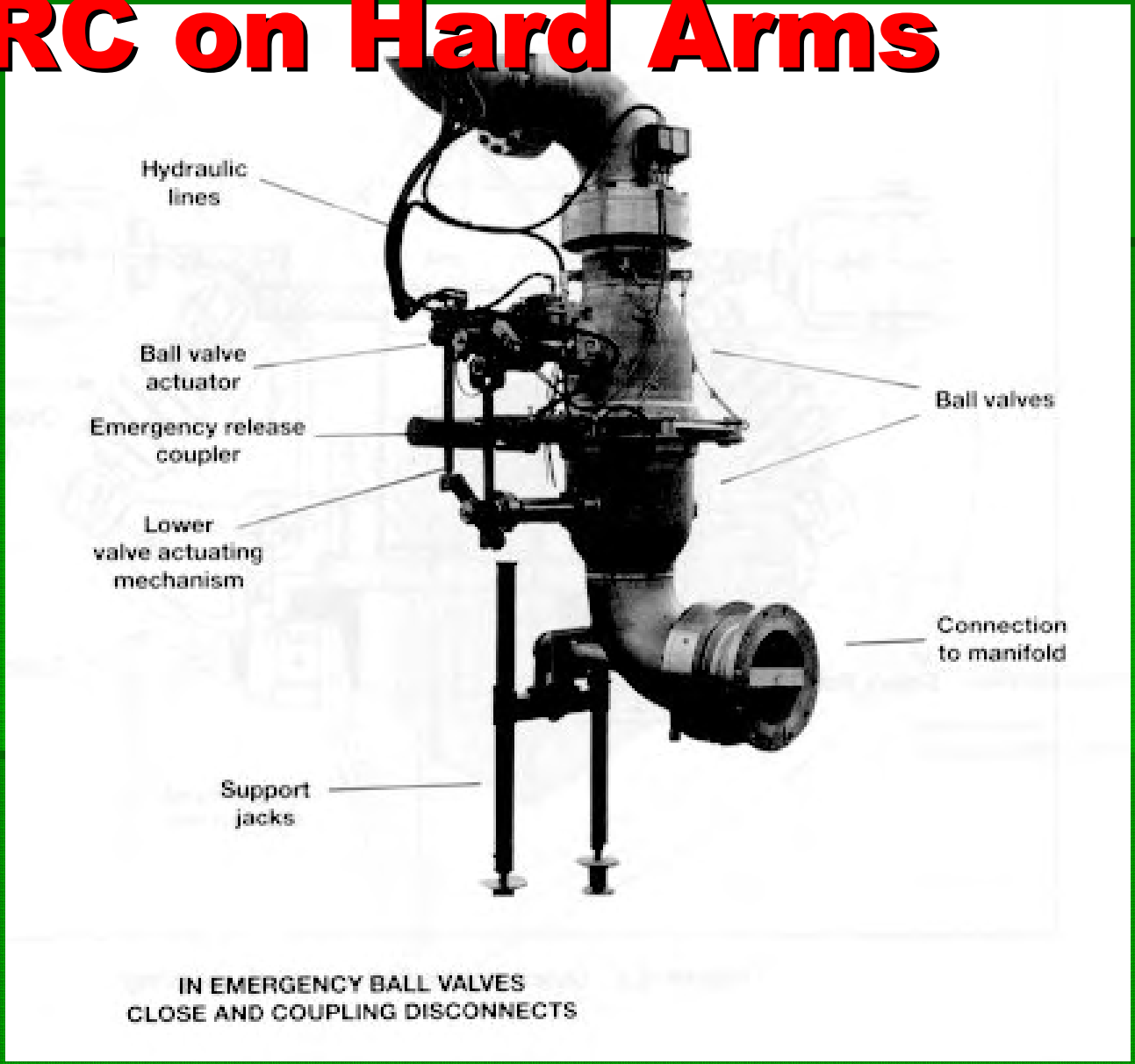


Technigaz Tank

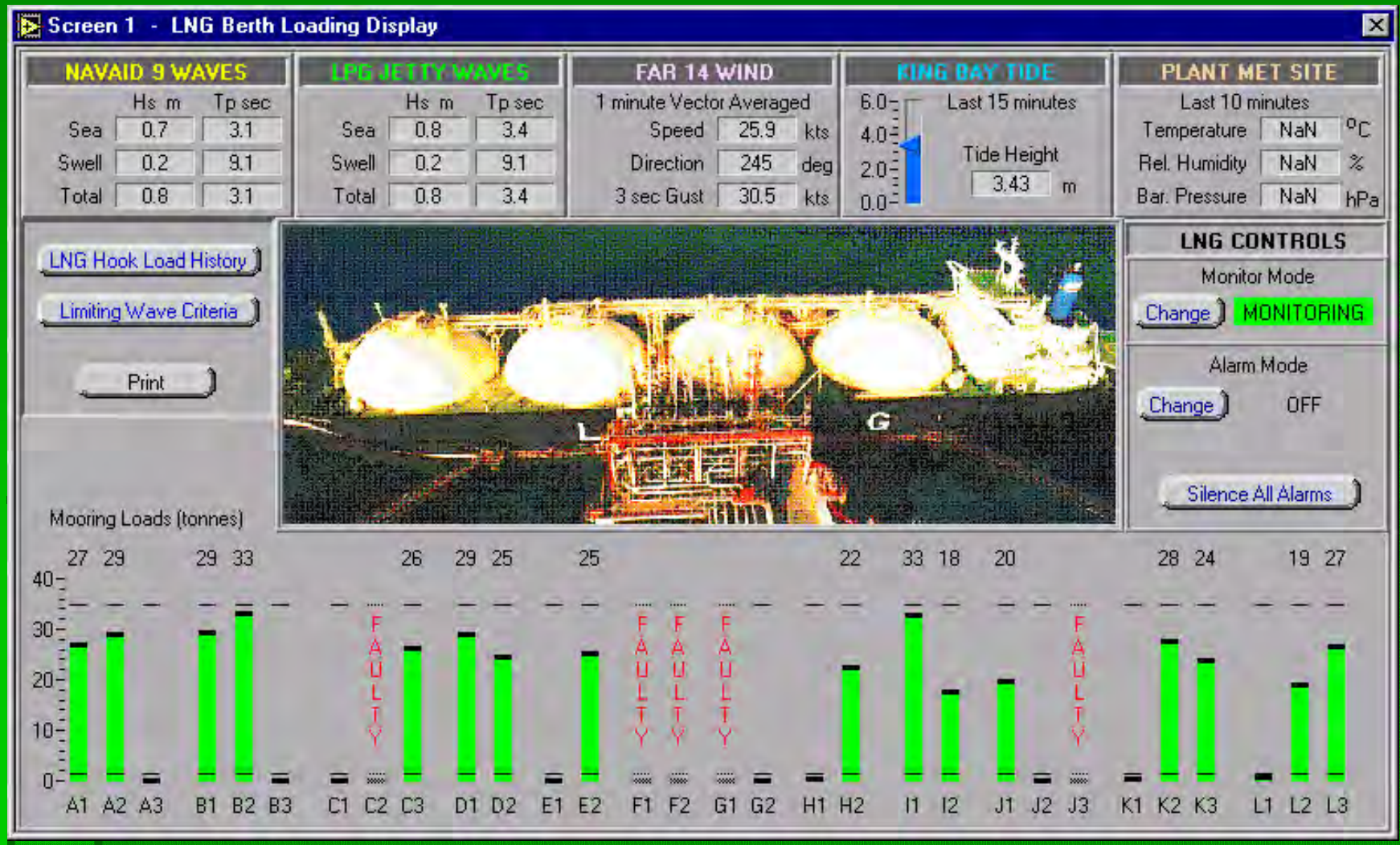


Spherical Tank

PERC on Hard Arms



Mooring Tension Monitoring



Simulator view of proposed LNG Terminal

Simulator View of Delaware Memorial Bridge