Liquefied Natural Gas: Description, Risks, Hazards, Safeguards

Done By: Maryam Manojahri, Maha Kafood, Mateen Kamal

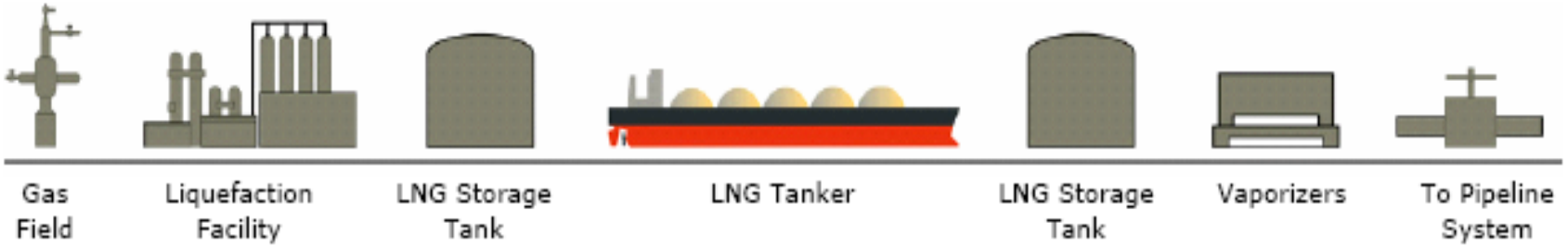
Outline

- Introduction
- Value Chain
- Liquefied Natural Gas Process Description
- Risks Associated with the Production process
- Safety and Risk Assessments
  - Plant Location
  - Process Operation
  - Product Storage
  - Product Shipping
- Conclusion

Introduction

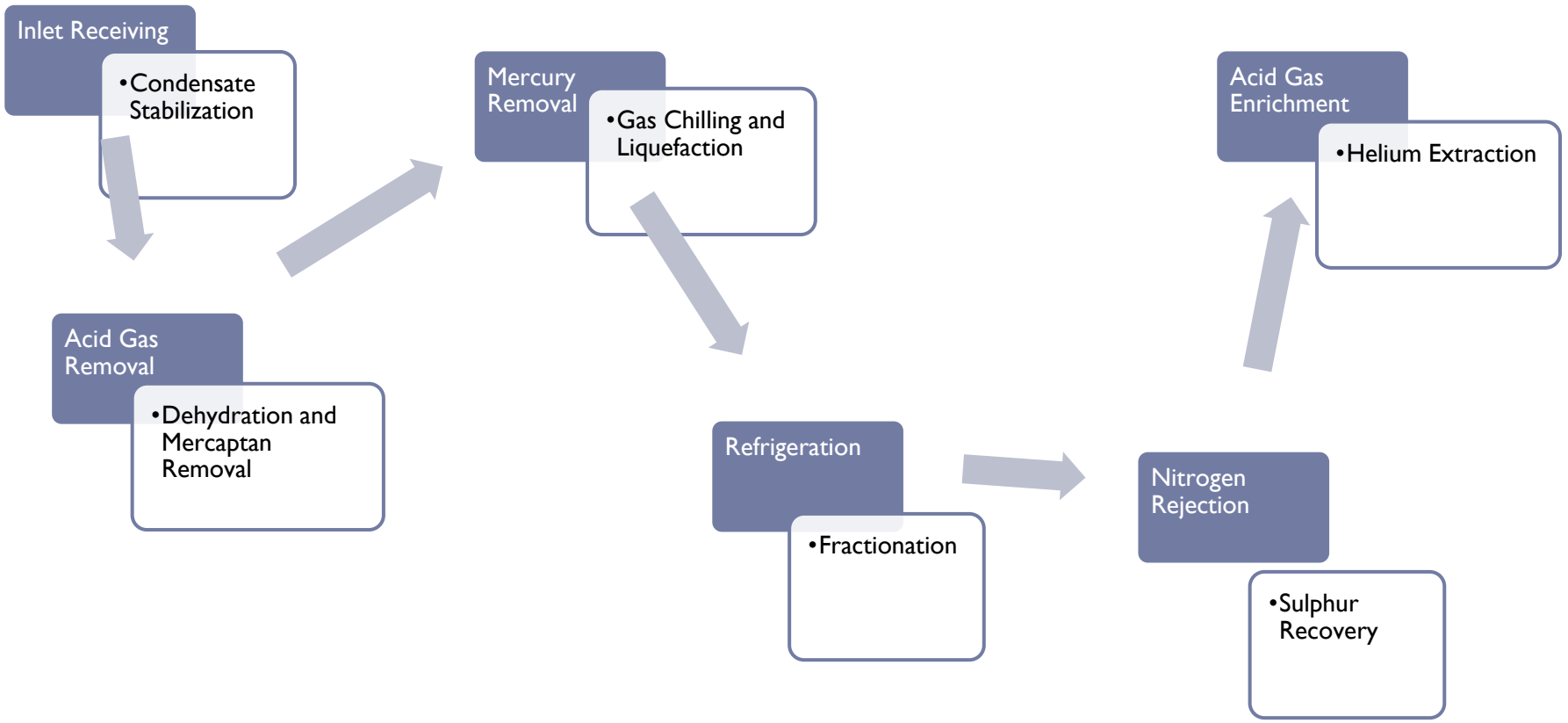
- Forty years of innovative oil and gas products
- What is LNG?
  - Light Hydrocarbons fraction
  - Cooled up to -162 ˚C
- Why LNG?
  - Source of Gas
  - Convenience and Efficiency
  - Volume
- LNG in Qatar

Value Chain



Source: CMS Energy

Liquefied Natural Gas (LNG) Process



Risks Associated with the Production Process

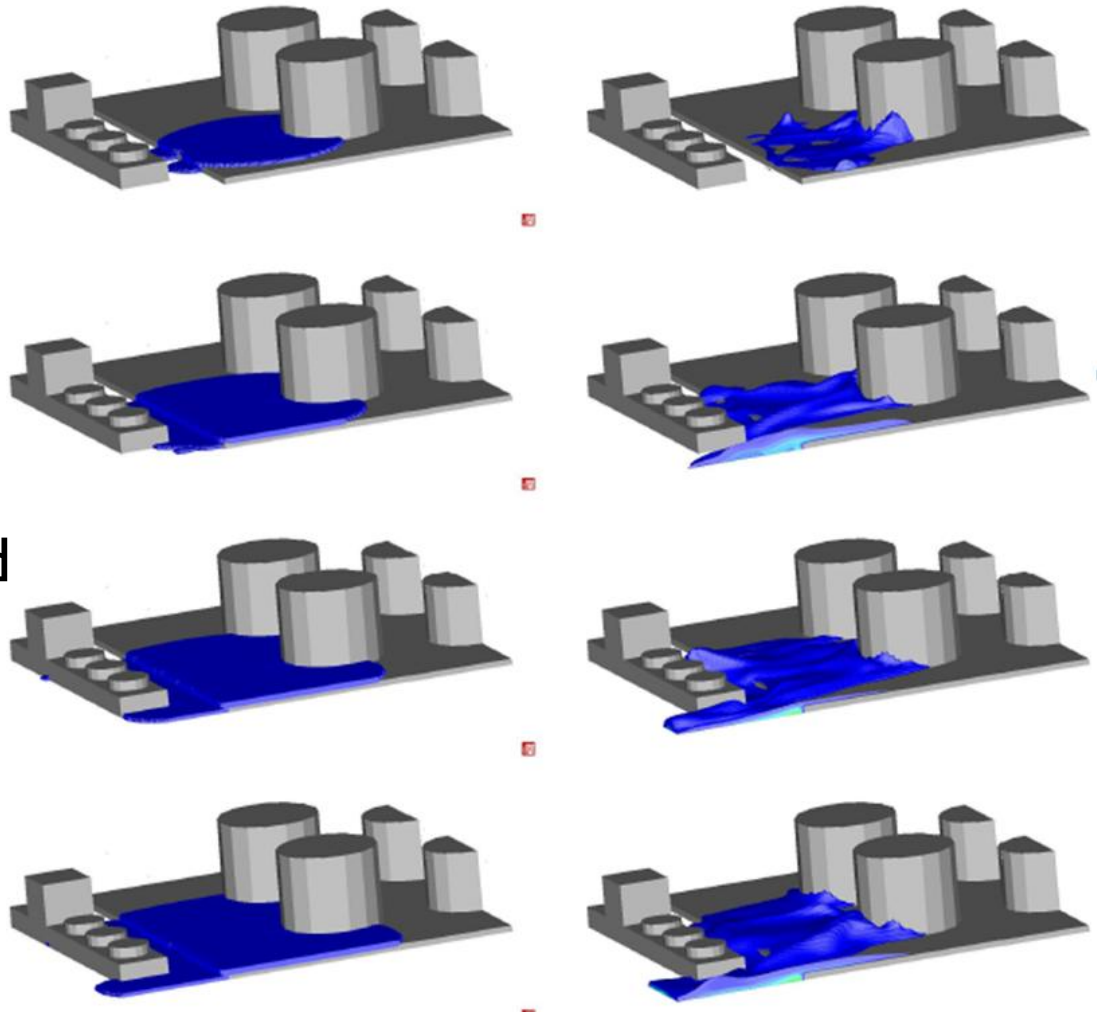
- Six Hazards
  - Explosion
    - Pressurized process
  - Vapor Clouds
    - Handling H_2S
    - Handling Mercury
  - Freezing Liquid
    - Insufficient Dehydration
  - Rollover
  - Rapid Phase Transition
  - Terrorism

Plant Location

- Demanding location
- Far away from cities and towns
- Near sea shore
- Lack of flammability materials
  - Better desert than rainforest
- Fair distance in-between offices
- Use of simulation to aid in location selection

Locating LNG Plants: FLACS

- 1000kg/s of LNG
- cylindrical tank
- left: liquid LNG spill
- right: methane vapor cloud
- time: 200 seconds
- distance travelled: 400m



Safety in Process Operation

- LNG temperature is kept by good insulation and pressure control.
- LNG should be stopovers of 1 to 2 days.
- All tanks kept under cold temperature at all times.

Risk Assessment in LNG Process Operation

- Hazards need to be identified and quantified by:
  - Collecting from existing resources
  - Identify all of the accident-initiating events
  - Training
  - Personal Protective Equipment (PPE)

Training

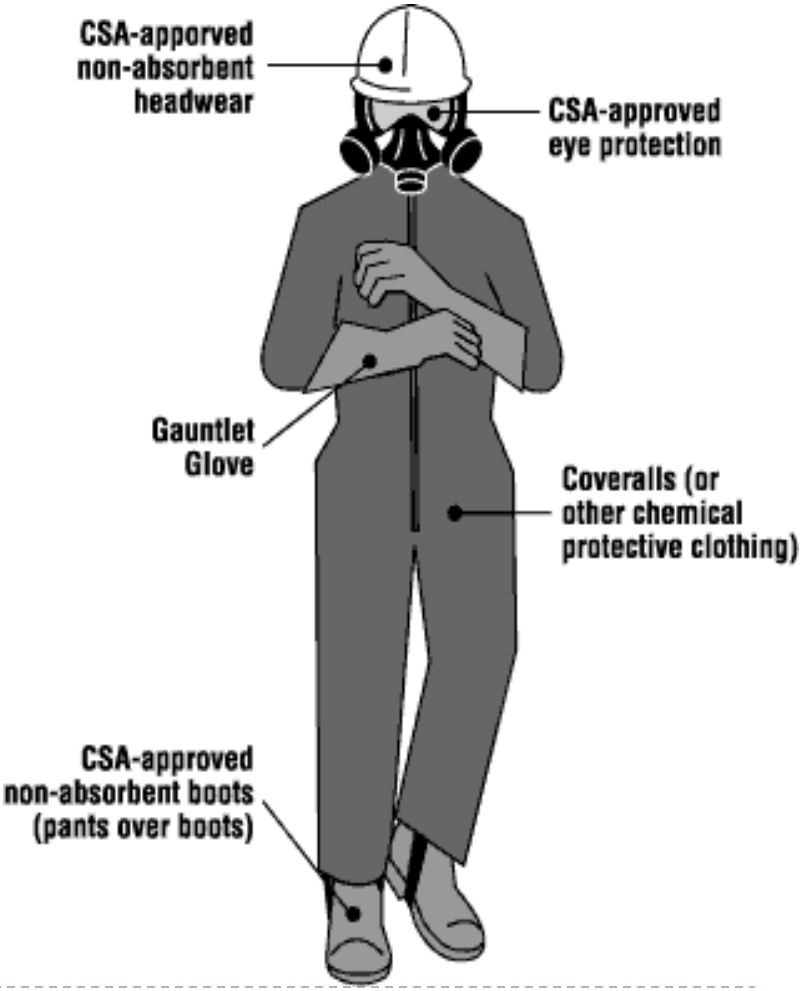
- H_2S Gas in LNG
  - Properties
  - Effect of *H_2S Concentration*

Material	Concentration/ppm	Time Exposure
H_2S	10	8 hours
	15	15 minutes
	20	No time

  - Several preventions were listed in companies to ensure the safety regulations for the employees.

PPE & Emergency Responses

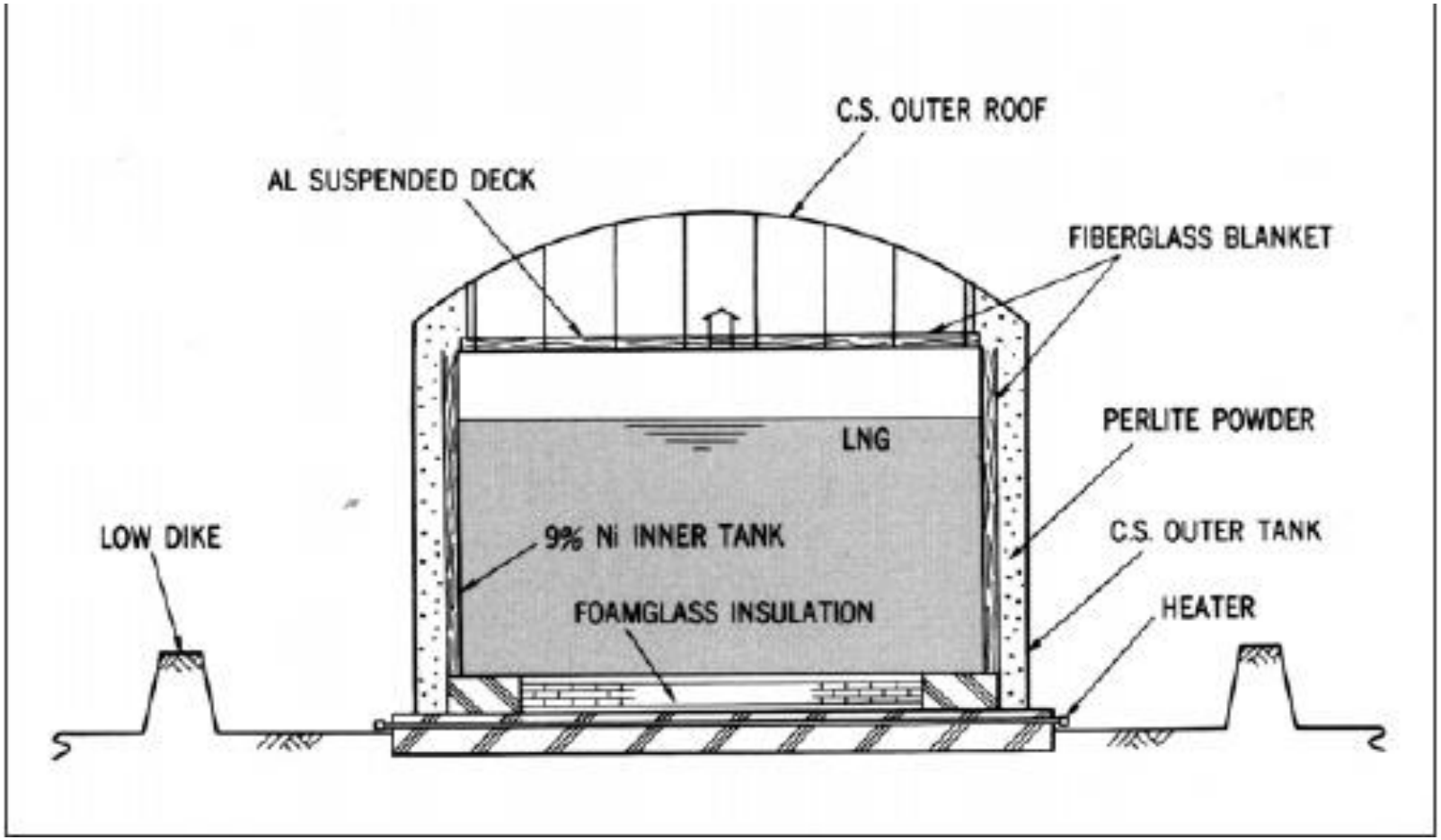
- PPE
  - Definition
  - Uses
- Emergency responses
  - Move to a safe area.
  - Report directly.
  - The exact location
  - The nature of the emergency
  - Individual information



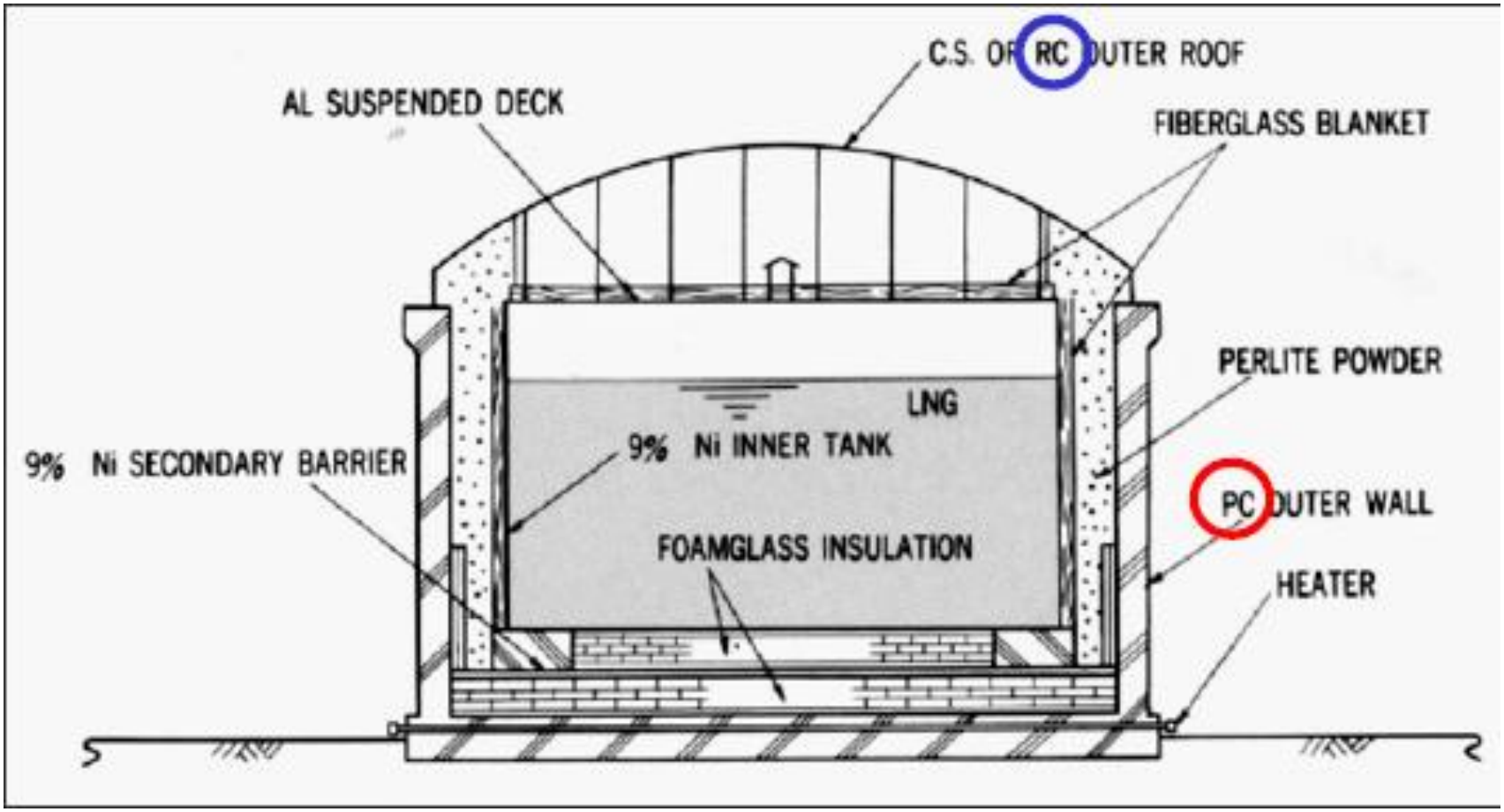
Safety in LNG Storage

- Classified as either aboveground or belowground storage.
- Liquefied Natural Gas (LNG) is stored in storage tanks of around 160,000 m^3 capacity.
- LNG tanks classified into three main types:
  - Single containment tanks
  - Double containment tanks
  - Full containment tanks

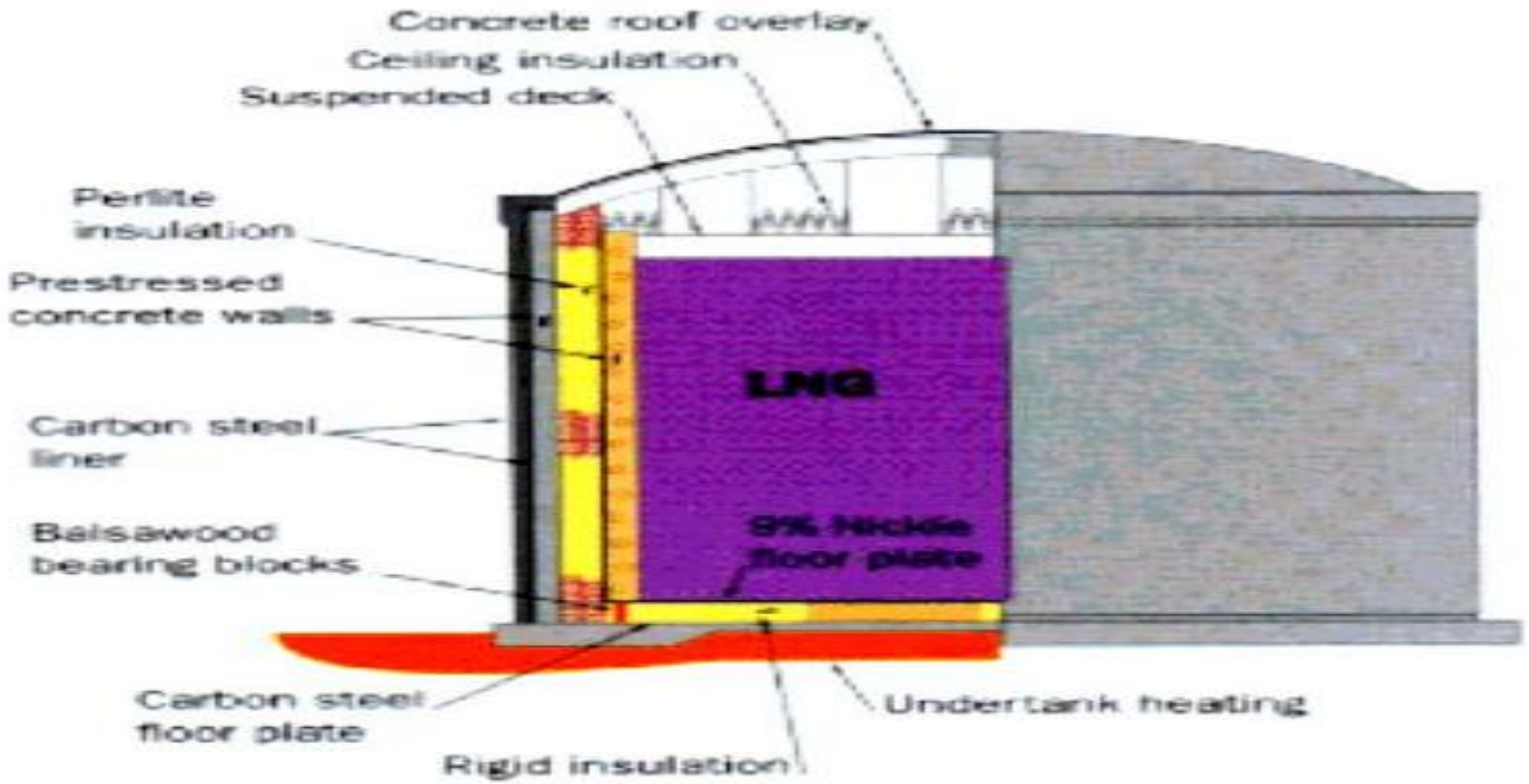
Single Containment Tank



Double Containment Tank



Full Containment Tank



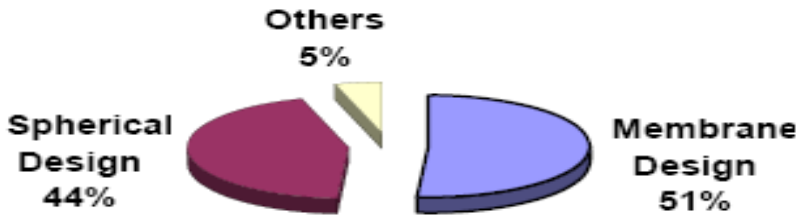
LNG Storage Potential Hazards

- Release of a large amount of LNG due to the mechanical failures of main tank.
- The impact from "missiles" on the outer tank.
- Adjacent explosion.
- A sudden variation of atmospheric pressure.
- A tank overfilling .

LNG Ships: Main Types

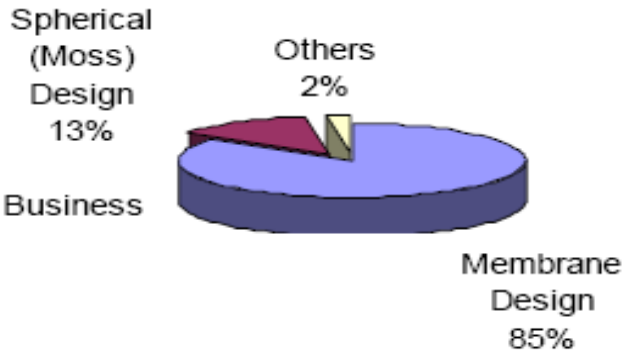
LNG Ships: Statistics

LNG Fleet Containment System - September 2006
(Number of ships)



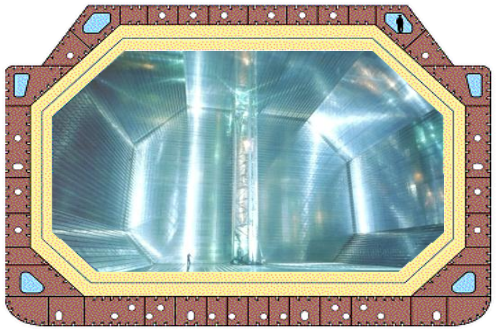
Source: Maritime Business Strategies, LLC

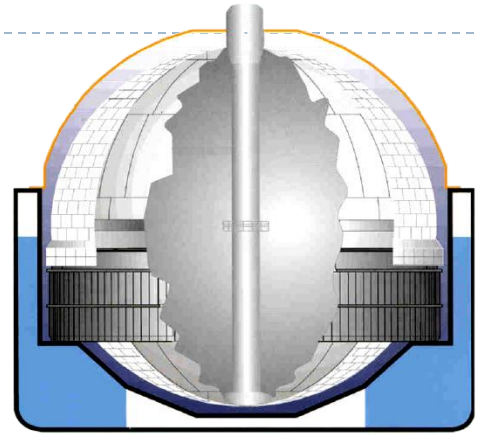
LNG Fleet Containment System - Order Book 2005 - 2010
(Number of ships)

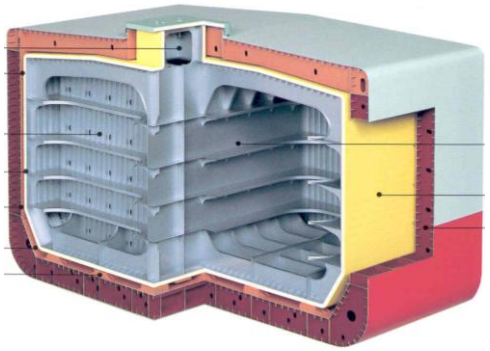


Source: Maritime Business

LNG Ships: Tank Specification







Membrane Tanks

- Tank interior composed of primary and secondary thin plates (membranes) supported by rigid insulation system
- Membranes provide liquid containment but are not self-supporting
- Membranes are subjected to all fluid dynamic loadings
- Insulation simplifies design of hull and tank for thermal expansion
- Enables savings by use of ship hull structure as part of the tank
- Korea's ability to build membrane ships a primary drivers behind lowering of LNG ship costs

Moss Rosenberg Spheres

- Spherical shell provides liquid containment and carries all liquid loading
- Insulation is external to containment sphere and carries no liquid load
- Load transfer between hull and spherical shell through extruded stainless steel skirt at equator
- External shell protects insulation from elements
- Opening in hull to accommodate tanks increases hull loads / cost
- Higher ship void space than other containment types results in higher sail area and higher Suez canal tolls
- Cost competitive with membranes

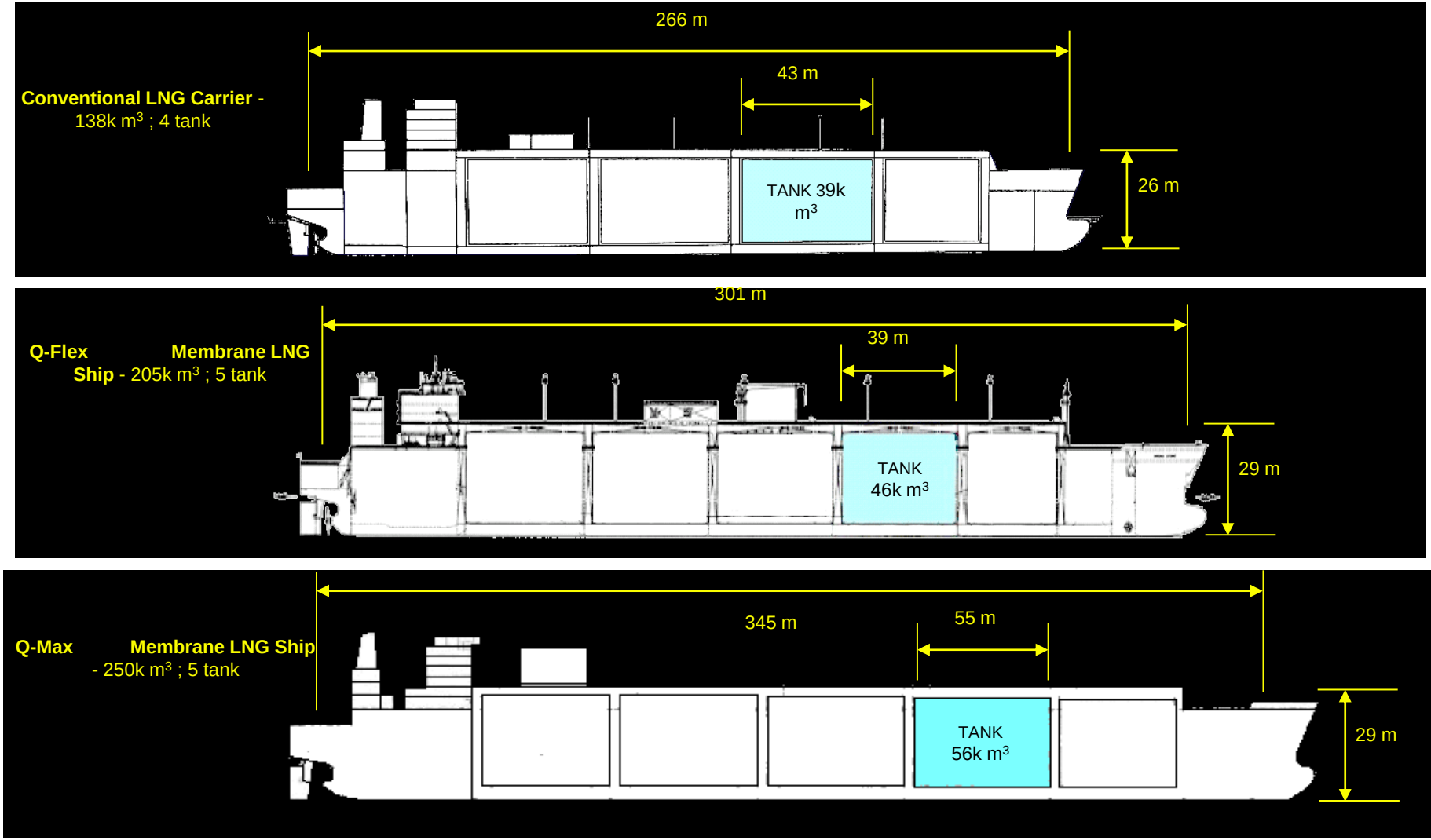
Semi-Primsmatic Tanks

- Prismatic self-supporting tank located within ship's hull
- Constructed using standard shipbuilding techniques
- Interior aluminum stiffened shell provides liquid containment and carries all liquid loading
- Insulation located between tank and ship's hull is not subjected to local liquid impact
- Load transmission between interior shell structure and hull is through insulation - sophisticated interface design
- Generally highest cost of the three containment systems

LNG Ships – Typical Requirements

- All ships must be capable of serving Japan market
  - Japan: ~50% of world LNG market
  - Obey Japan's maritime law
- Must have flexibility to deliver LNG to almost any other markets
- LNG ships use steam turbine drive systems
- LNG ship boil-off gas used as fuel to the boilers

LNG Ships – Scale-Up



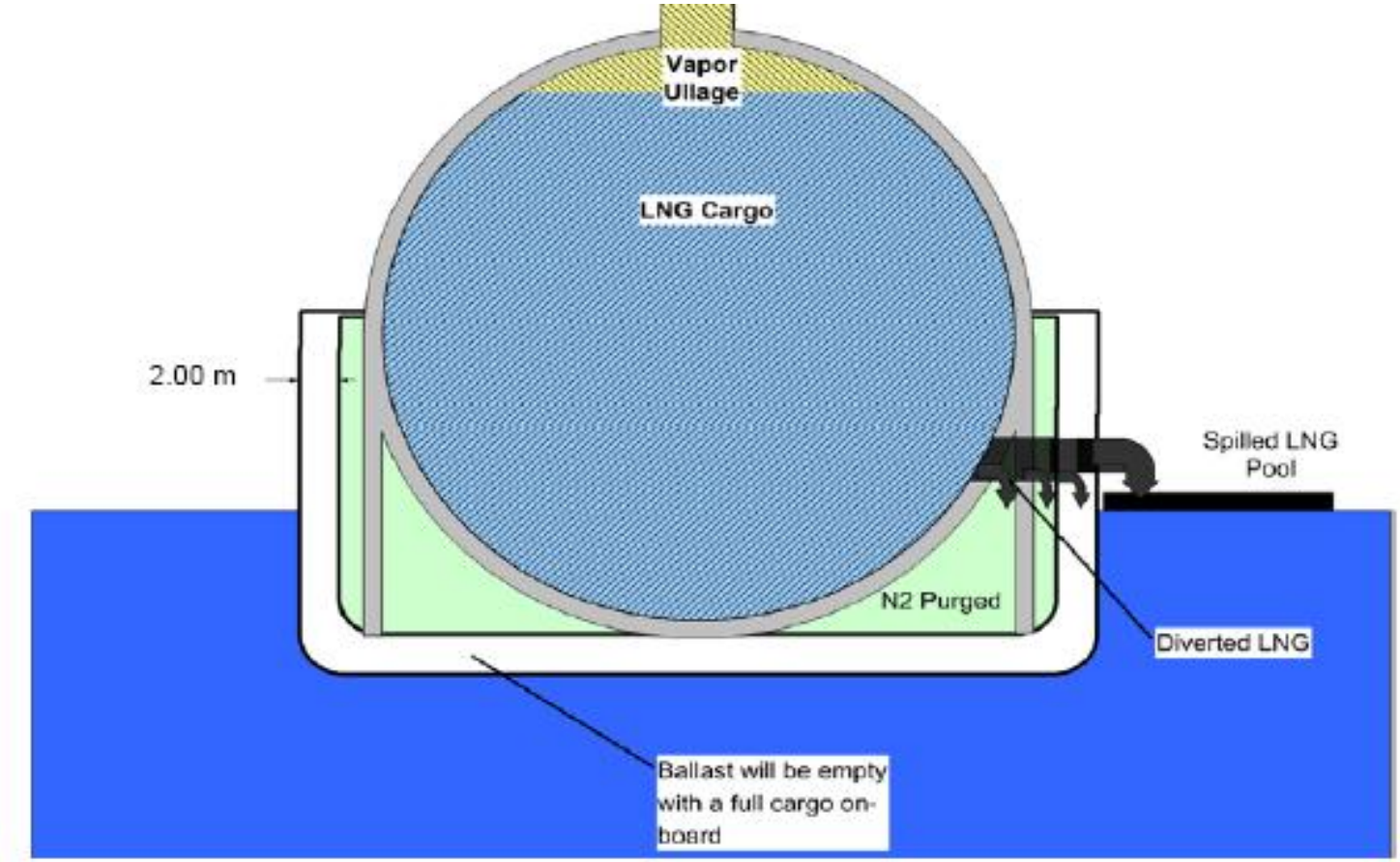
LNG Ships: Efficiency

- Steam turbines consume boil-off gas (~3%)
- Fuel = 15% of shipping costs
- Alternative propulsion more efficient:
  - Steam Turbine ~30%
  - Combined Cycle Gas Turbine + Electric Motor ~40%
  - Dual-Fuel Diesel + Electric Motor ~45%
  - Slow-Speed Diesel ~50%
- Solution: slow-speed diesel + reliquefication
- Reliquefication: boil-off gas back to LNG

LNG Ships: Potential Hazards

- Asphyxiation
- Cryogenic burns
- Structural damage
- Thermal damage
- Fireballs
- Air explosions
- Rapid Phase Transitions (RPT)

LNG Ships: Safety Scenario



Conclusion

- The safety record of LNG clearly indicates that LNG as a fuel is much safer than its competitors given those only seven major incidents occurred worldwide since the 1980s.

- The technologies and operating practices applied to creating LNG is inherently safe.