

The background of the slide is a dark blue color with a faint, semi-transparent image of an LNG tanker ship. The ship is shown from a high-angle perspective, moving towards the bottom left of the frame. The ship's deck is visible, showing various structures and equipment. The overall aesthetic is professional and technical.

AAPA Facilities Engineering Conference

November 6-8, 2013

Vancouver BC

LNG Terminal Configuration and Siting Considerations in Working Ports

Ron Byres, P.Eng., P.E.,

Moffatt & Nichol



Program

- LNG Facts
- LNG Shipping
- LNG Terminals
- Siting Considerations
- Regulatory Environment
- Challenges

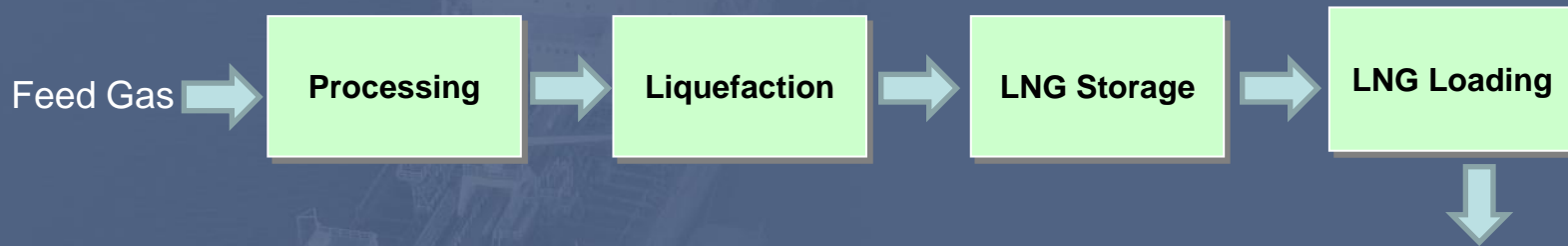


LNG Facts

- Natural gas (methane) cooled to -160°C
- Occupies $1/600^{\text{th}}$ the volume of gas
- Colourless, odourless, non toxic liquid
- Evaporates 100% with zero residue
- Stored in non-pressurized insulated tanks
- Flammable vapour @ 5% – 15% CH_4
- Non-explosive



LNG Supply Chain (Export)

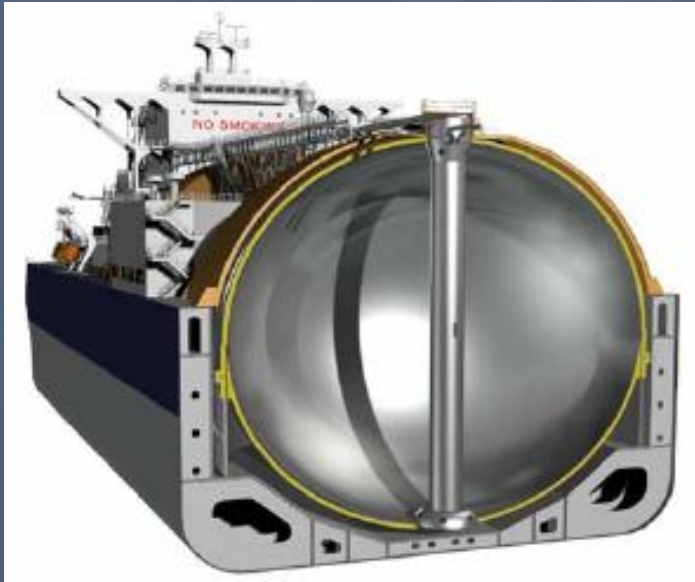


“Membrane” Type



“MOSS” Type

LNG Vessel Construction



Source: QatarGas & GlobalSecurity.org



LNG Shipping

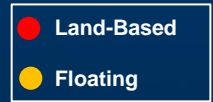
- Currently about 150 ships in service
- 170 Mt of LNG transported annually
- More than 80,000 voyages to date, 151 million miles
- >50 years of service: no collisions or groundings resulting in loss of containment.



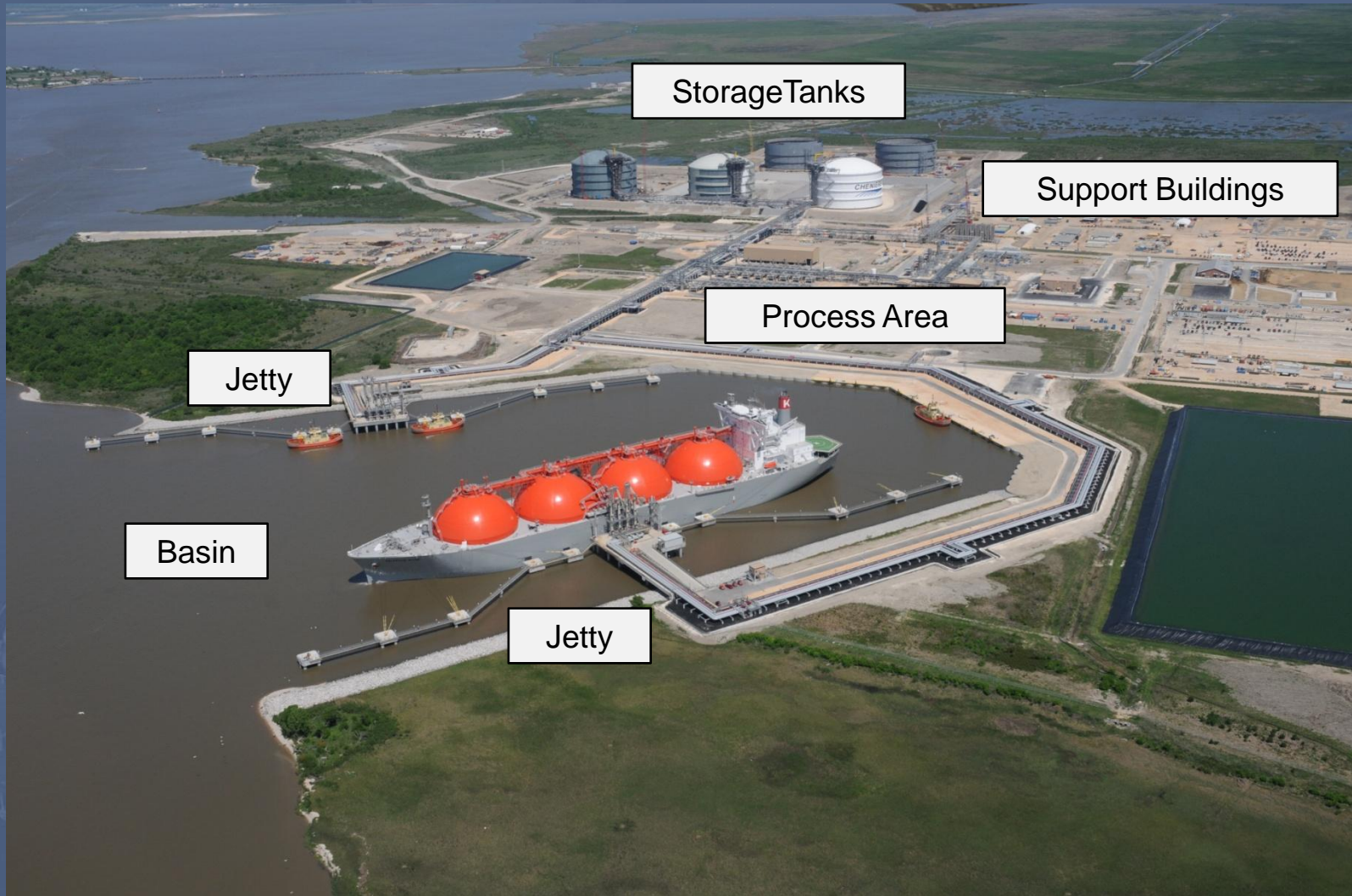
North American LNG/LPG Projects

37 Recent/Active Projects in USA and Canada

30 Projects with M&N Involvement



Sabine Pass, LA



LNG Berth Facilities

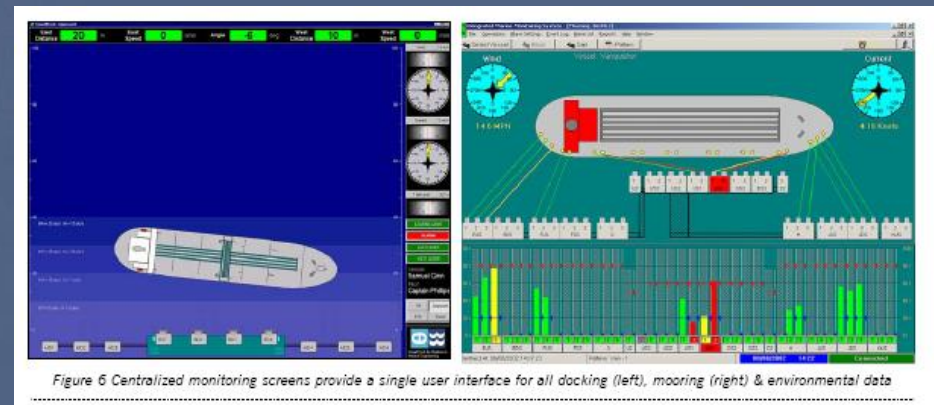


Laser Docking Systems

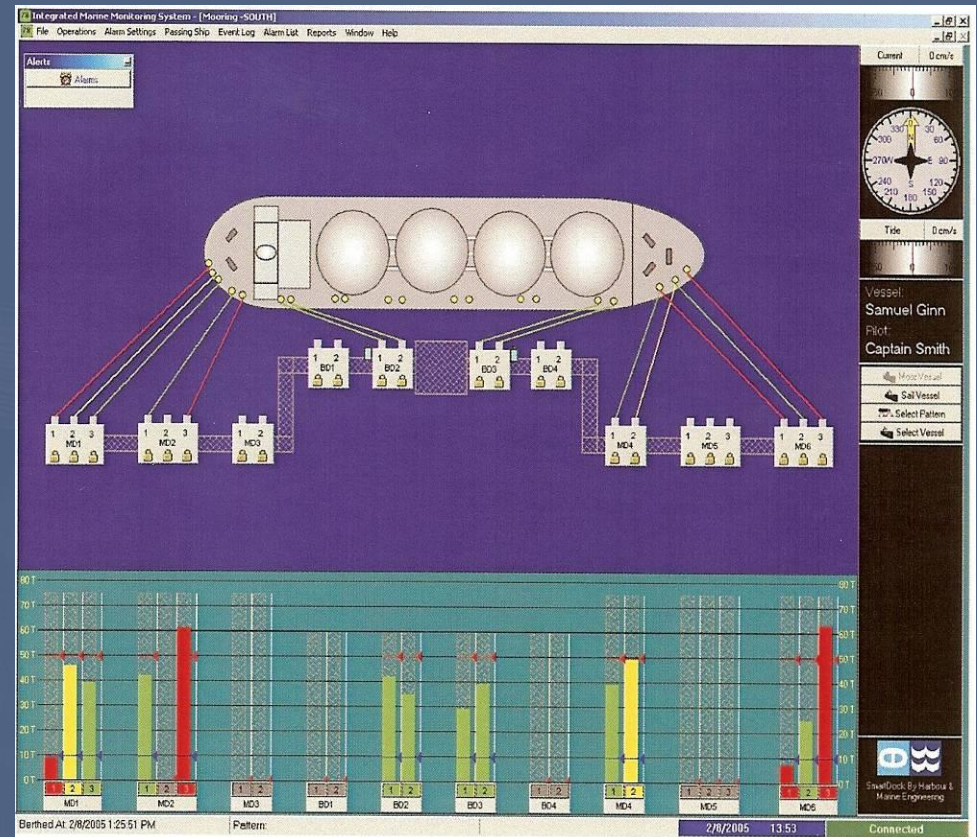


Courtesy of Trelleborg / Harbour & Marine

- Measures distance off and approach speed
- Audible/Visual warning system
- Monitor drift movements



Quick-Release Hooks & Controls



Courtesy of Trelleborg

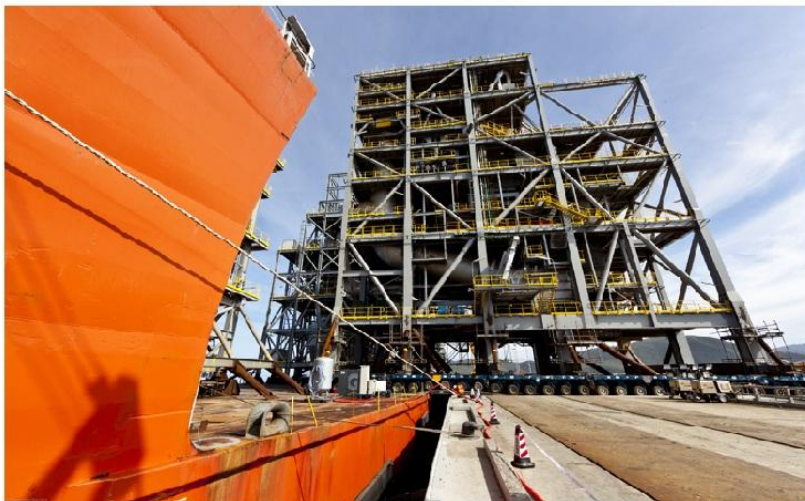


LNG Loading Arms



- Hydraulic arms connect to ships manifold
- Operational limits established for vessel motion
- Automatic alarms/shutdown
- Emergency Systems (e.g. PERC)

Materials Offloading Facility (MOF)



Courtesy of Dockwise



Tanggung LNG Export Terminal Papua, Indonesia



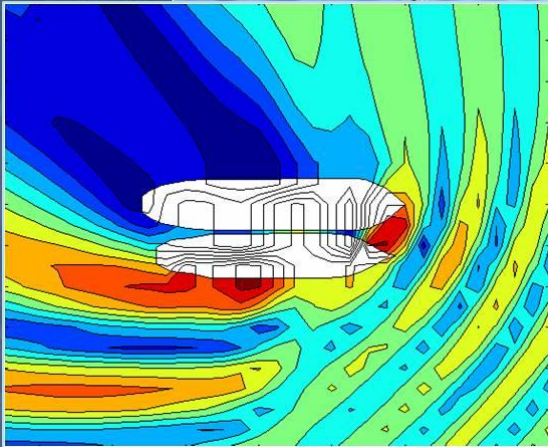
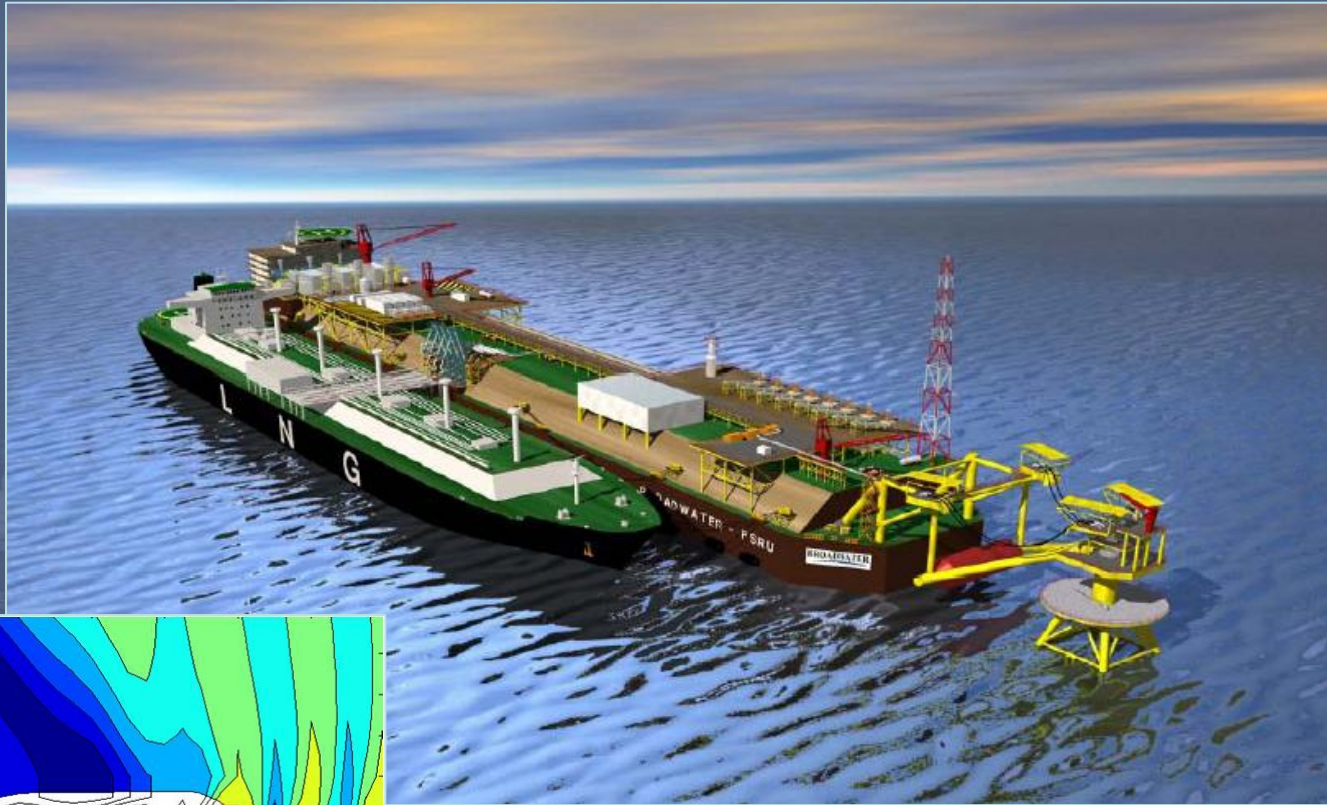
Rosarito LNG Terminal

Baja, Mexico

ConocoPhillips/El Paso



FSRU - Turret Mooring



*Broadwater LNG FSRU
Long Island Sound, New York*

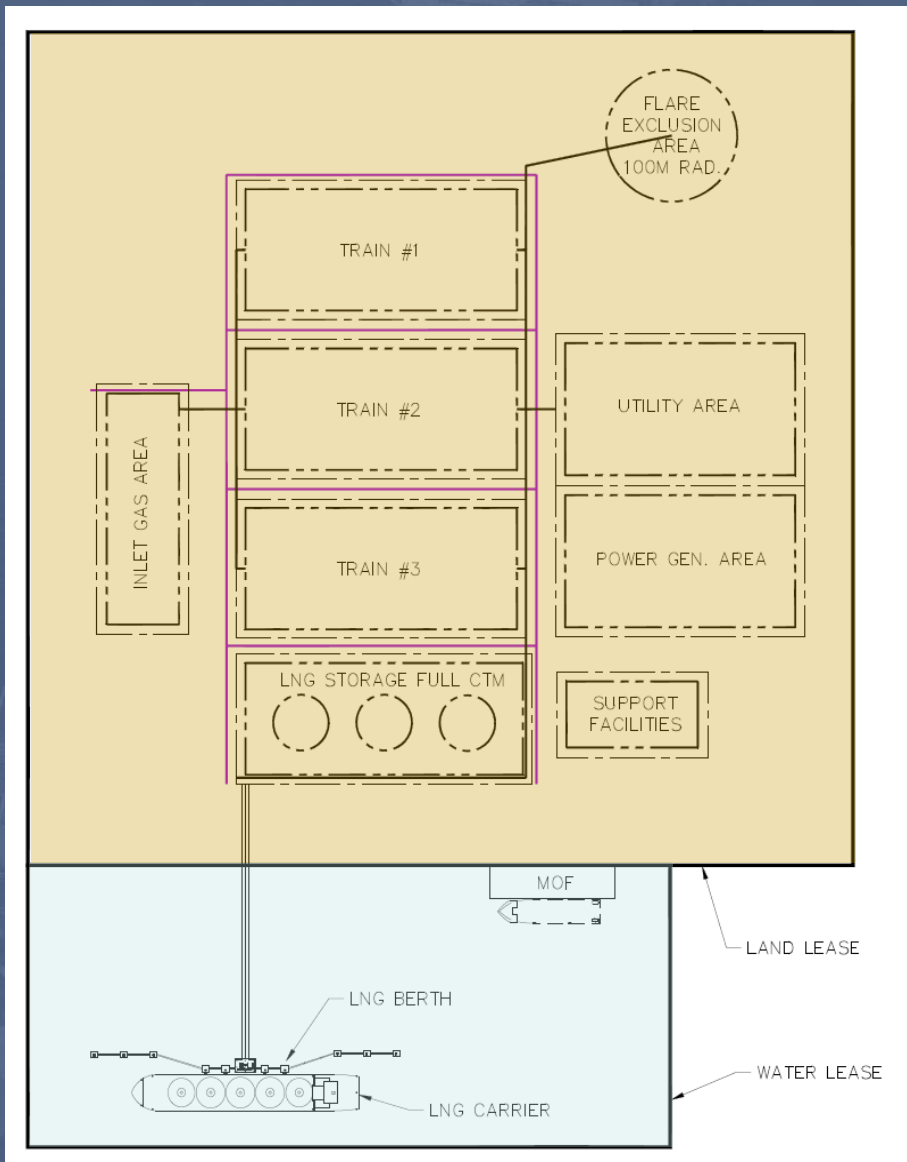
Floating LNG Terminal Tolu, Colombia Pacific Rubiales Energy



*Floating Liquefaction Barge with
FSU and LNG Carrier*



“Typical” LNG Export Facility

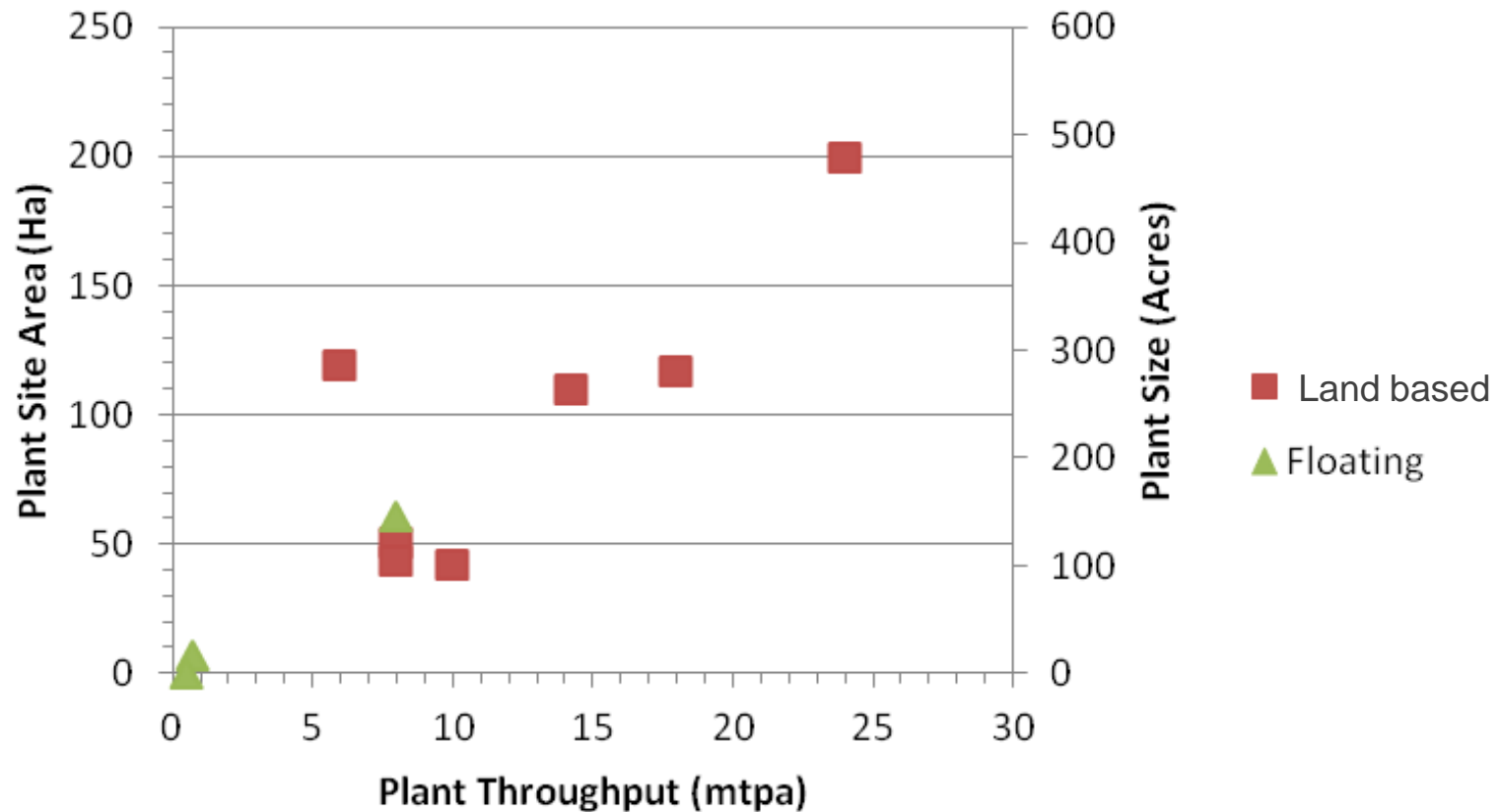


- Gas receiving
- Power generation
- Liquefaction plant
- Ancillary process
- Storage Tanks
- Support Facilities
- LNG Berth
- MOF



Land Area Required

LNG Plant Sizes

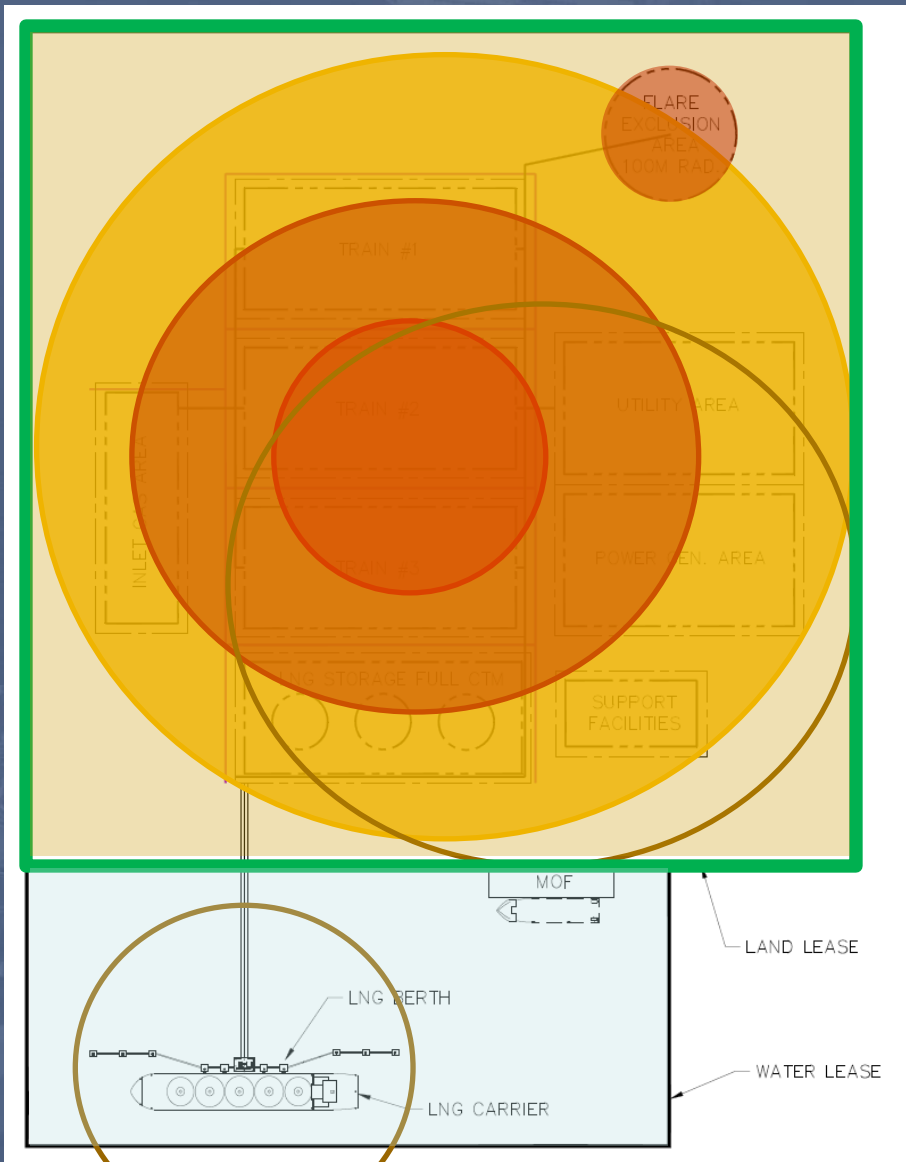


Siting Considerations (Uplands)

- Gas supply (pipeline)
- Land area required (throughput capacity)
- Land use / zoning / neighbours
- Terrain
- Geotechnical conditions
- Proximity to navigation channel
- Exclusion zones



“Exclusion Zones”



- Flare
- LNG spill - gas lower flammability limit (LFL) x 1/2
- Fire - Heat flux radiation zones
 - “5 kW/m² at a property line that can be built upon”



PIANC Guidelines

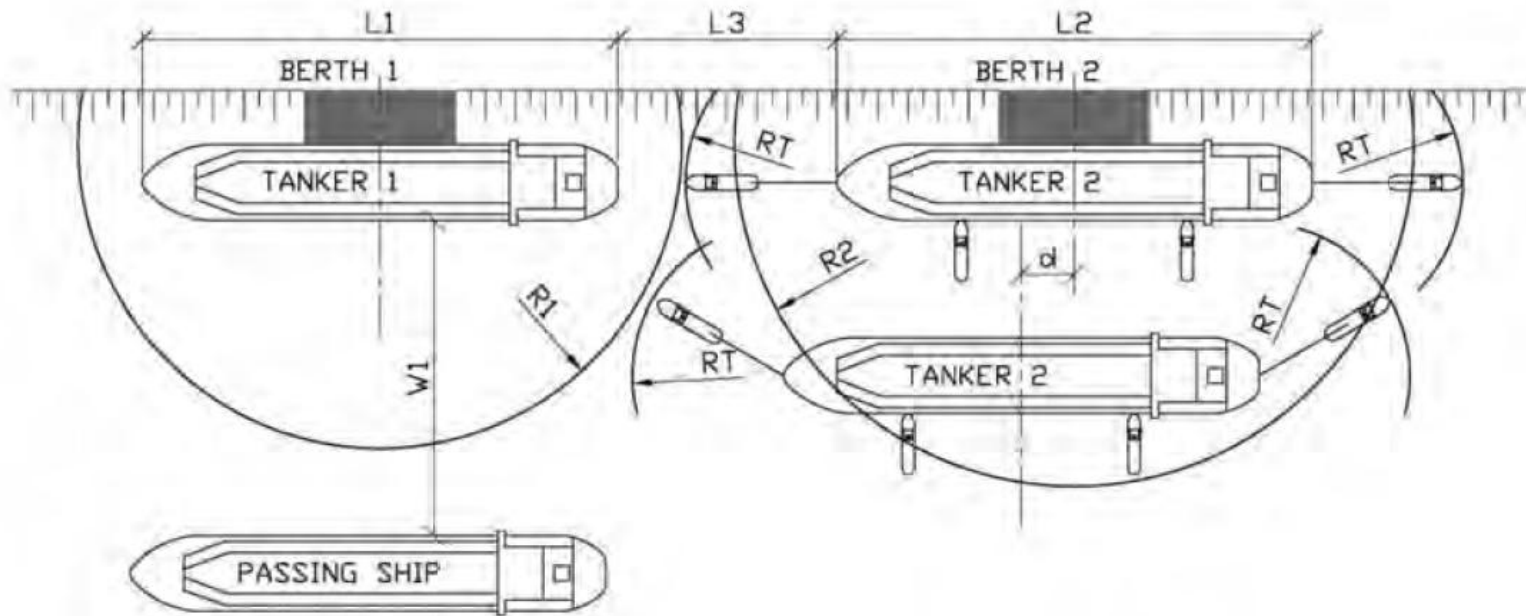
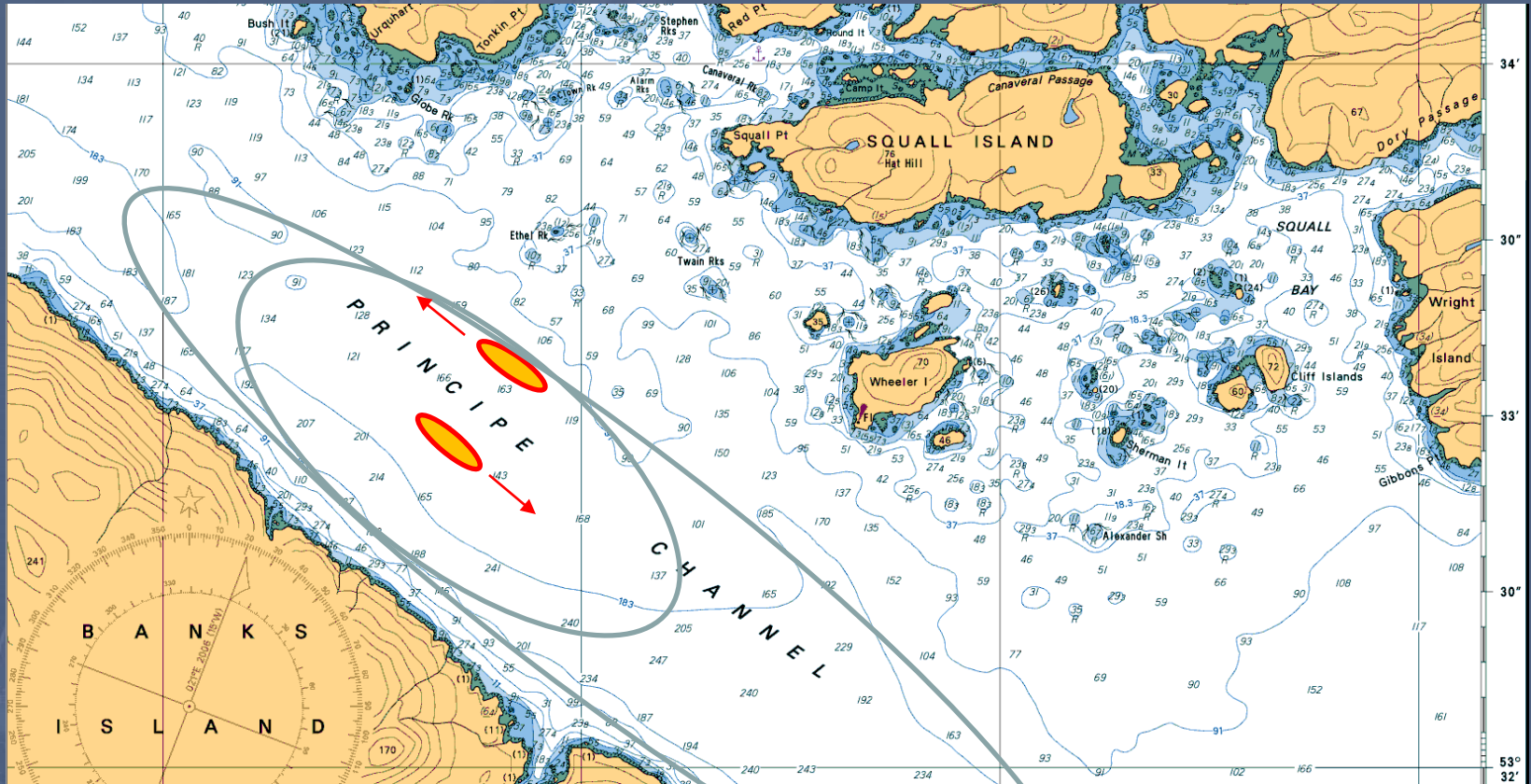


Figure 9.2: Alongside Distances and Passing Ships

PIANC 116: Safety Aspects Affecting the Berthing Operations of Tankers to Oil and Gas Terminals



Moving Exclusion Zones



e.g. US Gulf 1000y ahead + astern, 500 y each side
East Africa : 2 Nm ahead, 1 Nm astern.



Security Escorts?

- 4 – 80 ton bollard tractor tugs
- 6 – USCGC escorts (41' and 25') (armed)
- 3 – County Sheriff escorts
- Sheriff helicopter



Jetty Location Evaluation Criteria

- Navigation safety
- Water depth
- Exposure to wind, waves, current
- Berth downtime
- Geotechnical conditions
- Proximity to plant site
- Cost
- Risk/Safety
- Exclusion zones
- Environmental sensitivity



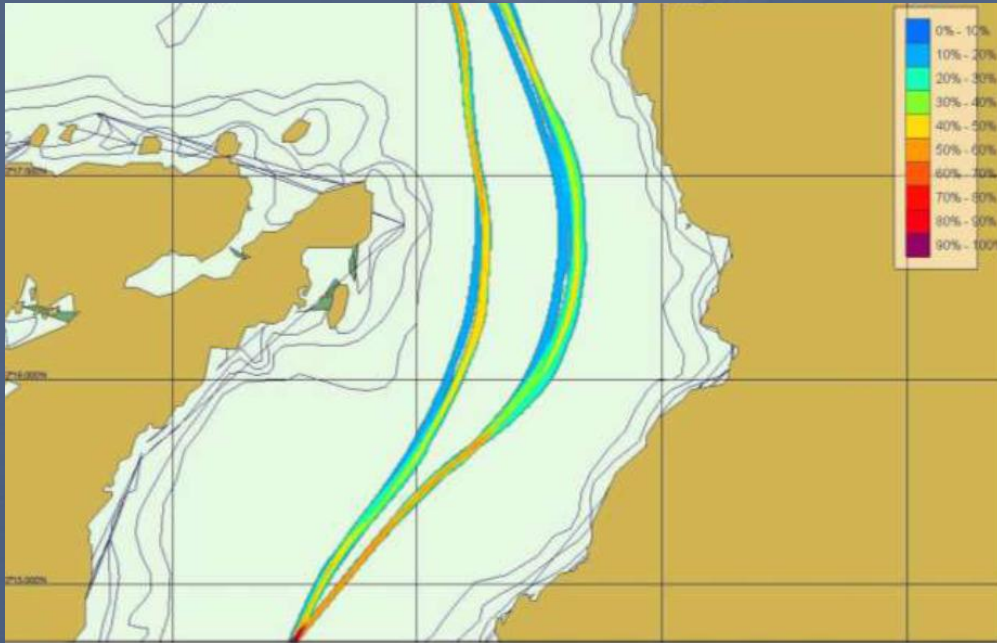
Navigation Assessments



- Desk-top review by master mariners (charts, regulations, experience)
- Fast-time Simulations (desk top software)
- Real Time Simulation (full mission bridge simulator)



Fast-time Navigation Simulation



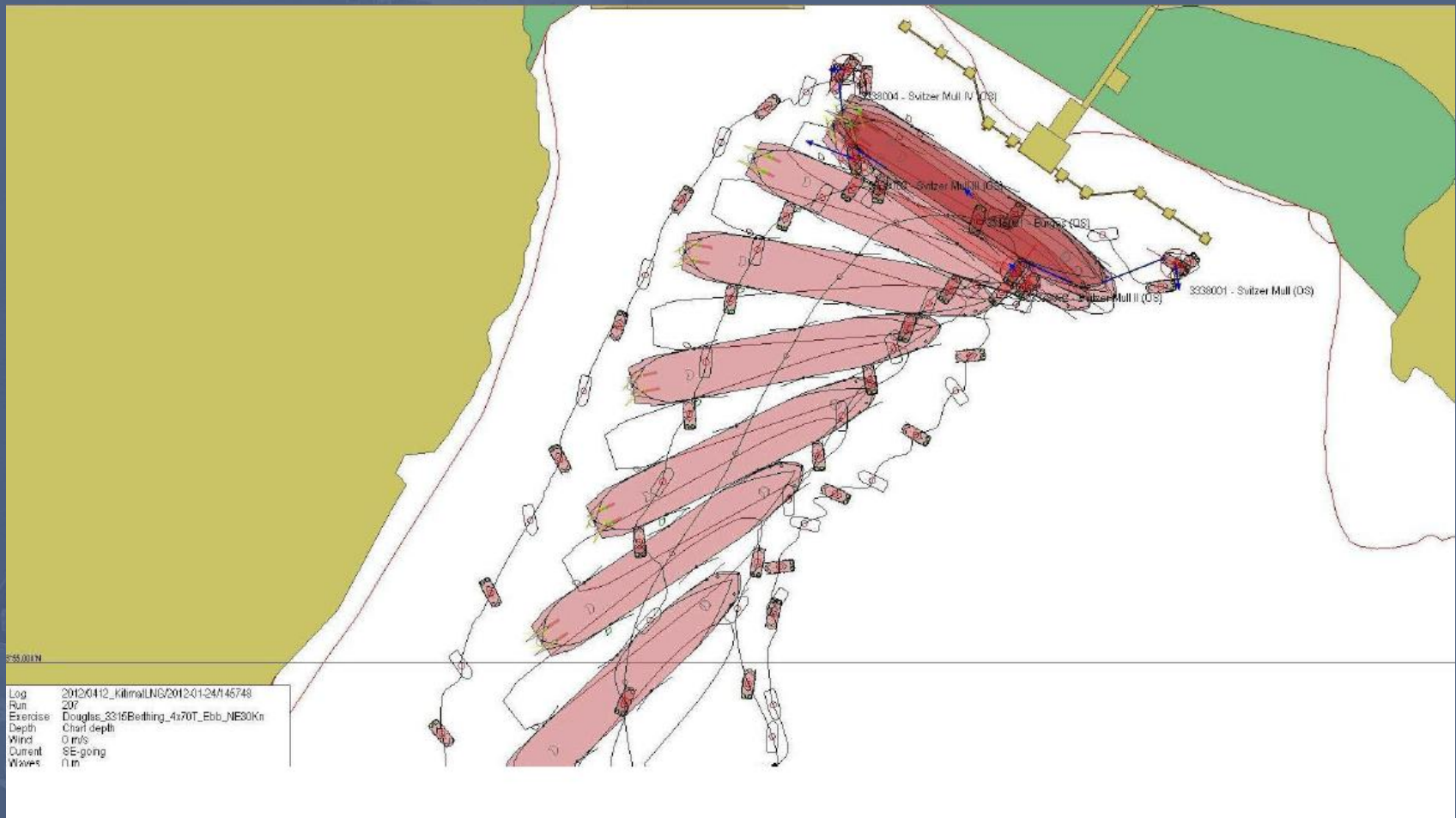
- Vessels are steered by a computer algorithm autopilot.
- Simulates maneuvering behavior of vessels.
- Turning, reverse sailing and berthing.
- Accounts for vessel characteristics, wind, bank suction, wave drift, currents and tug assistance.

Full Mission Bridge Simulations

- Project a realistic view from a ship's bridge.
- 'navigate' a vessel and 'operate' tugs
- Assess multiple scenarios
- Ship/tug Interactions
- Research tool (proof of concept)
- Pilot training tool (later)
- Focus on critical areas and conditions
- Actual human responses



Arrival & Departure Manoeuvres



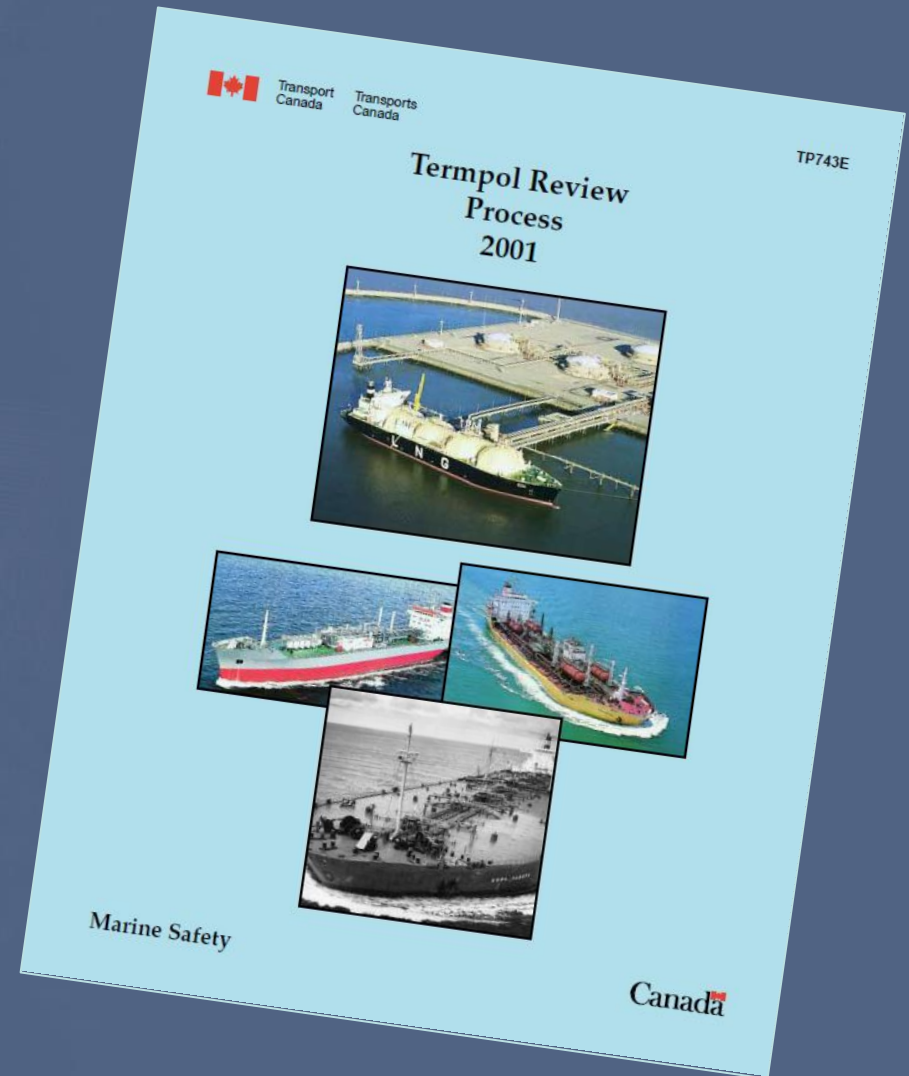
Regulatory Environment

- US
 - FERC
 - DOE
 - USCG
 - MARAD
- Canada (British Columbia)
 - Environmental agencies (NEB, CEAA, BCEAO)
 - Transport Canada (Canada Shipping Act, TERMPOL)
 - BC Oil & Gas Commission



TERMPOL

- Transport Canada
 - Origin, Destination, Traffic Surveys
 - Offshore Exploration Surveys
 - Route Analysis, Navigability Survey
 - Underkeel Clearance Survey
 - Transit Time and Delay Surveys
 - Ship Specifications
 - Site Plans and Technical Data
 - Cargo Transfer and Transshipment Systems
 - Channel Manoeuvring and Anchorage
 - General Risk Analysis
 - Port Information Book
 - Operations Manual



Approaching Challenges

- Competition
 - supply, markets, capital, labour, materials, equipment
- Market pricing certainty
- Lengthy and evolving regulatory requirements
- Royalty / taxation regimes (BC)



Conclusions & Lessons Learned

- Determine regulatory requirements early
- Include stakeholder and public engagement early
- Supply – demand market pricing still evolving
- Optimize the plant site first, the berth can usually be made to work



Thank You!

