PIANC WG 172
Design of small- to mid-scale marine LNG terminals including bunkering
Safety Moment

• When over water, **ALWAYS remember your PFD**
Agenda

- Why Develop Document?
- Scope
- Greenfield / Brownfield / Bunkering
- WG172 Topics Covered
- LNG Hazards
- Differences of LNG Terminals and MOTs

- LNG in California?
  - History, Future, and Challenges
  - Applicability of MOTEMS
  - Bunkering

- Conclusions
Why Develop PIANC WG 172?

- LNG history
  - Developed larger Carrier sizes for international trade
  - Codes are set for big boats
- LNG bunkering in europe
  - Power and fuel in scandinavia
  - Emission Control Areas
- LNG regional trade
  - Increasingly desired for regional trade
  - Call at smaller facilities in smaller volumes
  - Increasing need for breakbulk
- How to apply known technology to novel small to mid size uses
Scope

- Primer – new to LNG or small to mid sized operations
- Focus on infrastructure
  - Design and Planning
  - Structure
  - Topside Equipment
  - Marine Hardware
  - Risks and Safety Management
- Not in scope:
  - Ship to ship transfer
  - Vessel side operations
  - Isocontainers
Greenfield / Brownfield / Bunkering

• Greenfield
  o New site straightforward
  o Likely rare unless away from port

• Brownfield
  o Most likely close to port or at existing facilities
  o Influence on existing facilities / operations

• Bunkering
  o Need LNG supply / storage
  o Will start small, develop larger operations as norms are set
Topics Covered

• Concept of Operations ➔ Functional Requirements ➔ Basis of design
• **Terminal Planning**
• Environmental Conditions
• **Navigational Aspects**
• Berthing & Mooring
• **Terminal Infrastructure & Equipment**
• Loads, Load Combinations, and **Design Codes**
• **Risk Assessments**
• **Safety Management**
• Inspection and Maintenance

Largest differences from MOTs
LNG Hazards

• Fire
  o Burns as a fuel, but needs:
    ▪ 5% to 15% Air Mix
    ▪ Ignition Source
  o Does not explode unless confined
  o Can be fought

• Cryogenic Exposure

• Asphyxiation
  o Gas cloud which does not combust
Differences of LNG Terminals and MOTs

• Planning
  o Siting – access to
    ▪ Natural gas - local liquefaction
    ▪ LNG storage – breakbulk terminal
    ▪ Trucked LNG - small only
  o Acceptable offsite exposure and site standbacks

• Navigation
  o LNG risk along transport route to be considered (waterway assessment)
  o Existing USCG criteria geared towards larger LNGC
Differences of LNG Terminals and MOTs

• Equipment
  o Cryogenic Arms and hoses
    ▪ Cold burn and asphyxiation personnel hazards
  o Emergency Shut Down (ESD) and Emergency Release System (ERS)

• Cryogenic protection of structure & personnel
  o Waterfall to protect vessel

• Design Codes
  o US: NFPA 59A – Seismic requirements
  o 2,475 Year Earthquake Events >> than MOTEMS high 475 year earthquake event
  o PIANC “Special Structure”?
    ▪ More stringent performance than MOTEMS (no damage for large event)
Differences of LNG Terminals and MOTs

• Risk Assessments
  ○ HazID early in project
  ○ Quantitative Risk Assessment (QRA) during design development
  ○ Early days → expect QRA required
  ○ Simultaneous operations likely critical when facilities located within ports & bunkering

• Safety Management
  ○ Establish exclusion zones
    ▪ security and safety
  ○ Thermal exposure modeling
    ▪ On site and off site
LNG in California?

• History
  o No LNG marine terminals in California
  o Early 2000’s LNG import terminals considered, but projects died due to changing economics / challenging regulatory environment / public image

• Future
  o Unlikely to see large near shore export facilities
  o Offshore floating LNG possible, but challenging environment / deep water
  o Port facilities providing bunkering **more plausible**

• Challenges
  o Price of natural gas vs low sulfur fuel (bunkering)
  o Availability of LNG (local liquefaction, trucking only works for very small use)
  o Chicken and egg problem… **any volunteers?**
  o Early form regulations will be on case-by-case basis
Applicability of MOTEMS

- CSLC has determined they have jurisdiction on LNG
  - “Oil” = Hydrocarbon = Natural Gas = LNG
  - Now no limit on transfer size, so iso-containers and trucks may be within jurisdiction

- LNGTEMS
  - Still in draft / purgatory, not adopted

- MOTEMS Section 12
  - Very basic skeleton, needs to be developed

- First facility will face the learning curve
Bunkering

- LNG as fuel depends on cost of low sulfur bunker oil
- Truck to Ship, Isocontainers
  - Tugs, ferries, other small boats
  - W/in a port or region
  - Stepping stone to bigger development
  - Requires CSLC review???
    - Supporting structure assessment???
- Ship to Ship (barge operations)
  - International trade vessels
  - Similar to current oil bunker barges
  - Requires simultaneous operations to be economical
  - Likely the focus of future development
  - Expect CSLC involvement
Bunkering

- New uses will require new facilities
- Natural gas supply / site surroundings will constrain locations
  - Power company involvement
- Some major players are now getting into LNG

Three new LNG Fueld Carnival Cruise Ships Ordered

Carnival Corp. has agreements in place to build seven LNG-powered cruise ships across four of its 10 cruise brands in the coming years. http://www.miamiherald.com/news/business/tourism-cruises/article100140887.html
Conclusions

• Driven by economics, ECA’s
• Smaller vessels used regionally
• Infrastructure mostly similar to MOTS
  • Risks vary
  • Seismic return period varies
  • Safety requirements vary
• California – Chicken & egg problem
  • Economic and political challenges
• Proven technology & safety