PIANC WG 172

Design of small- to mid-scale marine LNG terminals including bunkering

moffatt & nichol

Creative People, Practical Solutions.®

moffattnichol.com

Safety Moment

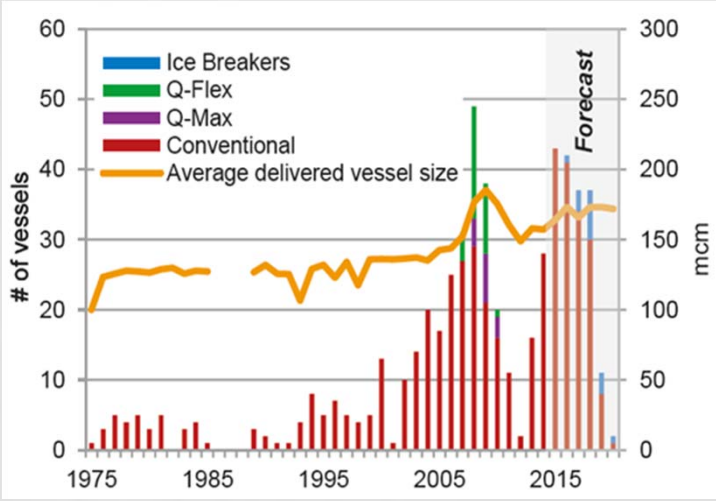
- **When over water, <u>ALWAYS</u> <u>remember your PFD</u>**

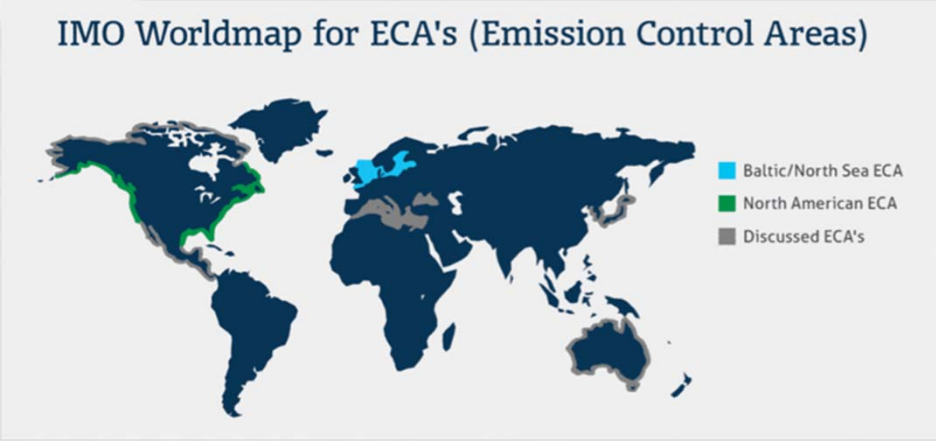
Agenda

- 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?

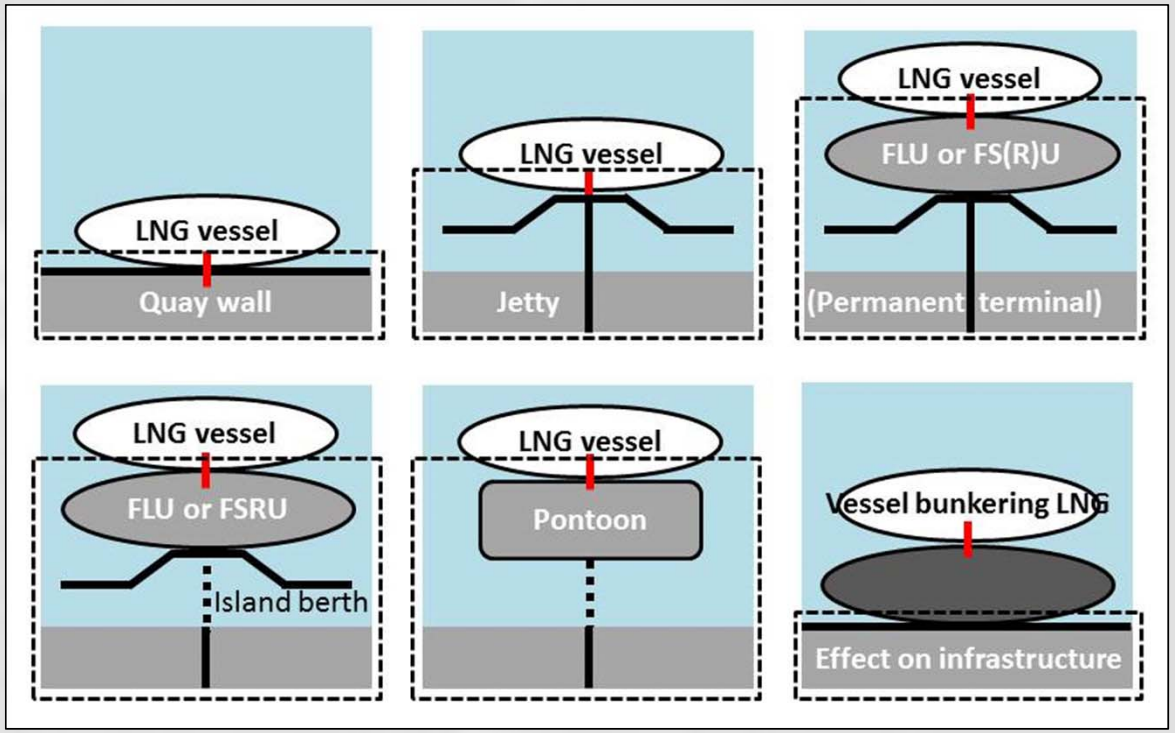
- LNG history
  - Developed larger Carrier sizes for international trade
  - Codes are set for big boats
- LNG bunkering in europe
  - Power and fuel in scandinavia
  - Emission Control Areas
- LNG regional trade
  - Increasingly desired for regional trade
  - Call at smaller facilities in smaller volumes
  - 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



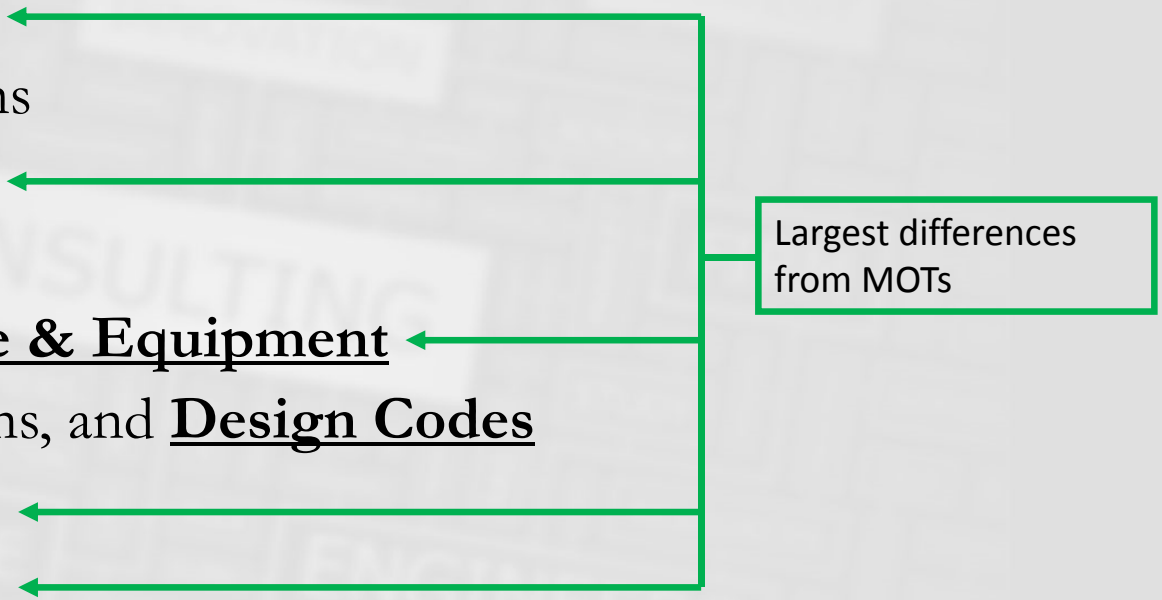
Greenfield / Brownfield / Bunkering

- Greenfield
  - New site straightforward
  - Likely rare unless away from port
- Brownfield
  - Most likely close to port or at existing facilities
  - Influence on existing facilities / operations
- Bunkering
  - Need LNG supply / storage
  - Will start small, develop larger operations as norms are set

Installation of LNG Storage Tank at
Existing Ferry Terminal [Port of Hirtshals, 2015]

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



LNG Hazards

- Fire
  - Burns as a fuel, but needs:
    - 5% to 15% Air Mix
    - Ignition Source
  - Does not explode unless confined
  - Can be fought
- Cryogenic Exposure
- Asphyxiation
  - Gas cloud which does not combust

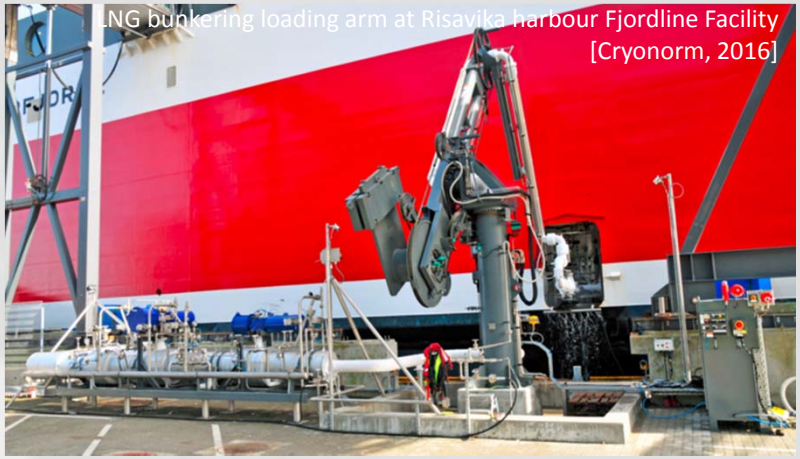
Differences of LNG Terminals and MOTs

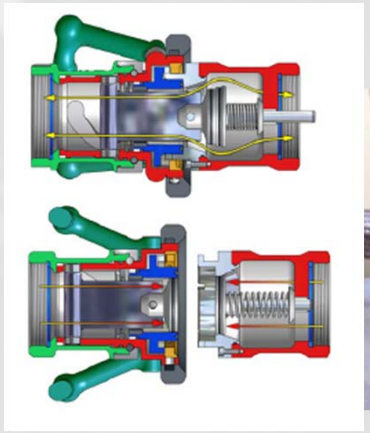
- Planning
  - Siting – access to
    - Natural gas - local liquefaction
    - LNG storage – breakbulk terminal
    - Trucked LNG - small only
  - Acceptable offsite exposure and site standbacks
- Navigation
  - LNG risk along transport route to be considered (waterway assessment)
  - Existing USCG criteria geared towards larger LNGC

LNG Bunkering Tote Vessel Jacksonville Fla

Differences of LNG Terminals and MOTs

- Equipment
  - Cryogenic Arms and hoses
    - Cold burn and asphyxiation personnel hazards
  - Emergency Shut Down (ESD) and Emergency Release System (ERS)
- Cryogenic protection of structure & personnel
  - Waterfall to protect vessel
- Design Codes
  - US: NFPA 59A – Seismic requirements
  - 2,475 Year Earthquake Events >> than MOTEMS high 475 year earthquake event
  - PIANC "Special Structure"?
    - More stringent performance than MOTEMS (no damage for large event)

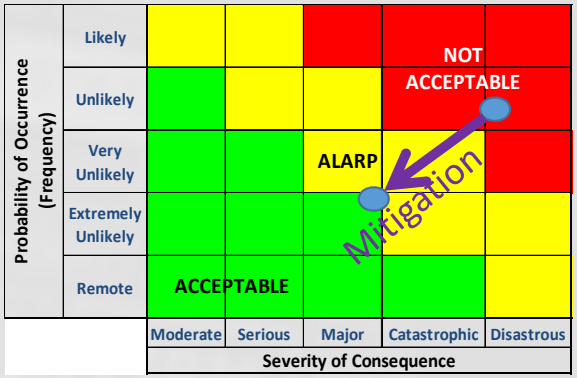

LNG bunkering loading arm at Risavika harbour Fjordline Facility [Cryonorm, 2016]

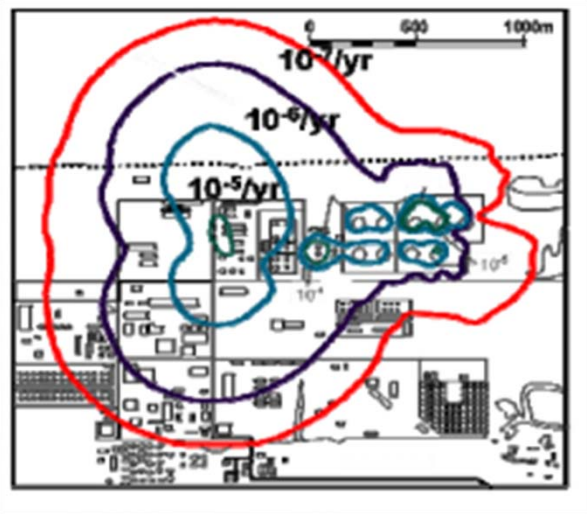



Mann Tek ERS

Differences of LNG Terminals and MOTs

- Risk Assessments
  - HazID early in project
  - Quantitative Risk Assesment (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



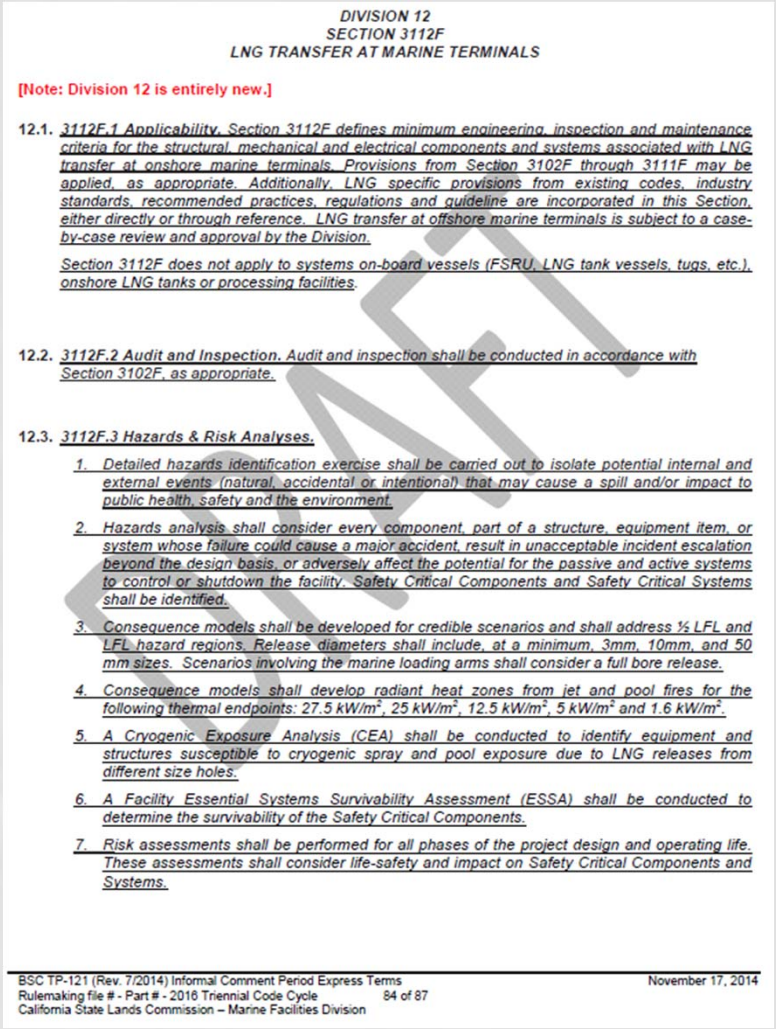


LNG in California?

- History
  - No LNG marine terminals in California
  - Early 2000's LNG import terminals considered, but projects died due to changing economics / challenging regulatory environment / public image
- Future
  - Unlikely to see large near shore export facilities
  - Offshore floating LNG possible, but challenging environment / deep water
  - Port facilities providing bunkering **more plausible**
- Challenges
  - Price of natural gas vs low sulfur fuel (bunkering)
  - Availability of LNG (local liquefaction, trucking only works for very small use)
  - Chicken and egg problem…**any volunteers?**
  - 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 w/in 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



DIVISION 12
SECTION 3112F
LNG TRANSFER AT MARINE TERMINALS

[Note: Division 12 is entirely new.]

12.1. *3112F.1 Applicability.* Section 3112F defines minimum engineering, inspection and maintenance criteria for the structural, mechanical and electrical components and systems associated with LNG transfer at onshore marine terminals. Provisions from Section 3102F through 3111F may be applied, as appropriate. Additionally, LNG specific provisions from existing codes, industry standards, recommended practices, regulations and guideline are incorporated in this Section, either directly or through reference. LNG transfer at offshore marine terminals is subject to a case-by-case review and approval by the Division.

Section 3112F does not apply to systems on-board vessels (FSRU, LNG tank vessels, tugs, etc.), onshore LNG tanks or processing facilities.

12.2. *3112F.2 Audit and Inspection.* Audit and inspection shall be conducted in accordance with Section 3102F, as appropriate.

12.3. *3112F.3 Hazards & Risk Analyses.*

1. Detailed hazards identification exercise shall be carried out to isolate potential internal and external events (natural, accidental or intentional) that may cause a spill and/or impact to public health, safety and the environment.
2. Hazards analysis shall consider every component, part of a structure, equipment item, or system whose failure could cause a major accident, result in unacceptable incident escalation beyond the design basis, or adversely affect the potential for the passive and active systems to control or shutdown the facility. Safety Critical Components and Safety Critical Systems shall be identified.
3. Consequence models shall be developed for credible scenarios and shall address ½ LFL and LFL hazard regions. Release diameters shall include, at a minimum, 3mm, 10mm, and 50 mm sizes. Scenarios involving the marine loading arms shall consider a full bore release.
4. Consequence models shall develop radiant heat zones from jet and pool fires for the following thermal endpoints: 27.5 kW/m^2, 25 kW/m^2, 12.5 kW/m^2, 5 kW/m^2 and 1.6 kW/m^2.
5. A Cryogenic Exposure Analysis (CEA) shall be conducted to identify equipment and structures susceptible to cryogenic spray and pool exposure due to LNG releases from different size holes.
6. A Facility Essential Systems Survivability Assessment (ESSA) shall be conducted to determine the survivability of the Safety Critical Components.
7. Risk assessments shall be performed for all phases of the project design and operating life. These assessments shall consider life-safety and impact on Safety Critical Components and Systems.

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

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
- <u>Proven technology & safety</u>

Gate LNG Terminal
Port of Rotterdam

THANK YOU!

moffattnichol.com