

# **NEW CANADIAN GUIDELINES FOR THE DESIGN OF MARINE STRUCTURES ASSOCIATED WITH LNG FACILITIES**


Martin L. Eskijian, P.E., D. PE

[mleskijian@gmail.com](mailto:mleskijian@gmail.com)

Senior Engineer, Moffatt & Nichol

September 28, 2016

Prevention First, 2016



# Design Requirements for Marine Structures Associated with LNG Facilities (DRMS), EXP 276.1-2015

- Effort partially funded by the British Columbia Oil and Gas Commission (BCOGC)
- Sponsored by CSA (Canadian Standards Association)

*Document is 50 pages, available for free from CSA (need to register)*



# Committee Participation DRMS EXP 276.1

- BCOGC government
- Transport Canada
- Prince Rupert Port Authority
- Numerous consulting firms
- Shell Oil
- Exxon/Mobil
- CSA Group

# Background and Applicability of EXP276.1

- Initiated with SLC/MFD LNGTEMS
- Document designed to be Canadian
- Enforceable in British Columbia, “recommended practice” for all of Canada
- Applicability – Engineering analysis/design of permanent marine structures providing support for topworks/vessels used to moor/berth LNG tank vessels
- Does NOT include topworks (e.g. loading arms, fire detection/suppression, pipelines, etc.)
- Includes Structures:
  - Shore-side abutment
  - Access trestles from shore to loading platform
  - Loading platform
  - Berthing and mooring dolphins
  - Catwalks
  - Quay wall structures

# EXP276.1-2015 Outline

- Scope and Reference Documents
- General Requirements
- Structural Design of LNG Marine Facilities
- Seismic Hazards and Geotechnical Issues
- Mooring and Berthing Analyses

# General Requirements CSA 276.1

- Operational/Functional Considerations
- Data Acquisition
- Design Service Life
- Structural Performance Criteria
- LNG Vessel Parameters
- Berth Layout/Orientation
- Design Environmental Conditions and Accidental



# General Requirements

- Applicable Codes/Design Standards
- Seismic Criteria
- Berth Layout
- Design Metocean Parameters
- Service Life
- Normal and Extreme Operating Conditions

# Structural Design

- Various Design Codes can be used:
  - CSA S6 – Canadian Highway Bridge Design Code
  - ISO Standards adopted by Canada for offshore structures
  - US Standards (MOTEMS, UFC 4-152; 4-159 API RP 2A, ASCE 61-14)
  - European codes in conjunction with BS 6349



# Load Categories

- Dead, Live
- Buoyancy
- Environmental (wind, wave, current)
- Earth and tidal pressures
- Mooring/Breasting Loads
- Berthing
- Earthquake (2 Levels)
- Temperature, Construction, Snow/Ice, Tsunami and Process Loads

# Earthquake Loads

- Operating Earthquake (OBE) 10% Probability in 50 years (475 year return period)  
*Performance Requirement: Remain operational*
- Safe Shutdown Earthquake (SSE) 2% Probability in 50 years (2475 year return period)
  - *Performance Requirement: Prevent Collapse, fire protection system to be operational. No release of significant quantities of LNG. ASCE 61-14 can be used as a conservative approach.*

# Load Combinations

- Load combinations and factors developed based on the design selected codes.
- Basic combinations provided in MOTEMS, UFC 4-152 and BS 6349
- Engineering judgement if references are insufficient.





# Seismic Hazards and Geotechnical Issues

- Site Characteristics and Probabilistic Seismic Hazard Assessment (PSHA)
- Slope, foundation and earth retention systems
- Static and Dynamic Soil Properties
- Selection of independent time histories
- Liquefaction
- Tsunamis



# Mooring and Berthing Analyses

- Normal and Extreme Operating Conditions
- Metocean and operational considerations
- Seiche, Passing Vessel Loads
- Mooring Analysis (static and dynamic)
- Berth Monitoring Systems

# EXP 276.1-2015

*Available to the public through the CSA website  
(free)*

<http://shop.csa.ca/en/canada/petroleum-and-natural-gas-industry-systems/exp2761-2015/invnt/express27612015>



# QUESTIONS/COMMENTS

