Program

• LNG Facts
• LNG Shipping
• LNG Terminals
• Regulatory Environment (TERMPOL)
North American LNG/LPG Projects

37 Recent/Active Projects in USA and Canada
30 Projects with M&N Involvement
LNG Facts

• Natural gas (methane) cooled to -160° C
• Occupies 1/600th the volume of gas
• Colourless, odourless, non toxic liquid
• Stored in non-pressurized insulated tanks
• Evaporates 100% with zero residue
• Non-explosive
• Flammable vapour @ 5% – 15% CH₄
LNG Supply Chain (Export)

Feed Gas → Processing → Liquefaction → LNG Storage → LNG Loading

“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.
“Typical” LNG Terminal
LNG Berth Facilities
Laser Docking Systems

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

Courtesy of Trelleborg / Harbour & Marine
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)
Floating LNG Terminal
Tolu, Colombia
Pacific Rubiales Energy

Floating Liquefaction Barge with FSU and LNG Carrier
Regulatory Environment

• Environmental agencies (NEB, CEAA, BCEAO)
• BC Oil & Gas Commission
• Transport Canada (Canada Shipping Act, TERMPOL)
Termpol Review Process

- **TERMPOL Code:** The "Code of Recommended Standards for the safety and prevention of pollution for marine transportation systems and related assessment procedures".
- Navigation & Operational Safety
- Petrochemical vessels including LNG
- Voluntary
TERMPOL Studies

- 3.1 - Introduction
- 3.2 - Origin, Destination and Marine Traffic Volume Survey
- 3.3 - Fishery Resources Survey
- 3.4 - Offshore Exercise, Exploration and Exploitation Activities Survey
- 3.5 - Route Analysis, Approach Characteristics and Navigability Survey
- 3.6 - Special Underkeel Clearance Survey
- 3.7 - Transit Time and Delay Survey
- 3.8 - Casualty Data Survey
- 3.9 - Ship Specifications
- 3.10 - Site Plans and Technical Data
- 3.11 - Cargo Transfer and Transhipment Systems
- 3.12 - Channel, Manoeuvring and Anchorage Elements
- 3.15 - General Risk Analysis and Intended Methods of Reducing Risks
- 3.16 - Port Information Handbook
- 3.18 - Contingency Planning
- Navigation simulations
Navigation Assessments

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

• Shipping routes well established in the region
• 12-16 hour journey from Triple Island to Kitimat (2 pilots)
• Navigation Validation completed for LNG Ships
Douglas Channel
Wright Sound
Fast-time Navigation Simulations

- Vessels are steered by a computer algorithm autopilot.
- Simulates manoeuvring behavior of vessels.
- Accounts for vessel characteristics, wind, bank suction, wave drift, currents and tug assistance.
Full Mission Bridge Simulations

- Human piloting decisions
- Realistic view from a ship’s bridge.
- ‘navigate’ a vessel and ‘operate’ tugs
- Ship/tug Interactions
- Focus on critical areas and conditions
Passing Vessels - Lewis Channel
Arrival & Departure Manoeuvres
Summary

• LNG Shipping is well established, safe
• Extensive due diligence and risk assessments
• No real technical hurdles to overcome
• BC poised to become a major LNG player
  – but... some commercial & regulatory challenges remain