American Association of Port Authorities
Facilities Engineering Seminar & Expo

Liquid Bulk Terminal Technology
Liquefied Natural Gas Technologies & Emerging Challenges

Scott K. Wagner, P.E.
Project Manager, Oil & Gas Projects

Liquid Bulk Terminal Technology – LNG

Existing Large-Scale Import/Export Operations

- Transfer Technologies – Marine Loading Arms
- Mooring System Technologies
- Ship-to-Shore Compatibility
- Ship Assist Tugs
- Natural Disaster Protection – Terminal Design Highlights

Emerging Small to Mid-Scale Marine Fuel Operations

- Drivers – Environmental Regulations & Costs
- Emerging Market Challenges – Supply, Storage & Bunkering Operations











Transfer Technologies – Marine Loading Arms

Marine Loading Arms – Operation

- Manual
- Remotely Operated Hydraulic System
- Fully Automatic Hydraulic System (Offshore Applications)

Marine Loading Arms – Connection

- Bolted Connection
- Quick Connect (Cam-Lock System)
- Fully Automatic Hydraulic System

Marine Loading Arms – Monitoring

- Continuous Position Monitoring System
- Alarms, Shutdowns & Emergency Release

Marine Loading Arms – E-Release

- Powered Emergency Release Coupling






Marine Loading Arms – Emergency Release

Start – Valves Close

Finish – Arm Released






Mooring System Technologies

* Graphics courtesy of Trelleborg Marine (http://www.trelleborg.com/en/Marine-Systems/Home/)

Approach Monitoring

- Real time monitoring and display of vessel approach to dock
- Display on dock with ‘scoreboard’
- Data available to pilot through hand-held device

Mooring Hooks

- Integrated mooring hooks / capstans
- Quick release capability (on station or remotely)
- Continuous line tension monitoring

Met/Ocean Data

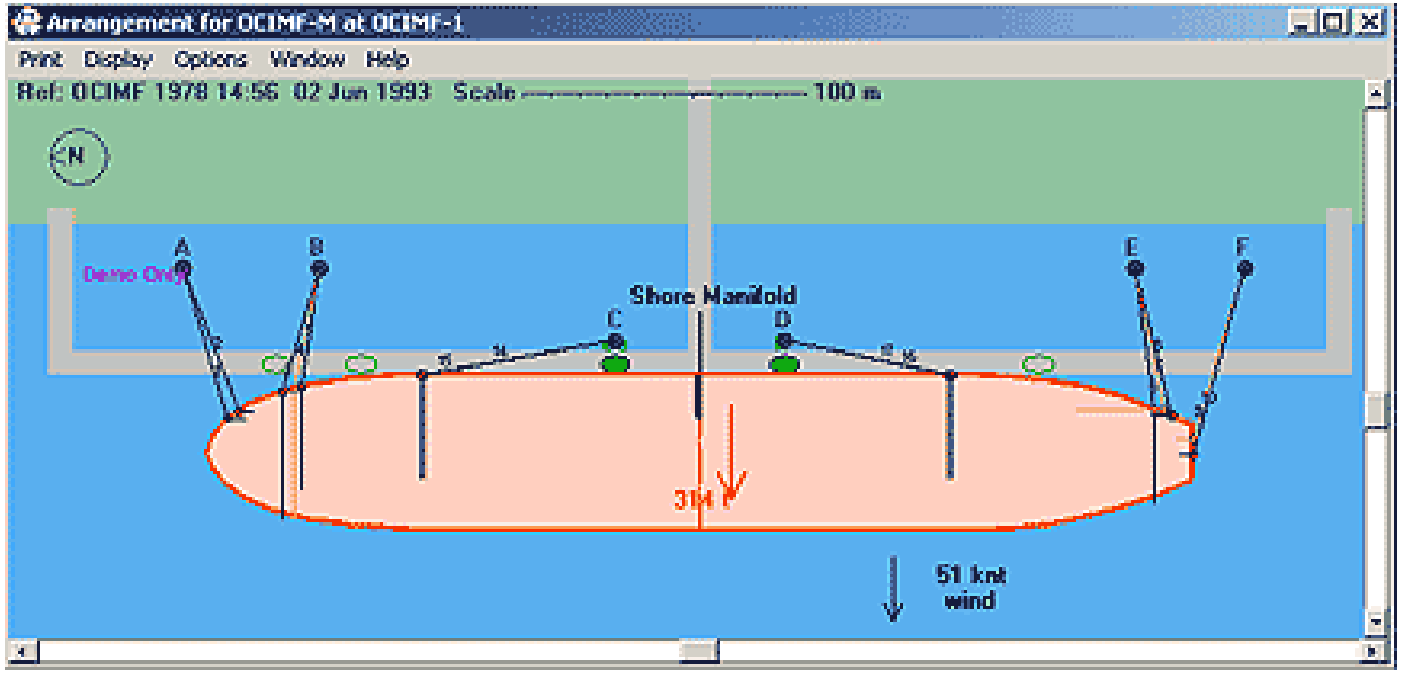
- Real time data
  - Wind speed & direction
  - Current velocity & direction
  - Wave height, period & direction
  - Etc.
- Data available to terminal and vessel (pilot)






* Graphics courtesy of Trelleborg Marine (http://www.trelleborg.com/en/Marine-Systems/Home/)

Ship-to-Shore Compatibility



* Graphics courtesy of Tension Technology (http://www.tensiontech.com/software/optimoor.html)






Ship-to-Shore Compatibility

- Mooring Arrangements
  - Mooring arrangements determined well prior to vessel arrival
  - Computer models are used to analyze and optimize mooring arrangements
  - Mooring arrangement is conveyed to ship, terminal, pilots and line handlers prior to vessel arrival to ensure accuracy
- Emergency Communications Link
  - Fiber optic or electric link between ship and terminal
  - Integrates the ship and the terminal safety systems so problems on either side are immediately identified
  - Allows for manual or automatic shut down of all transfer equipment and valves on both the ship and terminal to put the entire operation in a safe condition

Stainless Reel for Shore Side ESD Cable

AF 37 Pin Connector

Ship Assist Tugs







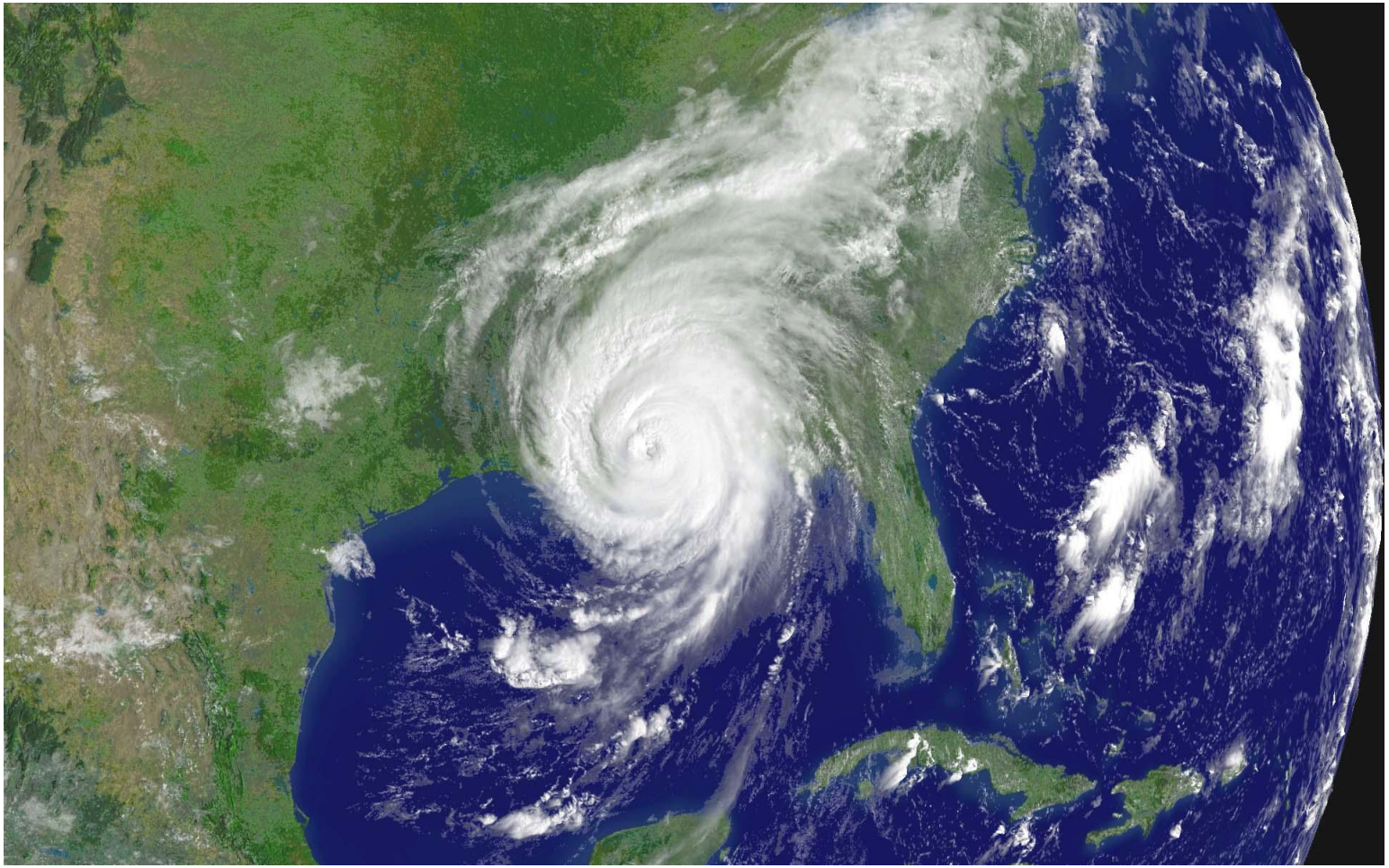




Ship Assist Tugs

- Increasing bollard pull capabilities – 80MT
- Z-Drives – enhanced capabilities for ship assist work
- Advanced winch systems employed
  - Continuous line tension monitoring in the wheelhouse
  - "Render/Recover" control system prevents overloading line and prevent damage to ships fittings
- FiFi1 fire fighting capabilities
  - Water cannons
  - Wheelhouse deluge system

Natural Disaster Protection – Terminal Design Highlights








Hurricane Protection (Pascagoula, Mississippi)

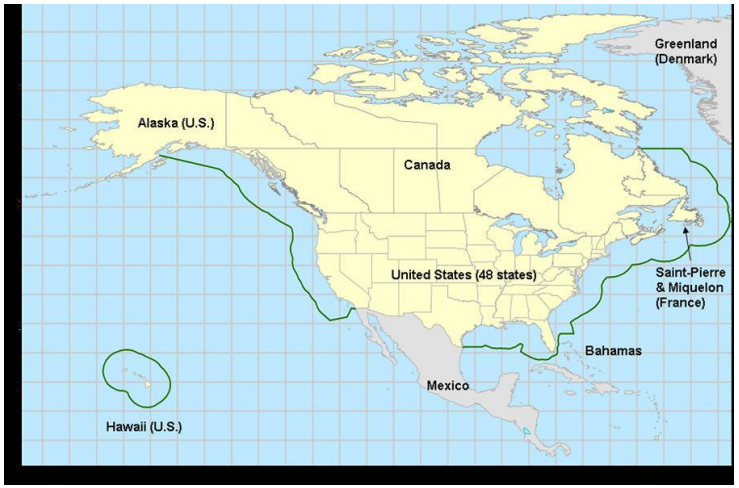
- Seawall (27 feet above normal sea level)
- Marine Unloading Platform & Pipe Trestle (34 – 37 feet above normal sea level)

Emerging Small to Mid Scale Marine LNG Fuel Operations

* Graphics courtesy of Marine Log (http://www.marinelog.com/index.php?option=com_content&view=article&id=3819:stockholm-offers-vessel-to-vessel-lng-bunkering&catid=1:latest-news&Itemid=195)

LNG Marine Fuel - Drivers

- Environmental (Emission Control Areas)
  - Significant Sulfur Oxide (SOx) Emission Reductions
  - Nitrogen Oxide (NOx) Emission Reductions
  - Carbon Dioxide (CO2) Emission Reductions
- Costs
  - LNG can be up to 2.0 to 2.5 times less expensive as fuel when compared to ‘environmentally friendly’ marine fuels
  - However, shore-side infrastructure costs and vessel retrofit or new-build costs may offset this savings













LNG Marine Fuel – Challenges (North America)

- Supply (Liquefaction)
  - Large import terminals turning to liquefaction for export
  - Peakshaving facilities and trucking alternatives
  - New mid to small scale liquefaction facilities
- Storage
  - Proper sizing of storage facilities for bunkering throughput
  - Handling of boil-off gas
- Bunkering Operations
  - Consideration of the advanced technology applied to the large-scale import/export trade
  - Need for standardization

PIANC Working Group 172 is focused on this issue and DNV has published a draft recommended practice (RP-G106) on LNG Bunkering Facilities/Operations. Other industry and regulatory groups are studying this as well as the momentum builds.






LNG Project Development & Execution – The CB&I Advantage

- *Liquefaction Technology* – CB&I has executed 15 projects involving the liquefaction of natural gas in the last 15 years
- *LNG Storage* – CB&I is an industry leader in the design and construction of low temperature and cryogenic storage tanks, including more than 200 LNG storage tanks
- *LNG Transfer* – CB&I is a leading contractor for cryogenic equipment, including pumps, compressors and marine loading arms as well as cryogenic piping – all necessary for the LNG transfer process.
- *Marine Facilities* – The “CPM” group within CB&I provides full service development and design of all marine components associated with oil and gas projects such as these.

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