Small-Scale LNG: Developments in Distribution & Bunkering Solutions

June 11-12, 2013
Platt’s – Annual Bunker & Residual Fuel Oil Conference
Houston, Texas
• Maersk – Argent Marine: Joint Venture
• Efforts in Europe, Asia, North America (Harvey Gulf Marine, TOTE)
• Our Distribution Model: 3 Areas
• LNG Bunkering Options
• LNG Sourcing
• Real Projects under Development: Caribbean, Jamaica, No. Europe (Rotterdam / Gothenburg), Germany (power barges)
Maersk-Argent: a Unique solution to the LNG supply chain

**Maersk Line, Limited**

- Ship design and engineering expert
- 28 years of experience in:
  - Tanker operations
  - Vessel management
  - Maritime technical services
- Global intermodal capability
- Established U.S. flag network

**Argent Marine**

- Specializes in LNG marine vessels
- Advisor to domestic and international LNG marine operations
- Service provider to major oil & gas companies

Designed Articulated Tug/ Barges for the safe and economical distribution of LNG
LNG in Marine Markets: The Drivers

Environmental Driver
- Emissions Control Areas

Economic Driver
- Price (especially in US)

Supply Driver
Emission Control Areas set by the International Maritime Organization (IMO ECA’s) are driving LNG as a marine fuel.

**IMO Annex VI:**
August 2012: sulphur content in fuels < 1.0%
January 2015: sulphur content in fuels < .1%

Source: DNV 2011 Report, *Greener Shipping for North America*
Europe is Leading The Way

- Major ports are driving adoption
  - Rotterdam
  - Antwerp
  - Hamburg
  - Baltics

- Major shipping companies
  - Evaluating LNG as Fuel

- Every major vessel segment
  - Ferries - Norway since 2001
  - Short Sea
  - Inland
  - Ocean

- Organizational Efforts
  - SIGTTO
  - IMO
  - DMA
  - Society for Gas as Marine Fuel - new

- Classification
  - Lloyds
  - ABS
  - DNV
  - Bureau Veritas
Marine Fuel

Existing Ship Types

- Ferries
- Container Feeder Vessels

New Concept Designs

- DNV Concept Vessel: *Trialty* An LNG-fueled VLCC
- DNV Concept Vessel: Quantum 6,200 TEU container ship
LNG-fueled power barges
Cleaner, In-port auxiliary power

In-Port Options:

- Hamburg, Germany
  - Eckelmann Group / Tui Cruises
  - Becker Marine Sys / AIDA Cruises
- In-port electrical service at berth for Cruise Ships
- Vapor gas for dual fuel genset on the barges

Sources: World Maritime News; Eckelmann
Harvey Gulf International Marine: New Orleans, LA

- Contract signed in Oct 2011
- Building six (6) offshore supply vessels to run on LNG
- 302 ft, Dual fuel engines
- Trinity shipyard, Gulfport, MS
- Operate in Gulf of Mexico
- U.S. Coast Guard Inspected
- American Bureau of Shipping
TOTE: 2 Conversions and 2 New Builds for LNG

TOTE / Totem Ocean Trailer Express Carriers:

- Two conversions announced Fall 2012
  - Orca & Midnight Sun, built 2003
  - Operate Tacoma to AK
  - Lengthy conversion timeline
  - USCG / EPA issued waiver to ECA emissions
  - Early 2015 first one / second in 2016

- TOTE, Inc. signed new construction contract in Dec 2012
  - Two New 3,100-TEU containerships
  - Build at GD NASSCO in San Diego
  - ABS Classed
  - In-service, late 2015 / early 2016
  - Operate Jax to Puerto Rico
Our JV Business Model: Three Major Areas of Focus

- Bulk Distribution – up to 20,000 cubic meters
  - Nominal design to carry 13,500

- Intermodal transport
  - Containerized LNG

- Bunker Fueling: LNG as marine fuel
Combined AT/B LNG Carrier

**CARGO UNIT:**
- LOA: 515’ – 545’
- Beam: 75’
- Depth: 40.6’
- Design Draft: 20’

**COMBINED VESSEL:**
- LOA: 591’
- Loaded Draft: 20’
- Service Speed: 12 Knots
Our two LNG distribution concepts are flexible and scalable, and can serve markets via intermodal and bulk AT/B’s.

- Both AT/Bs are designed for offshore, rivers, ports and inter-island and for loading and receiving terminals.
- The ATB concepts meet IMO, and International Gas Carrier Code.

**Bulk**

- Capacity of 13,300 m³ in its baseline configuration.
- Flexibility to separate propulsion (tug) from cargo (barge), enabling a "swap and drop" arrangement.
- Provides pier-side storage without the need to construct additional LNG holding tanks.
- Bulk AT/B design is also being considered for ship refueling (bunkering) of LNG-powered vessels.

**Intermodal**

- Total capacity of over 6,500 m³, comprised of 168 ISO “tanktainers” (each container approx 9,500 gals).
- Loading: tanktainers are interconnected and loaded through a specialized piping system, taking 6–8 hours to load.
- Utilizes Established Intermodal System:
  - Eliminates bulk handling, land based tanks.
  - Use all container port facilities.
  - Other ports using self geared vessel.
Bulk AT/B: 5,000 - 15,000+ m³ Design

- MLL / AMM Vessel Design - in development since 2008
- Approval in Concept - Class Society
- HAZID Study conducted in March 2012

Example of an AT/B Product Carrier, Brandywine
Illustrative Routes: Bulk Design – East Coast

Cove Point LNG Barge
Possible Delivery Routes

Elba Island LNG Barge
Possible Delivery Routes
Intermodal AT/B; Containerized LNG

Cutaway of Tanktainers

Tanks within one hold space

Bird’s eye view of the six hold spaces
Argent/Maersk: Intermodal ATB

- 40’ or 45’ ISO tanktainers
- Approx 168 tanktainers
Intermodal LNG moves via truck and rail – ISO “tanktainers” are modular and move efficiently

ISO Tanktainers: efficient storage, loading and transport
LNG Fuel Intermodal Distribution System

- **Containerized LNG**
  - Replaces Bulk Transfers / Handling
  - No Land Storage Tanks required
  - ISO/US DOT or UN Certified Tanktainers
  - Ideal for Ferries/Small Vessels, Inland Fueling Stations

- **Simplifies Distribution Start-Up**
Intermodal System
Vessel Fuel Propulsion/Bunkering

Marine Services GmbH
North America

- North America In Second Place behind Europe
- Activity
  - Harvey Gulf
  - TOTE
  - Staten Island Ferry
  - Washington State Ferry
  - BC Ferries
  - Great Lakes interest
- USCG Engaged: New Policy Letters on LNG - soon
- Many Ports “Wait and See”
North America

- Unique Opportunity
  - Establish US as LNG Bunker Center
  - First Mover Potential

- Distribution Services Options
  - Port Facilities / Fueling Station
  - Vessel Bunkering Operations
Bunker Vessel Concepts
Argent/Maersk: Port Bunker Vessel

- Dedicated bunkering vessel for in port operations
- 1,500 – 5,000 m³ (scalable) to port customer needs
- Tug/Barge - or - Integral Vessel
Vessel Bunkering Options

- Pier side via truck
  - Fueling option of choice for early adopters
  - Limited for large bunker volumes

- Dedicated bunker berth (Fueling Station)
  - Vessel must shift to bunker berth
  - Not most desirable option due to vessel delay

- Piped LNG to vessel’s usual berth (restrictive)
  - Requires shore based tanks

- Bunker vessel alongside ship at berth
  - Mirrors current oil bunkering process
  - Bunker vessel either self propelled or tug/barge
Bunkering From Truck

**LNG Trailer - 40 m³ (US GVW limit)**

- **Suitable to Service**
  - Viking Energy ~ 209 m³
  - US PSV ~ 300 m³
  - Laker ~ 300 m³

- **Not Practical For**
  - Coastal Ro/Ro ~ 2000 m³
  - Trans Atlantic Containership ( ~ 6000 m³)
Alongside Ship at Berth

A commercial approach for sea-going vessels

- Least disruptive to vessel operations
- Bunker vessel either self propelled or tug/barge
- Similar to current bunkering operations
- Lowest commercial cost model
- Required to maximize LNG fuel adoption
Bunkering Issues

- **LNG Quality**
  - Heating value
  - Composition
  - Methane Number

- **LNG Quantity**
  - Volume measurement (tank level measurement accuracy)
  - Mass flow meters (coriolis meters)

- **Bunkering Time** - (approx 1000 m3 in 4 hours)

- **Flow Rate / Delivery Pressure**

- **Vapor Return**
LNG Bunkering Safety

- **Flammable - makes good fuel**
  - Prime Directive – Never let natural gas and air in the same place at the same time
  - Proper inerting is critical

- **Cryogenic**
  - Personnel safety - cryogenic burns
  - Brittle fracture of vessel structure
    - Drip trays
    - Hull water curtains

- **Training**
  - LNG properties – root understanding of fuel
  - Proper Procedures
LNG Sourcing

- **Peak Shaving Plants - not a long term viable source**
  - Regulated
  - Interruptible supply only
  - Small liquefaction capability
  - Will play a relatively small role in LNG fuel sourcing

- **Import / Export Terminals - maybe**

- **Dedicated LNG fuel liquefaction plants - hopefully**
  - Inland locations – and “Truck it in”
  - Water Access / Maritime locations
  - Small scale to mid scale plant designs
  - Need aggregated volumes to make FID
Rotterdam – Gothenburg
- Port of Rotterdam and the Port of Gothenburg have signed a collaboration agreement

Hamburg, Germany
- In-Port auxiliary power generation / power barges

Singapore Maritime and Port Auth announced it will have LNG bunkering in place in 2015

European Commission: “Clean Fuel Strategy”

U. S. Great Lakes – Interlake Shipping / Shell (Sarnia)

Puerto Rico – looking to generate power from NG

Jamaica – seeking alternative energy for many years

LNG Fuelled Ships – DF ships under construction
Advantages of using Small Scale AT/B distribution:

**Safety**

- Limited Quantities in distribution
- Reinforced Vessel Construction – beyond requirements
- Multiple High Strength Tanks (Double-hulled barge)
- HAZID Risk Assessment – performed in March 2012 w/ USCG participation
- Enhanced Vessel Maneuverability (barge bow thrusters)
- Self Contained Assist / Response in tug capabilities

**Operational Flexibility**

- Flexible: separate propulsion and cargo units enable ongoing deliveries and “swap and drop” options for customers
- “Hub & Spoke” Distribution from any terminal / liquefaction location
Conclusions

- Markets for LNG are growing
- Environmental and Economic drivers favorable to NG
- Challenges remain to establish reliable supply chain
- Markets / customers will expand rapidly once distribution infrastructure is established
- Unique, scalable distribution methods needed now

Maersk-Argent has a well-designed, well-developed solution
Thank You

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