Drivers to Promote use of LNG as Fuel
Historic Vessel Power Transitions

- Sail to Coal
- Coal to Oil
- Oil to Gas
Advantages of LNG Fuel

- Environmental advantages (SOx, NOx, particulates)
- Regulatory drivers (fuel oil 0.1% sulfur limit in ECA’s now, and 0.5% elsewhere after Jan. 1, 2020)
- Availability (limited but expanding)
- No longer simply limited point to point
- C Type Tank hold time makes these more schedule friendly.
- Relatively easy to use drones with sensors to verify compliance
- Innovative containment systems
Three Positives (Out of Many) to Consider about CH$_4$

- Abundant supply of shale gas in US (as well as Persian Gulf, Australia, Russia)
- Positive environmental impact compared to traditional fuels
- Relationship with petrochemical industries, driving increased processing of and exports of ‘Y’ grades: Eth, Prop, But, Pent, Hex, Sept., Oct., Nov. and Dec.

© Vasilyev/Shutterstock
Dealing with upcoming regulations

- Recently, IMO voted to have the new sulphur regulations come into effect in 2020. Essentially, within ECA’s 0.01% sulphur fuel is required. Worldwide (not in specific ECA), 0.05% sulphur.

- Sulphur removal sounds great until you realize what it does to lubricity, energy content and the challenges of supply.

- ABS has just released guidance on complying with these new regulations.
Safety Aspects of LNG as a Marine Fuel

• Let’s face it, if not for the embrittlement of normal steel, we’d have leapt into using LNG as fuel long ago

• Vacuum insulated tanks. We’ve seen photos of truck and ISO container LNG containers. I brought a smaller version known as the standard thermos. Why does it work so well?, vacuum insulated. Does anyone recall having broken their thermos? Glass shatters with a whoomph, you’re back to PB&J

• Holding up an Aladdin thermos bottle, “here’s your LNG tank!”

• One need only see an LNG demonstration to realize that it is being used right next to you in many instances.
Commercial Operations using LNG as Fuel
TOTE’s ‘Isla Bella’ under construction
LNG Storage Tanks on Vessels

IMO Classification of LNG Vessels

**Independent Tanks**
- **Type A**
  - $p < 700$ mbar
  - Full secondary barrier
- **Type B**
  - $p < 700$ mbar
  - Partial Secondary barrier
- **Type C**
  - $p > 2000$ mbar
  - No Secondary barrier

**Integrated tanks**
- **Membrane Tanks**
  - $p < 700$ mbar
  - Full secondary barrier

**Spherical (Moss)**
- **Prismatic (IHI SPB)**
- **Cylindrical**
- **Bilobe**
- **GTT No 96**
- **GTT Mark III**
- **GTT CS1**

Sources: Moss Maritime, IHI, TGE, GTT
Use of Membrane Tank for LNG as Fuel Supply

• UNDER CONSTRUCTION – first LNG Barge in North America – WesPac and Conrad Shipyard
• ABS Class – delivery in Q2 2017
Use of Type C tanks on Towing Vessels
‘Necessity is the Mother of Invention’

- Small scale necessity is driving the innovation we need
- FSRU’s that can not only deliver gas to power plants on one side but liquid fuel for small scale solutions on the other
- Smaller carriers, e.g. 10 ~ 12k CBM multigas vessels capable of transporting LNG
- Increasing FSRU capability by mooring LNG next to LNGC to increase offered capacity
Approval in Principle: LNG Vessels

• The AIP process gives companies that are introducing new technologies or concepts recognition by an independent party that attests to the acceptability of the concept at that stage of development. This in turn can be used as part of their funding strategy

• While classification societies do not own, design, or operate floating assets, they play a role as a verifier in the process of developing and building the units

• As a verification agency, ABS is often involved at the front end of concept development providing third-party review of new or novel design concepts

• ABS’s role in granting an AIP is acknowledgement that a proposed concept or design complies with the intent of ABS rules and / or appropriate codes
ABS Focused Initiatives in the US
ABS 2\textsuperscript{nd} Edition NA LNG Bunkering Study for NA

- Provides Guidance for:
  - Gas fuelled vessel operators
  - Bunker vessel operators
  - Bunkering facilities operator

- Includes:
  - Regulatory roadmap in North America
  - Risk assessment templates
  - Guidance on training competencies
  - Database of state and local agencies
  - Database of port stakeholders

- Second Edition
  - Port directory and survey
  - Project guide
  - Lessons learned from early adopters
ABS LNG Bunkering Advisory

- Key characteristics impacting tank capacity
- Vessel compatibility
- Operational issues for supplier and receiver
- Monitoring and controlling of LNG
- Bunkering operation
- Custody transfer
Cost Benefit Analysis for implementation

- Fleet profile
  - Operational profiles, time spent in an ECA, speed, draught etc.
- CAPEX for LNG adoption
- OPEX for LNG price sensitivity vs HFO MDO option vs Scrubber
- LNG availability
  - Source, liquefaction, distribution
  - Infrastructure – export facility, bunkering vessels, tank trucks, etc.
- Price spread of LNG and other alternative fuels
- LNG fuel system maintenance costs

<table>
<thead>
<tr>
<th>CAPEX</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel consumption (ton/day)</td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>Total CAPEX ($)</td>
<td>5M</td>
<td>11M</td>
</tr>
<tr>
<td>Equipment</td>
<td>40% of the CAPEX</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPEX</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance and repair</td>
<td>3% of equipment cost</td>
</tr>
<tr>
<td>Additional fuel consumption due to installation of scrubber</td>
<td>0.5%</td>
</tr>
<tr>
<td>Fuel cost</td>
<td>Fuel price x Consumption x Utilization factor</td>
</tr>
</tbody>
</table>
LNG Fuel Ready Vessels updated Jan 2017

- Class criteria for preparing vessels to use LNG as marine fuel
- The ABS Guide for LNG Ready Vessels provides guidance to shipowners and shipbuilders preparing a ship design to be ready for using LNG as a fuel
- The ABS Guide defines 3 ‘LNG Fuel Ready Levels’:
  - Level 1 – Concept Design Review
  - Level 2 – General Design Review
  - Level 3 – Detail Design Approval and Installation
LNG Fuel Ready Level 1: Approval In Principle

- Record Statement indicate on Class Certificate
- High level evaluation of the geometry and structural arrangements of the vessel
- General scope of review:
  - Safety concept
  - General arrangement
  - Hazardous area plan
  - LNG fuel containment type, location arrangement
  - BOG management
  - Fuel gas supply system and piping arrangements
  - Bunkering arrangements
  - Vent mast and venting systems
  - Preliminary Trim & Stability
LNG Fuel Ready Level 2: General Design Review

- Record Statement indicate on Class Certificate
- Additional to Level 1 and categorized in separate groups
- Design details ‘general’ except specific gas consumers included
- The subgroups of Level 2 are:
  - Hull structural reinforcement for LNG storage tank
  - LNG fuel storage tank arrangements
  - Fuel gas bunkering system and arrangement
  - Fuel gas supply system
  - Gas vapor handling system
  - Gas consumers

<table>
<thead>
<tr>
<th>System/Component</th>
<th>Descriptive Letter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull structural reinforcement for LNG storage tank</td>
<td>S</td>
</tr>
<tr>
<td>LNG fuel storage tank structure</td>
<td>TS</td>
</tr>
<tr>
<td>LNG fuel storage tank arrangements</td>
<td>TA</td>
</tr>
<tr>
<td>Fuel gas bunkering system and arrangement</td>
<td>BK</td>
</tr>
<tr>
<td>Fuel gas supply system</td>
<td>GS</td>
</tr>
<tr>
<td>Gas vapor handling system</td>
<td>BH</td>
</tr>
<tr>
<td>Gas Consumers</td>
<td></td>
</tr>
<tr>
<td>Main engines</td>
<td>ME</td>
</tr>
<tr>
<td>Auxiliary engines</td>
<td>AE</td>
</tr>
<tr>
<td>Gas turbines</td>
<td>GT</td>
</tr>
<tr>
<td>Main or Auxiliary boilers</td>
<td>B</td>
</tr>
</tbody>
</table>
LNG Fuel Ready Level 3: Detail Design Approval & Installation

- Class notation **LNG Ready** with one or any combinations of statement description: S, TS, TA, BK, GS, VH, & M
- Incorporates both the Class Approval of the detailed drawings and the installation of specified equipment on board the ship
- Drawings to be in compliance with the relevant sections of the ABS Gas Fueled Ships Guide
- To be performed in combination with Level 2 or straight after Level 1
- Survey
  - Vendor
  - Ship Installation
  - After Construction
Your Qualified Project Partners

Upon satisfactory completion of each review level, ABS will provide:

Level 1 – Approval In Principle (AIP) for the concept design and a statement in the ABS Record

Level 2 – Statement of Compliance review and a statement in the ABS Record

Level 3 – Class Notation LNG Ready with description note(s)
US Coast Guard has recognized ABS for Unparalleled Support and Leadership in US Gas Development

- Successfully supported project designers to obtain US Coast Guard Design Basis Approval for US flag vessels
- Collaborated with US Coast Guard on behalf of non-US flag vessel owners to develop regulatory compliance roadmap for new projects calling US ports
- Performed risk assessments to fully comply with the US Coast Guard policy letters and IGF Code
- Provided training to the US Coast Guard marine inspectors to improve collaboration
Importance of Selecting your Partners

• You project is important
• You need partners who understand your operations, your needs and want to work together to find a solution. To question “In what sense can there be a winner and a loser in a long term relationship?” pretty much defines it all
  - Find servicing companies who work to your schedule
  - Select class society who has engineers, surveyors and project managers who understand your commercial pressures and will work with your to come up with innovative solutions to help keep you operating and bringing in revenue
  - Choose suppliers who are offering a quality product that will last with your vessel and not just today’s quick fix
The ABS Advantage

- 2017: Guidance on Complying with Global Sulphur Cap on Marine Fuel
- Thorough Understanding of requirements for US and non-US Flag vessels
- Global Gas Solutions: A dedicated team of specialists to support clients
- Dedicated Communication channels with Environmental Protection Agency (EPA) and the United States Coast Guard (USCG)
Global Gas Solutions – Dedicated Support

• Scope of Services
  - Team of specialists focused on technical and operational guidance and support to clients
    • Specification review
    • Risk assessment
    • Novel concept studies
  - Regulatory Services
    • Rules and Regulations Matrix to assist clients on specific projects to establish regulatory framework
    • Facilitate discussions between clients and regulators
  - Cost Benefit Analysis
ABS Group – Technical Services

• Scope of Services
  - Team of Specialists focused on technical and operational guidance and support to clients
    • Site Assessments
    • Port Feasibility Studies
    • Traffic / Impact Studies
    • Jetty Designs / Mooring Analysis
    • Risk Assessments
  - Contact: Mark McNiel at 281-673-2741 or mmcniel@absconsulting.com
Thank You

www.eagle.org