IMO 2020 Global Fuel Standards Update

Margaret Kaigh Doyle
The IMO 2020 requires ship owners to decide whether to:

- Continue using high sulfur fuel oil and add scrubbers/exhaust gas cleaning systems
- Switch to low sulfur fuel options i.e. distillates or MGO
- Switch to LNG - Tighter emissions standards are acting as a tailwind for LNG-fueled vessels.
## COMPLIANCE OPTIONS

<table>
<thead>
<tr>
<th>LNG</th>
<th>SCRUBBERS + HFO</th>
<th>MGO</th>
</tr>
</thead>
<tbody>
<tr>
<td>❖ Low OPEX</td>
<td>❖ Low CAPEX</td>
<td>❖ Zero CAPEX</td>
</tr>
<tr>
<td>❖ Meets NOX, Particulate and Tier III Engine Requirements</td>
<td>❖ Easier Transition</td>
<td>❖ Easiest Transition</td>
</tr>
<tr>
<td>❖ Infrastructure</td>
<td>❖ Technical Challenges</td>
<td>❖ Tier II Compliance Issues</td>
</tr>
<tr>
<td>❖ High CAPEX</td>
<td>❖ HFO Scarcity</td>
<td>❖ Fuel Availability</td>
</tr>
<tr>
<td>❖ Increased Containment</td>
<td>❖ Effluent for Closed Systems</td>
<td>❖ High OPEX ($$)</td>
</tr>
</tbody>
</table>

- LNG: Low OPEX, Meets NOX, Particulate and Tier III Engine Requirements, Infrastructure, High CAPEX, Increased Containment
- SCRUBBERS + HFO: Low CAPEX, Easier Transition, Technical Challenges, HFO Scarcity, Effluent for Closed Systems
- MGO: Zero CAPEX, Easiest Transition, Tier II Compliance Issues, Fuel Availability, High OPEX ($$)
CLOSED LOOP SCRUBBER SYSTEM

Uses fresh water treated with a chemical (usually sodium hydroxide) instead of seawater as the scrubbing media. The SOX from the exhaust gas stream is converted into sodium sulphate. Before being re-circulated for use, the wash water from a closed loop scrubber system is passed through a process tank where it is cleaned.
OPEN LOOP SCRUBBER SYSTEM

This system uses seawater as the scrubbing and neutralizing medium, no other chemicals are required for desulfurization of gasses. The exhaust stream from the engine or boiler passes into the scrubber and is treated with only alkaline seawater only. The volume of this seawater depends upon the size of the engine and its power output.
IMPLEMENTATION ISSUES EARLY ON

"It's the Wild West': Greek shipping executives say IMO 2020 start is worse than it appears

Fuel switchover troubles are brewing just beneath the surface, industry bosses tell conference in Greece

By Harry Papanastasiou in Athens

MANY PORTS HAVE BANNED OPEN LOOP SCRUBBER EFFLUENT
The Cost of LNG Supply in the US is Very Competitive...

- Increased natural gas production in the U.S. has put significant downward pressure on natural gas pricing, pushing prices to the lowest levels in 20 years.
- April to September Henry Hub natural gas futures averaged $2.41/MMBtu.
- U.S. LNG export market is also dependent on international LNG market pricing and crude oil pricing, which impacts mid- to small-scale LNG cost.

Source: RBN Energy, October 2019.

Note: Confidence interval derived from options market information for the five trading days ending Oct 3, 2019. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Sources: Short-Term Energy Outlook, October 2019, and CME Group.
North America slow to react to changing global marine fuel market.
LNG BUNKERING - MULTIPLE SUPPLY PATHS AVAILABLE

Supply Point

- Liquefaction
- LNG Trucking
- LNG Rail
- LNG Barge

Bunkering Port

- Storage
- Bunkering Vessel
- Ship to Ship
- Shore to Ship
- Rail/Truck to Ship
STS is Primary Method of Fuel Supply in USEC

Current Methods of Supply

- Almost all bunkering on the USEC is done via ship-to-ship transfer ("STS")
- Vane Brothers dominates the USEC bunker supply market, providing STS bunkering in 7 locations from New York to Jacksonville
- Global operates bunkering facilities in Portland, Boston, Providence, Philadelphia and Baltimore delivering by barge, tank truck or to a dockside facility
- Port Canaveral has land-based storage facilities with bunkering services via pipeline, truck delivery and barge to the cruise terminal, tanker berth and cargo piers
- One of the project deliverables was to evaluate LNG barge navigation constraints. In discussion with harbor pilots in the targeted ports the feedback we received was that it is too soon to assess constraints until the fleet expands and there is more experience with these types of movements

Snapshot of Current / On Order LNG-Fueled Fleet in the USEC through 2023

<table>
<thead>
<tr>
<th>Vessel Type</th>
<th>Operator</th>
<th>Vessel Size</th>
<th># LNG Tanks</th>
<th>Tank Capacity</th>
<th>Total LNG Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cruise Ship</td>
<td>Royal Caribbean</td>
<td>200,000 GT</td>
<td>Two</td>
<td>2200 CBM</td>
<td>4400 CBM</td>
</tr>
<tr>
<td>Cruise Ship</td>
<td>Carnival</td>
<td>180,000 GT</td>
<td>Three</td>
<td>1100 CBM</td>
<td>3600 CBM</td>
</tr>
<tr>
<td>Cruise Ship</td>
<td>Disney Cruise Lines</td>
<td>144,000 GT</td>
<td>Three</td>
<td>1050 CBM</td>
<td>2100 CBM</td>
</tr>
<tr>
<td>Containership</td>
<td>TOTE Maritime</td>
<td>36,750 GT</td>
<td>Two</td>
<td>902 CBM</td>
<td>1804 CBM</td>
</tr>
<tr>
<td>Container/RoRo</td>
<td>Crowley Maritime</td>
<td>26,410 DWT</td>
<td>Three</td>
<td>600-720 CBM</td>
<td>2100 CBM</td>
</tr>
<tr>
<td>Asphalt Tanker</td>
<td>Desgagnes Group</td>
<td>15,000 DWT</td>
<td>Two</td>
<td>300 CBM</td>
<td>600 CBM</td>
</tr>
</tbody>
</table>

Accommodating these volumes will require an LNG barge or LNG supply on the waterfront, as truck fueling would be time and cost-prohibitive

Source: Industry Sources, Congressional Research Service report on LNG as a Maritime Fuel: Prospects and Policy, February 5, 2019
Complicated Logistics to Deliver LNG to a Vessel

- **By Barge:** Almost all bunkering on the USEC is done via ship-to-ship transfer (“STS”), requiring the use of barges. Recently built US-Flag LNG bunkering barges include the *Clean Jacksonville* and *Q-LNG 4000*

- **By Rail:** Restricted to ISO-containers, currently in limited volumes & restricted to special approvals (Florida, Alaska). Trump Administration seeking to move LNG by rail in approved (DOT 113) tank cars by mid-2020, which would still require the construction of a fleet of LNG tank cars

- **By Truck:** MC338 Tank Trailer or ISO-Containers

- **By Pipeline:** Most economical mode of transport if pipeline capacity is available, and infrastructure needs to be developed for “last-mile” delivery.
IMO GHG REDUCTION TARGETS

- 2030 - At least a 40% reduction in carbon intensity by 2030 and pursuing efforts towards a 70% reduction by 2050, both compared to 2008 levels.

- 2050 - Reduce them by at least 50% by 2050 compared to 2008 levels while pursuing efforts towards phasing them out consistent with the Paris Agreement temperature goals.
SEA\LNG and SGMF (GHG) EMISSIONS LIFECYCLE RESEARCH STUDY

- SEA\LNG and SGMF commissioned a Well-to-Wake (WtW) Greenhouse Gas (GHG) Emissions Lifecycle Research Study on the use of LNG as a marine fuel.

- This study was conducted by independent consultants and reviewed by a panel of academic experts.

- It is considered the most accurate study of the life cycle GHG emissions and local pollutants from LNG as a marine fuel compared with current and post-2020 conventional marine fuels because of its WtW parameters.
IMO 2030 AND 2050 STRATEGY

- Supporting the development and update of national action plans;
- Encouraging ports to facilitate GHG reductions from shipping;
- Initiating and coordinating R&D activities by establishing an International Maritime Research Board (IMRB);
- Pursuing zero-carbon or fossil-free fuels for the shipping sector and developing robust lifecycle GHG/carbon intensity guidelines for alternative fuels;
- Undertaking additional GHG emission studies to inform policy decisions and to estimate Marginal Abatement Cost Curves for each measure (if appropriate)
- Encouraging technical cooperation and capacity-building activities, as appropriate.
About Eagle LNG

*Our vision is to create a safe, economic and cleaner energy future through leadership and key partnerships in clean fueling solutions.*

Supplying fuel in ISOs for off-grid power generation in Puerto Rico/Alaska/Yukon.

FERC-regulated LNG export facility in Jacksonville to supply fuel for Caribbean island gas-fired generation.

Fuel two LNG powered Jones Act ConRo ships in Jacksonville-Puerto Rico service.

Maxville LNG Facility and Talleyrand Fuel Station in service Q1 2018.

Key vendor and technical advisor on LNG locomotive engine pilot programs for CN Railway in Western Canada and BNSF on Chicago-Barstow mainline service.

The Energy & Minerals Group (EMG) is a private investment firm with over $15 billion under management.
Eagle’s facilities in Florida are strategically located near abundant gas supply, interstate pipelines, transportation hubs and a community wanting to use LNG to improve air quality.

Eagle LNG’s Florida Projects

MAXVILLE LNG FACILITY
In-Service Q1 2018

TALLEYRAND STATION
In-Service Q2 2018

JACKSONVILLE LNG FACILITY
FERC-approved; EPC awarded
Maxville LNG – LNG for Bunkering

MAXVILLE LIQUEFACTION FACILITY
In service: Q1 2018
Initial Liquefaction: 87,000 GPD (330 m^3/d)
Max Liquefaction: 200,000 GPD (760 m^3/d)
Storage Size: 1,000,000 Gallons (3,800 m^3)
100 construction jobs and 8 full-time positions (plant and depot)
Talleyrand LNG Bunker Station

- In service: Q2-2018
- Innovative design for small 2-acre footprint
- 24-months from kick-off to first bunkering
- Storage: 528,000 LNG gallons (2 x 1,000m³ tanks)
- Load Out Rate: 2,400 gpm (540m³/hr)
- Below-grade bunkering lines
- Refill by trailer delivery (56 loads)
Talleyrand – Shore-to-Ship Bunkering
JACKSONVILLE LNG FACILITY – FERC-Approved; Matrix/Chart selected

Liquefaction: 550,000 GPD/train, 1,650,000 GPD (6,245 m³/d) at full production
Storage Size: 12,000,000 Gallons (45,420 m³)
Thank you for having me AAPA!

Margaret Kaigh Doyle
margaretdoyle@eaglelng.com
508-889-7747