Construction of World’s First GTT NO96 L03+ Low BOR LNG Carriers in China

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General Manager
GTT China
More than 50 years of history, Inventor of membrane systems

Around 350 LNG Carriers equipped with our Technologies

350 people dedicated to the development, engineering and industrialization

25 % of our workforces dedicated to innovation
Yamal LNG: Russian gas to Asia through shipping

- JSC Yamal LNG JV:
  - NOVATEK (50.1%)
  - TOTAL (20%)
  - CNPC (20%)
  - Silk Road Fund (9.9%)

- One of the largest oil and gas producing provinces in the world
- Export LNG plant located in Sabetta
- 4 trains of 17.4 MTPA, mainly for Asian LNG demand
- CNPC will take delivery of ~3 MTPA on train 2
Yamal LNG: Russian gas to Asia through shipping

- Between July and Nov: Summer route
- Winter Route: Trans-shipment in Europe
- LNG carrier fleet:
  - 15 custom-designed ARC7 ice-class vessels
  - 11 conventional LNG vessels, including 4 ships made by HZ in Shanghai

- Main infos:
  - Ship-owner: MOL/COSCO Shipping
  - Capacity: 174,000m³
  - Engines: XDF slow speed dual fuel
  - Tank feature: GTT’s NO96 L03+
  - Class: LR + CCS
LNG carrier BOR: A key competitiveness parameter

LNGC delivered in China so far: NO96 (0.15% BOR)

Yamal LNG Carrier: NO 96 L03+ (0.10% BOR)

**Main assumptions:**
- Operating days/year: 345
- Average speed: 16.5 knots laden, 15.4 knots ballast
- Route distance: 10,800 NM
- LNG price: $10/mmbtu
- Discount rate: 8% (for net present value calculation)

**Savings:**
- ~$100M net present value for a 20 years period
- For one vessel, ~$1,3M savings per year.
NO96 L03+ : An improvement of the 3 layers concept

- Two conventional INVAR ® membranes
  - Primary membrane
    - 0.7 mm thick
  - Secondary membrane
    - 0.7 mm thick

- Primary Insulation conventional
  NO boxes filled with Glass Wool

- NO96 couplers

- New Secondary Insulation

- Mastic ropes for leveling
NO96 L03+ : World’s first made in China

- First application of L03+
- Reduction by 1/3 of the BOR compared to previous LNG carrier made in China
- First application of local supply chain Foam panel

<table>
<thead>
<tr>
<th></th>
<th>NO96</th>
<th>NO96 GW</th>
<th>NO96 L03</th>
<th>NO96 L03+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nbr of vessels at sea and under construction</td>
<td>140</td>
<td>85</td>
<td>15</td>
<td>4</td>
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<tr>
<td>BOR (*)</td>
<td>0.15%</td>
<td>0.125%</td>
<td>0.11%</td>
<td>0.10%</td>
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<tr>
<td>Main insulating material</td>
<td>Perlite</td>
<td>Glass-wool</td>
<td>Glass-wool and R-PUF 130 kg/m³</td>
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<tr>
<td>Membranes</td>
<td></td>
<td></td>
<td>Invar® 0.7 mm</td>
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<tr>
<td>Support</td>
<td>Boxes with bulkheads: Plywood</td>
<td>Primary Boxes: Plywood</td>
<td>Secondary Boxes: Plywood</td>
<td>Secondary Panels : R-PUF &amp; plywood</td>
</tr>
<tr>
<td>Thickness</td>
<td>530 mm (Primary box: 230 mm + secondary level: 300 mm)</td>
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Local content development

Yoke LNG : Reinforced PU foam and Panel assembly

- Brand new factory for PU foam production and prefabrication line
- Factory already produced foam for FSRU project in Korea
- GTT qualified for R-PUF foam, and L03+. Current Mark III prefabrication panel ongoing
Construction improvements

3 key improvements:
1. Cargo tank hull area to be built in 50 days
2. Ballast tank pressure test at dry dock stage, and CCS erection in dry dock
3. Grand assembly of cargo machinery room

→ 10 months schedule saving compared to first LNG carrier built in this yard
Some photos of the LNG carriers during construction
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Some photos of the LNG carriers during construction
• World’s first NO96 L03+ LNG carriers are being successfully built in HZ Shipyard, Shanghai and due for delivery starting Q4 2019
• NO96 L03+ system offers further reduction in BOG as to 0.1%, savings estimated at ~$1.3m / year per ship compared to previous NO96 ships
• Local supply chain developed and involved to the NO96 L03+ construction: Chinese supplier of the PU-foam for L03+ and soon for Mark III
• The construction progress have been improved based on the NO96 L03+ system
• Total construction schedule have reduced by 10 months compared to first LNG carrier
• Successful implementation of new technology thanks to good cooperation between all the project partners