Selecting the right cargo containment system

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Presentation documents:

Page 2: Carlos Guererro, Bureau Veritas
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Selecting the Right Cargo Containment System

Gas Carriers Webinar Week - Riviera Maritime Media Ltd
Wednesday 17 June

Carlos Guerrero
Global Market Leader Gas Carriers & Tankers
Cargo Containment Systems (CCS) - LNG
Class society early involvement within a concept approval

Well known regulatory framework: IMO IGC & IGF Codes
### CCS - LNG

Selection depends on many aspects

Volume and purpose (cargo, FS(R)U or LNG fuel applications) are key drivers

<table>
<thead>
<tr>
<th></th>
<th>Independent type C</th>
<th>Independent type B</th>
<th>Independent type A</th>
<th>Membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo</td>
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<tr>
<td>FS(R)U</td>
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<td>FS(R)U</td>
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<tr>
<td>Fuel</td>
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</tbody>
</table>

- **Volume efficiency**
- **Technology Maturity**
- **Proven experience**
- **Conversion project**
- **Shipyards installation ability**
- **BOR (linked to tank volume)**
- **Sloshing**

Note: Fuel include LNG fuel ships and LNG bunkering ships (volume considered is maximum 20,000 m³)
CCS - Stats of the Standard LNGc Fleet
LNG carriers over 40,000 m³ including laid-up (as of May 1, 2020)

→ The market demand full flexibility
  ▪ Low BOR (BOG as fuel always considered)
  ▪ Re-liquefaction capacity in line with BOR
  ▪ Operations: Reloads, partial deliveries, STS, etc
  ▪ Specific challenges for LNGc – FSRU projects

→ Technical developments carried out
  ▪ High insulation performance
    ▪ GTT Mark III Flex + and NEXT1
    ▪ Max BOR 0.7% Vol/day laden cond.
  ▪ Specific sloshing studies and reinforcement if needed
  ▪ Other operational solutions
    ▪ Reduced cooling down
    ▪ Solutions for filling limits increase (98% by default)
GTT Membrane
Mark III Flex Technology

→ Increased thickness: 270 mm to 400 mm
   Improved insulation performance

→ Increased foam density: 130 to 210 kg/m³
   - Improved performance against sloshing

→ BOR 0,085% of tank volume/day

→ Evolutions of Mark III
   - Addition of ribs on the corrugations of primary barrier,
   - Wedges under the corrugations of the primary barrier,
   - Mark III Flex + (thickness 480 mm; BOR 0,07%)
CCS - Stats of the Small Scale LNGc Fleet
LNG carriers of 40,000 m³ and below including laid-up (as of May 1, 2020)

→ Market driven by
  - Well proven technology (track record)
  - Increased number of expert shipyards
  - CCS fabrication in parallel to ships construction
  - Relevant ship design offices (i.e. Wartsila, TGE, etc.)
  - Volume efficiency & sloshing is less important

→ Specific applications
  - LNG Bunkering ships
  - Small scale FSRU’s
  - Similar path for LNG fuel ships

<table>
<thead>
<tr>
<th>&quot;Coral Energy&quot; TYPE C</th>
<th>&quot;Aman Bintulu&quot; MARK III</th>
<th>&quot;Sun Arrows&quot; MOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>15,600 m³</td>
<td>18,928 m³</td>
</tr>
<tr>
<td>L.o.a.</td>
<td>155.64 m</td>
<td>130 m</td>
</tr>
<tr>
<td>Beam</td>
<td>22.7 m</td>
<td>25.7 m</td>
</tr>
</tbody>
</table>

On order
- Type C: 15
- GTT Mark III: 2
- MOSS: 2
- GTT NO96: 1
- IHI SPB: 1

CCS Fleet by number of ships

Selecting the Right Cargo Containment System – June 17, 2020
LNGC Containment System Selection – Is it as easy as “A, B, C”?

Chris Clucas, MSc CEng
Liquefied Gas Consultancy Ltd
LNGC Containment System Selection:
A) Cargo capacity, design speed, Boil-off Rate

- Cargo Capacity
- Design Speed
- Lessons of History!
LNGC Containment System Selection: B) Propulsion vs Boil-off Rate

4-stroke vs 2-stroke Diesels?
High-pressure vs Low pressure?
Design service speed?
Sea Margin?
PTO/PTI?
Balance BOG vs Consumption?
BOG reliquefaction? Full/Partial?
Minimise CO₂ emissions

\[ E = \frac{M C^2}{\sqrt{3.95127121}} \]

**Formula**

\[ \text{B.O.R.} = \left( \frac{1}{C_T} \left( V_i d_i - V_d d_2 \right) L + C_p V_i d_i (T_2 - T_1) - \frac{C_i}{d_i L_m} \right) \times 100 \] [%]

with:

\[ C_T = (1 - \alpha_{\text{sr}} (45 - T_{\text{sr}})) \times (1 - \alpha_{\text{sw}} (32 - T_{\text{sw}})) \times (1 - \alpha_{\text{cof}} (5 - T_{\text{cof}})) \]

Correction factor for the external temperature condition
LNGC Containment System Selection:

C) Boil-off Handling Alternatives

- Cargo reliquefaction increases CAPEX, OPEX and Power demand
- Full reliq. offers maximum flexibility – including floating storage
- Partial reliq. offers flexibility at reduced speed – depending on spec.

![Generic Speed vs Consumption curve for an LNGC](image)
LNG as Fuel - Containment System Selection – is not as easy as “A, B, C”!

- New application – much to learn from LNG industry’s 55 year history …
- But also a lot of new considerations
- Tank capacity vs Duration is a critical decision
- Integral (membrane) and Tank Types “A” or “B” offer space advantages compared to Type “C”
- Boil-off rate is absolutely critical
- New LNG handling practices – join SGMF and keep up-to-date!
LNGC Containment System Selection
– Remember your “A, B, C”!

Thank you for your attention

Chris Clucas, MSc CEng
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Selecting the right cargo containment system

Gas Carriers Webinar Week
Wednesday 17 June
Kjetil Sjølie Strand
CEO, LNT Marine
What are the needs of LNG shipping going forward - and how to solve these needs?

- There will be more diversity in capacity to serve new trade routes and terminals
- Partial discharge and sailing with partially loaded tanks will be required
- Ship-to-ship (STS) operations to floating terminals and smaller ships will be required
- Energy efficiency and low carbon footprint

- More shipyards capable of building LNG carriers
- More flexible design and size classes for ships
- Tank systems mitigating sloshing allowing operation with partially loaded tanks
- Lowest possible boil-off rates
- Reasonable CAPEX
Primary barrier:
Self-supporting IMO independent tank type A

Interbarrier space:
Accessible space between tank and insulation

Secondary barrier:
Insulation with liquid tight secondary barrier

Cargo tank support:
Preventing bodily movement of the tank

Our proposition – LNT A-BOX®

An un-insulated IMO independent tank type A in an insulated hold space.
Tank type A offers the simplest design & construction – key features

- Independent tank
- Enabling parallel building activities
- Flexible prismatic shape
- High volume utilization
- Self-supporting tank structure
- Internal structure preventing sloshing
- No filling restrictions
Insulation & secondary barrier – BOR and CAPEX

• For LNT A-BOX®, the insulation system is not exposed to cargo loads and sloshing.

  ![LNT A-BOX®](image)

  ![Membrane systems](image)

• Low density foam for optimized thermal performance, gives low BOR and also low weight and low CAPEX.

• Pre-manufactured PU panels which are secured to the hull with a single stud-bolt in centre.

• A flexible system offering simple installation and reasonable tolerance requirements
LNT A-BOX® is a flexible system suitable for various sizes and applications

45,000m³ LNG carrier

80,000m³ LNG carrier

LNG fuel tanks

174,000m³ LNG carrier
THANK YOU

LNT Marine

www.lntmarine.com