LNT

Enabling Efficient Storage
& Transportation of Energy

# LNT A-BOX®

## Status & Experience So Far

LNT Marine • SIGTTO 65th Panel Meeting, Athens • 30th March 2022

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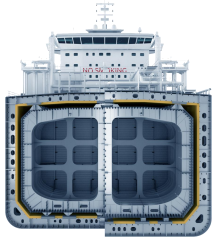
# AGENDA

- LNT Marine in brief
- Background & initial idea
- From concept to reality
- The first newbuilding project
- Operational experience
- Next steps & way forward

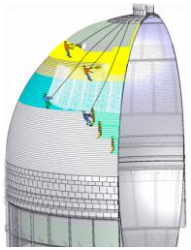
# BUSINESS AREAS & PRODUCTS

LNT A-BOX®



LNT A-BOX® panel insulation system

Spray foam insulation



Moss type repairs

## LNG containment

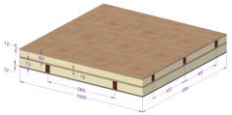

## LNG fuel

## Gas carrier insulation


## Other

Spray foam insulation


Hold space insulation



Insulation panels

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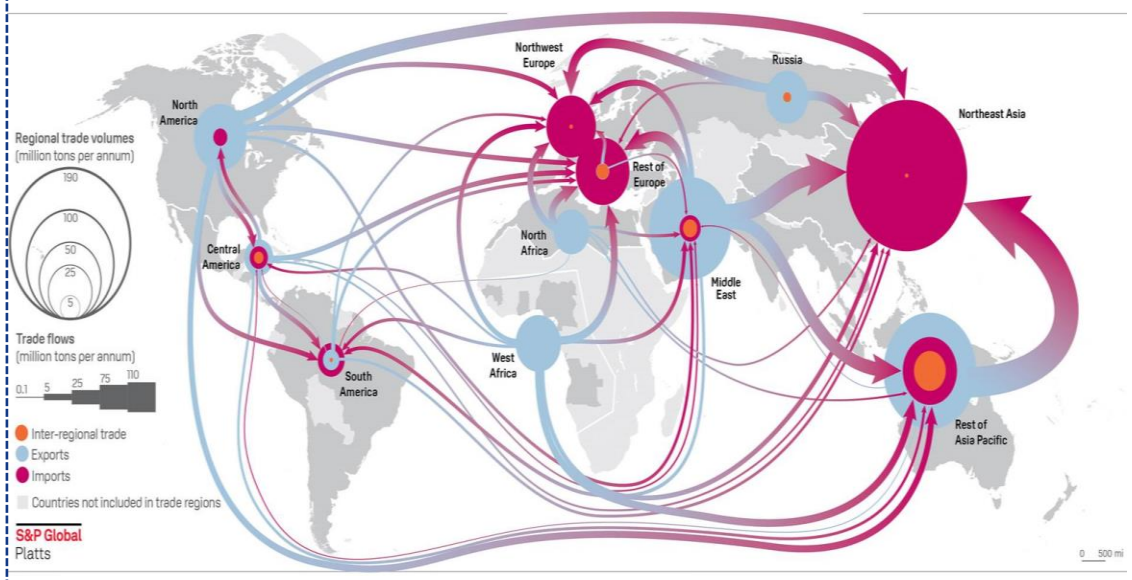
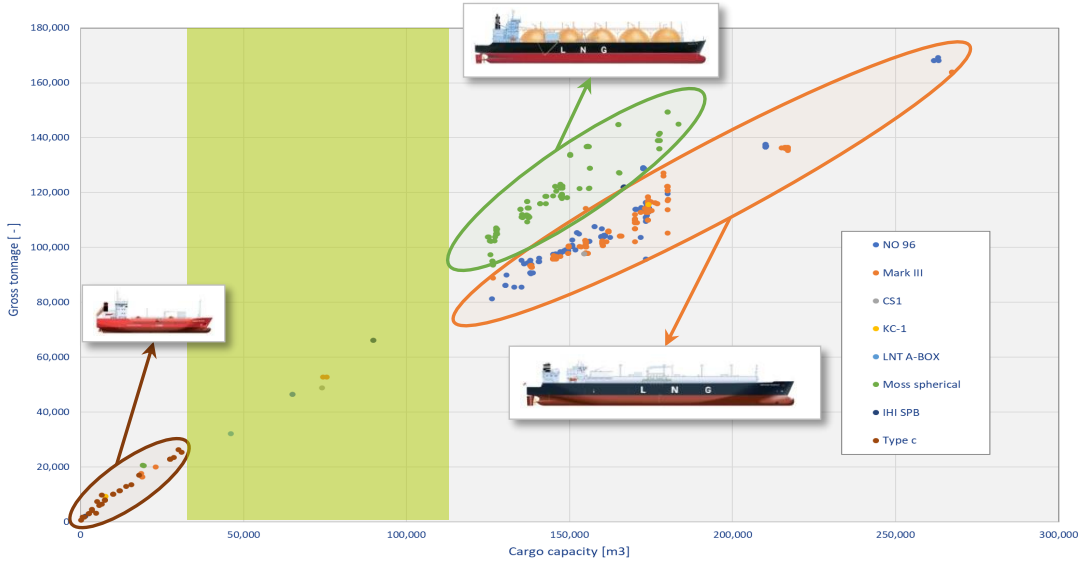
# LNG SHIPPING MARKET

## New LNG trades evolving




- Market development calls for more diversity and flexibility in LNG shipping.
- More local and regional LNG trades evolving and requiring smaller terminals and vessels to be served.
- Costs per energy unit is however very critical, and in order to get economy of scale, cost efficient mid-size LNG ships and terminals are needed.
- There is however limited existing tonnage available to support this emerging market.

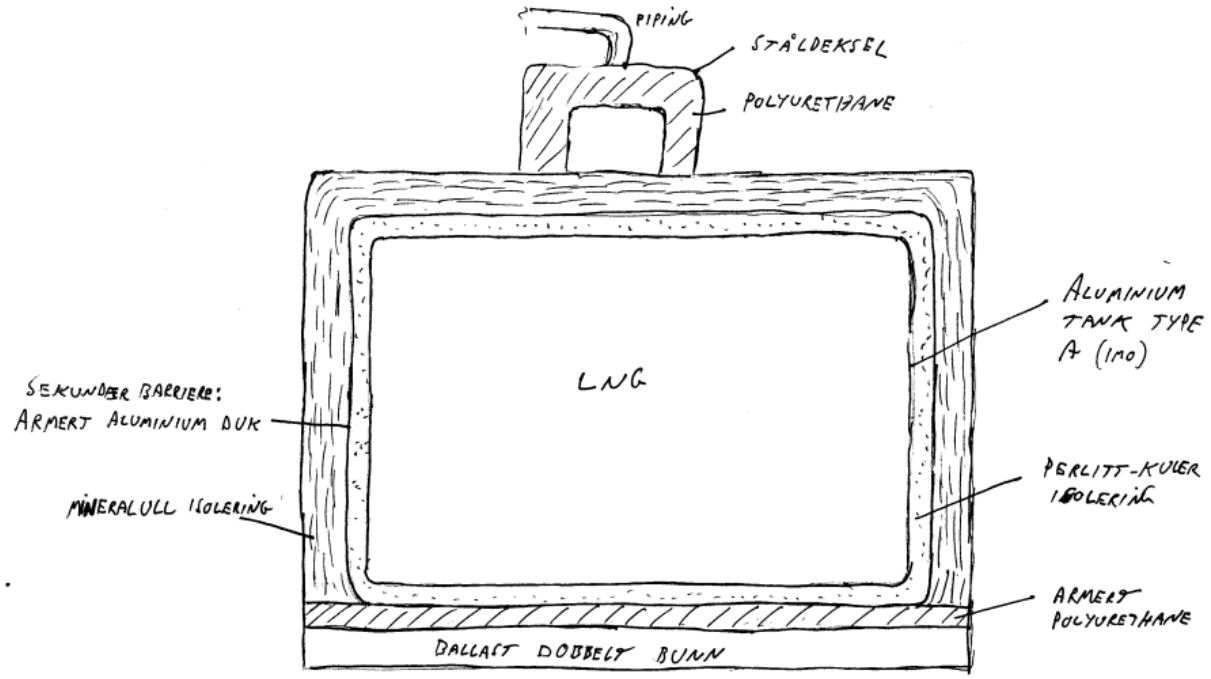
## LNG fleet and cargo containment systems




- Small scale LNG carriers based on type C tanks are proven for the smallest sizes, but not suitable to be scaled-up due to low volume utilization and high weight of the tanks.
- Down-scaling traditional solutions for large scale LNG, such as spherical tanks and membrane systems, on the other hand, had also proven to be costly.
- There seems to be a lack of technologies optimized for the mid-scale segment.

# LNT A-BOX® – THE IDEA

- Develop a simple and efficient cargo containment system for medium to large scale LNG.
- A system that can enable more shipyards to build the LNG carriers.




# LNT A-BOX® CHARACTERISTICS

*An un-insulated IMO independent tank type A in an insulated hold space.*

1. **PRIMARY BARRIER**
   Self-supporting IMO independent tank type A

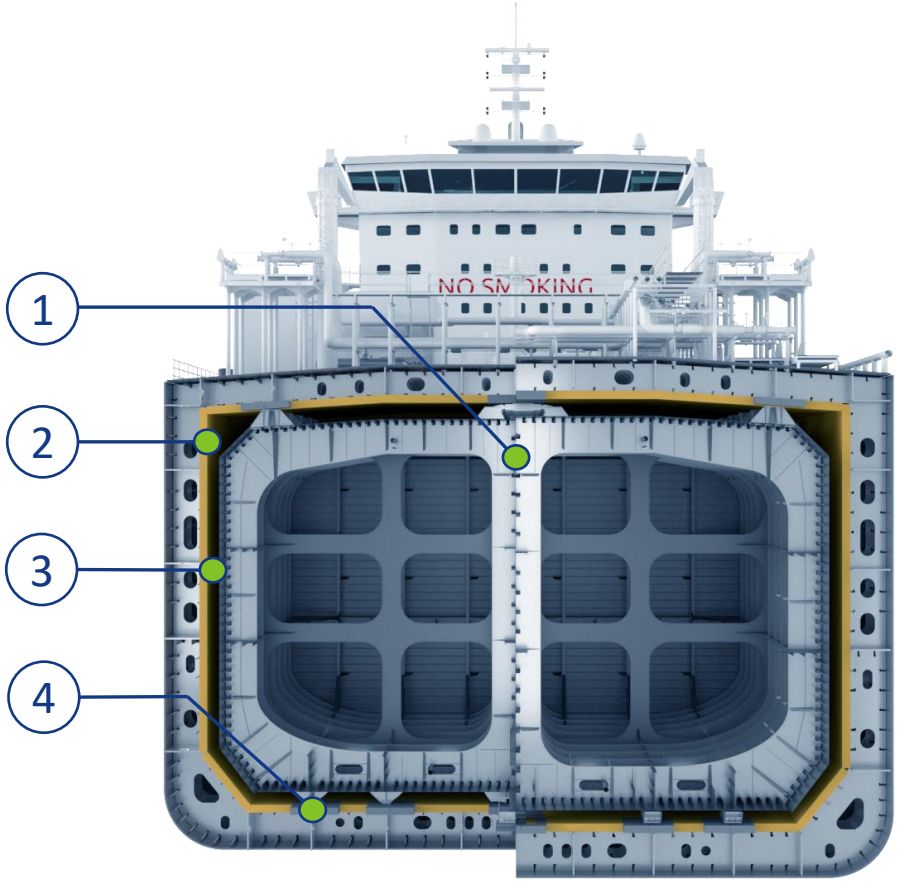
2. **INSULATION & SECONDARY BARRIER**
   Liquid tight insulation system acting as full secondary barrier

3. **INTERBARRIER SPACE**
   Accessible space between tank and insulation

4. **CARGO TANK SUPPORT SYSTEM**
   Preventing bodily movement of the tank

# LNT A-BOX®

**Flexible | Efficient | Robust**




***LNT A-BOX® offers safe and reliable storage and transportation of LNG in bulk.***

LNT

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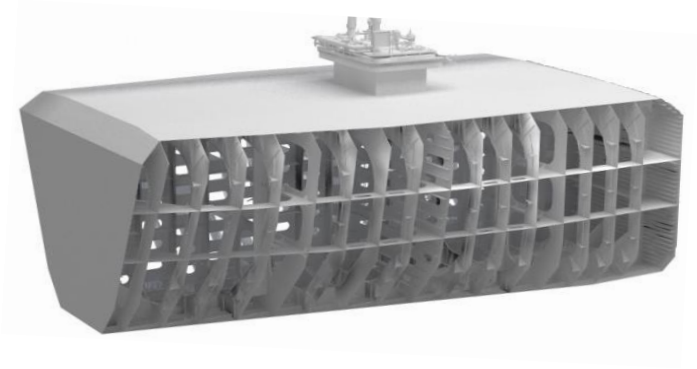
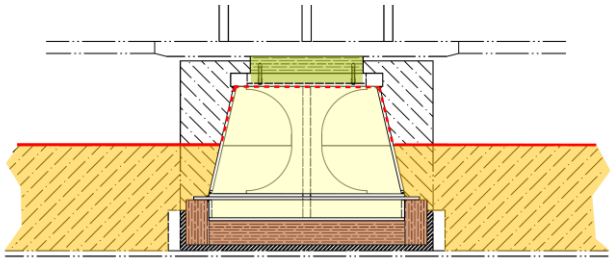
# LNT A-BOX®

System elements and key-characteristics



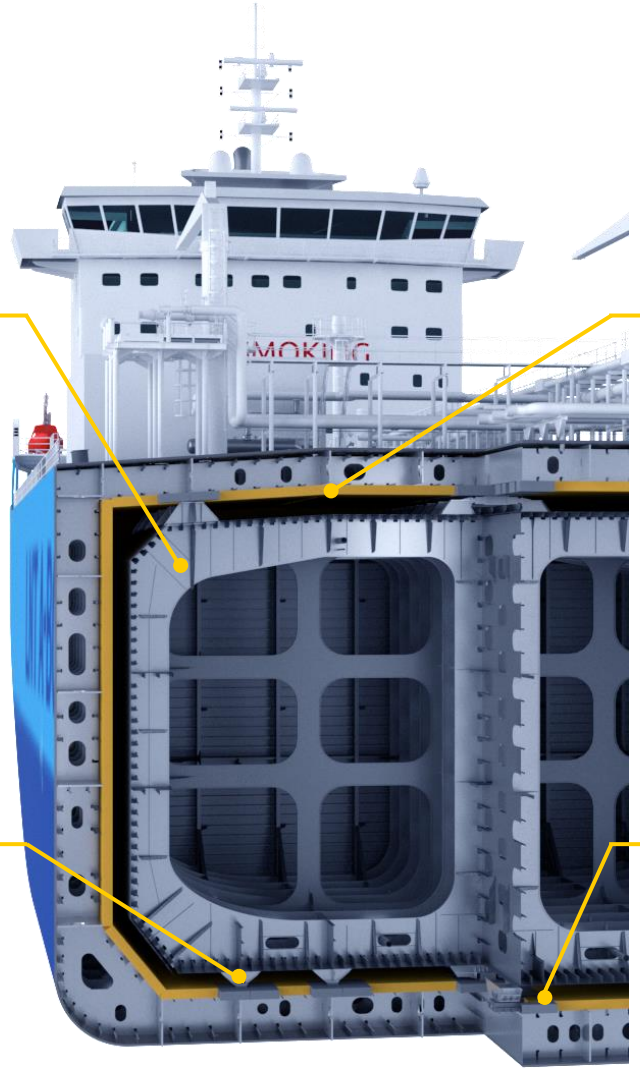
**Cargo tank:**

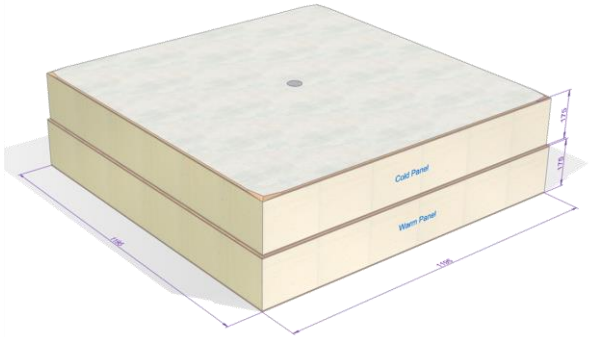
- IMO independent tank type A
- Made from stainless steel, 9% nickel or aluminum



**Tank support system:**

- Thermal break and preventing bodily movement.
- Made from tank material and laminated wood.



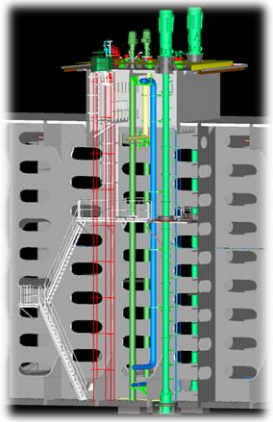


**Insulation & secondary barrier system:**

- Two layers of polyurethane foam panels
- Reinforced aluminum sheet as secondary barrier

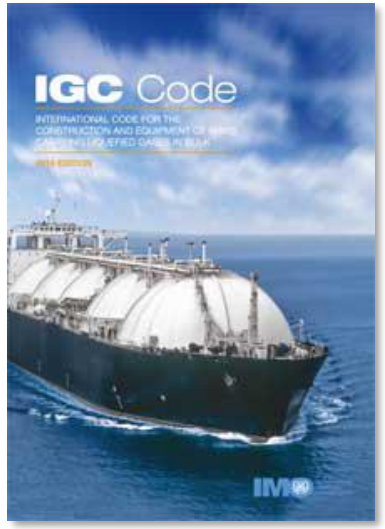
**Safety & auxiliary systems:**

- Arrangement & access
- Atmosphere control (N2)
- Gas detection
- Sounding & alarm
- Bilge systems
- Instrumentation & monitoring

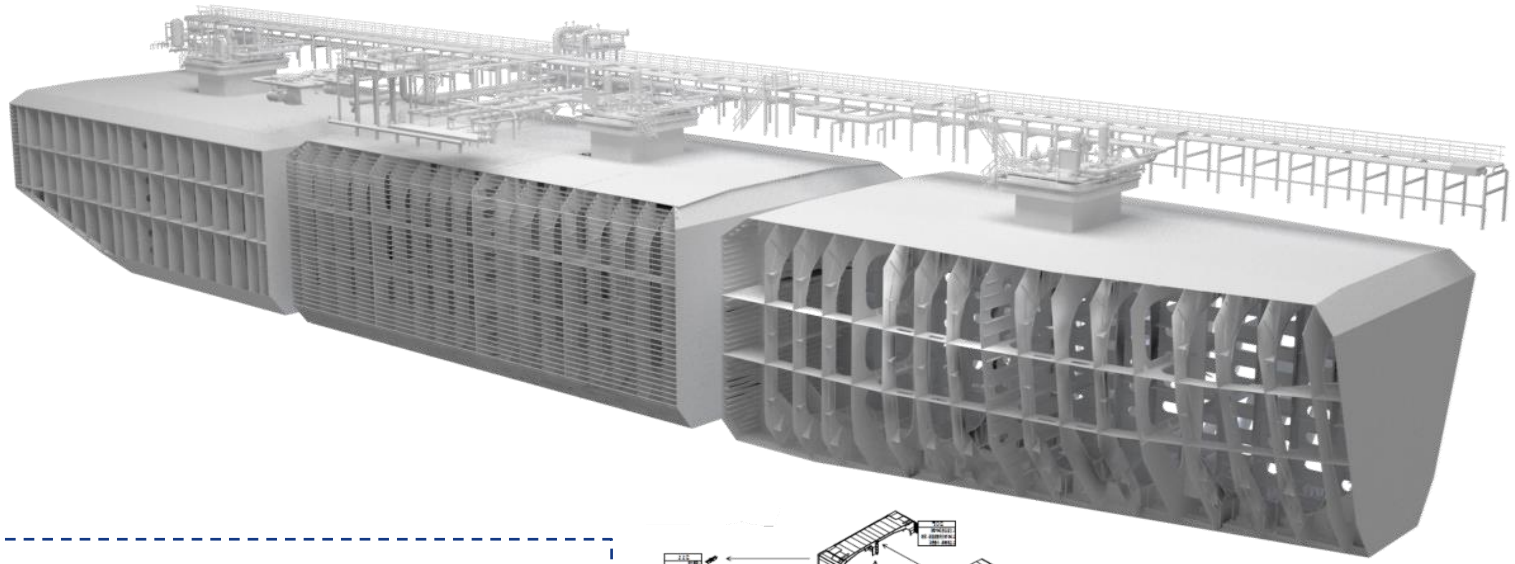


# IMO INDEPENDENT TANK TYPE A

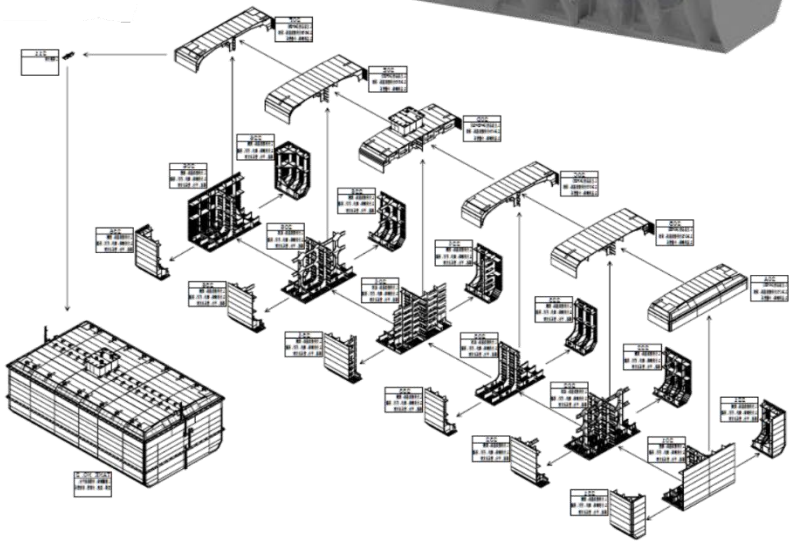
The simplest design according to IMO IGC Code




IMO



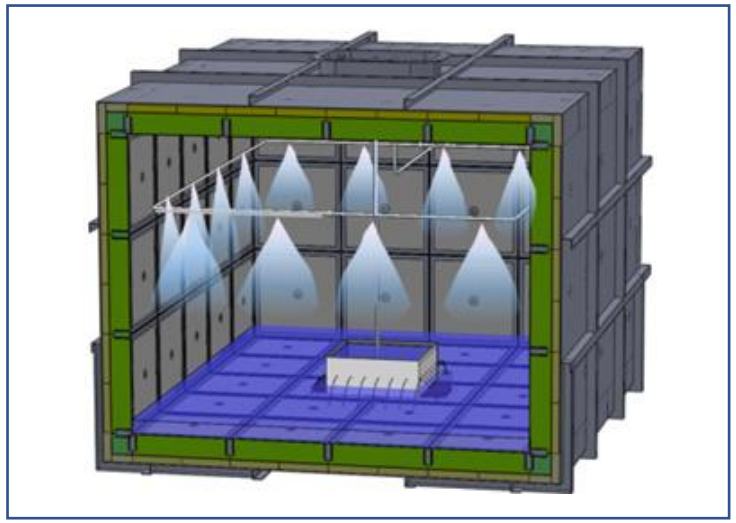
| | |
|---|---|
| **Building friendly** | Type A tanks are constructed primarily of flat surfaces and designed according to classical ship structural procedures |
| **Qualified yards** | Limited infrastructure requirments at building yard |
| **Qualified workers** | Reasonable welding and construction requirements |
| **Flexible** | Type A tanks can be designed and built for various densities, design pressure and material grades |



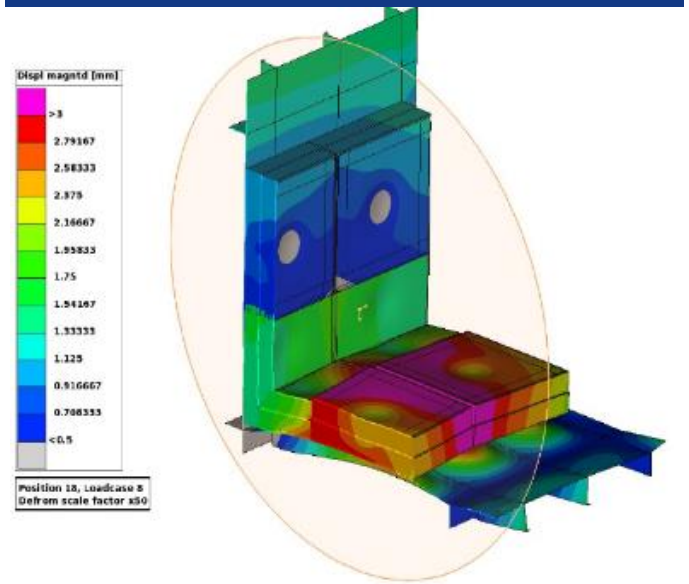
# INSULATION & SECONDARY BARRIER DEVELOPMENT

R&D – Innovation & improvement

- Although the principles are familiar and proven, significant efforts have been put into the development of a simple and flexible system.
- During the years of development extensive test programs have been carried out, including laboratory tests, factory tests and larger mock-up units.



**Theoretical analysis**

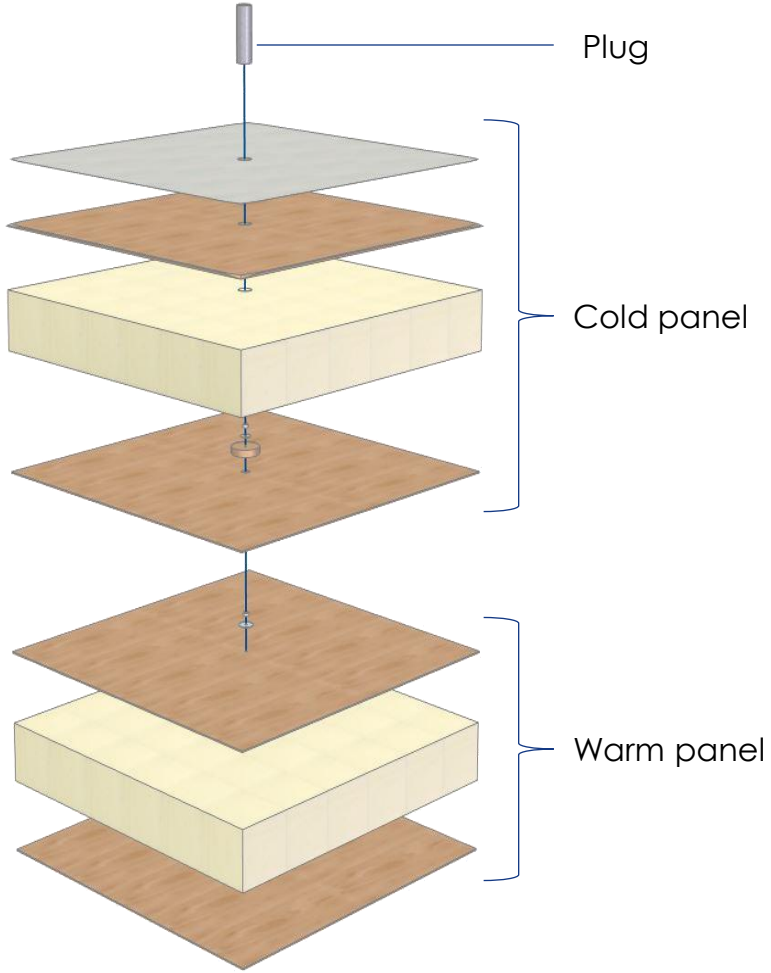


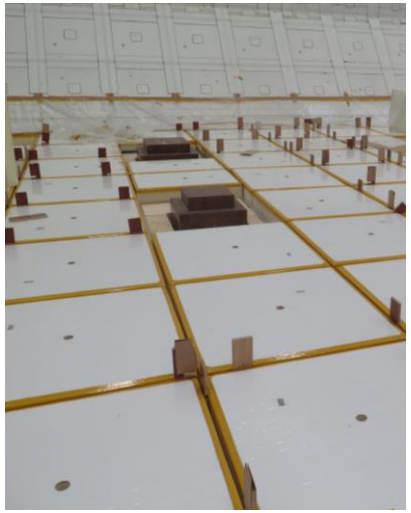

**Practical tests**

# INSULATION & SECONDARY BARRIER

A proven panel system

- **Insulation system with full secondary barrier**
  - Two layers polyurethane (PU) panels with plywood on both sides
  - Panels secured to inner hull plating with stud-bolt and an anchoring system
  - Secondary barrier: Alu foil w/ glass-fiber reinforced mesh clothing, bonded to panel surface
- **Managing movement: Hull deflection and thermal expansion/contraction**
  - Panels are fixed in their center point
  - Flexible joints
- **Density of PU foam**
  - Nominal density 40 kg/m3 (optimal thermal density)
- **Thickness/BOR**
  - 45K: 350mm BOR 0.15%
  - 174K: 400mm BOR 0.07%
  - Flexibility to meet customized BOR demand



- ***The panels are relatively small and light, making the system easy to install and flexible enough to allow for relatively soft tolerance requirements.***

# CLASS APPROVALS

- Approval in Principle (**AiP**) for feasibility and interpretation of regulatory framework.
- First insulation system AiP issued in 2010.
- Complete system AiP process started with DNV in 2012 and certificate issued in 1H 2013.
- Later same process with ABS, BV and CCS

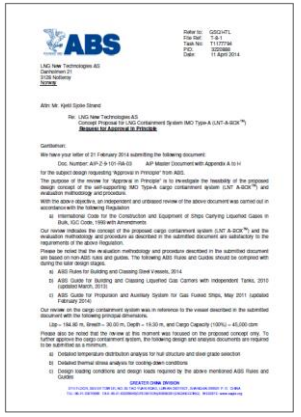
- Class societies have also issued General Approval for Ship Applications (**GASA**), General Design Approvals (**GDA**) for the insulation & secondary barrier system.
- In addition, class has assisted to establish test criteria and witnessed and number of key tests during the course of development.

**Containment Systems**

- **MEMBRANES**
- **INDEPENDENT TANKS**
  - **Type A**
  - **Type B**
  - **Type C**



DNV
DET NORSKE VERITAS
APPROVAL IN PRINCIPLE
LNG Containment System Type-A
LNG New Technologies AS.


ABS


BUREAU VERITAS
APPROVAL IN PRINCIPLE
LNG New Technologies
LNT A-BOX™
LNG containment system


CHINA CLASSIFICATION SOCIETY
CERTIFICATE OF APPROVAL IN PRINCIPLE
LNG New Technologies Pte Ltd.
LNT A-BOX Type A Independent Tank

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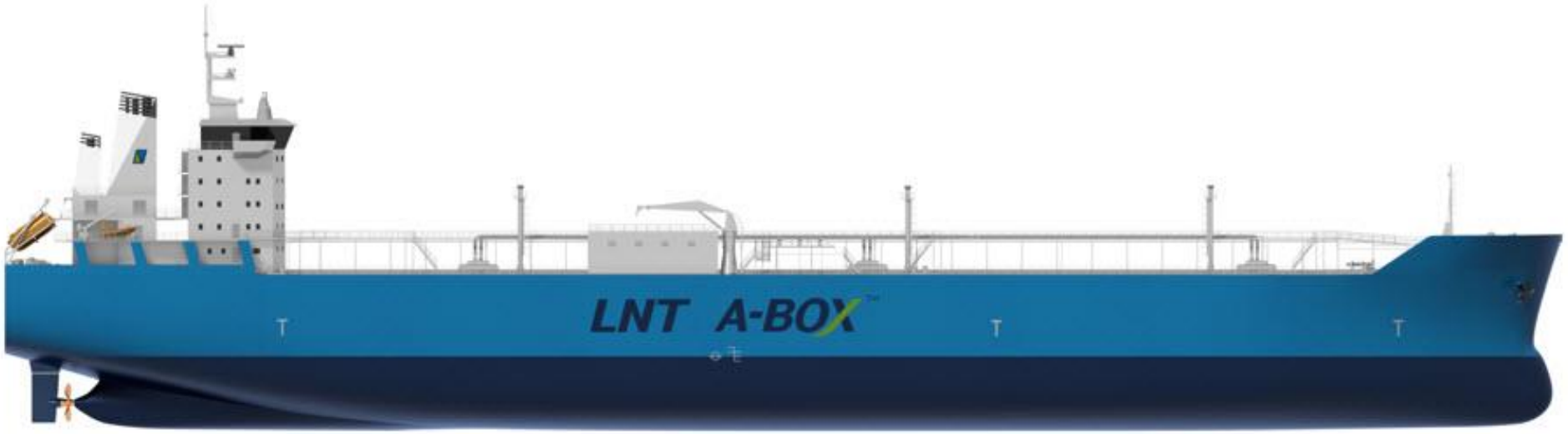
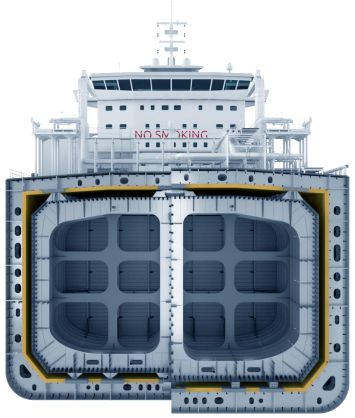
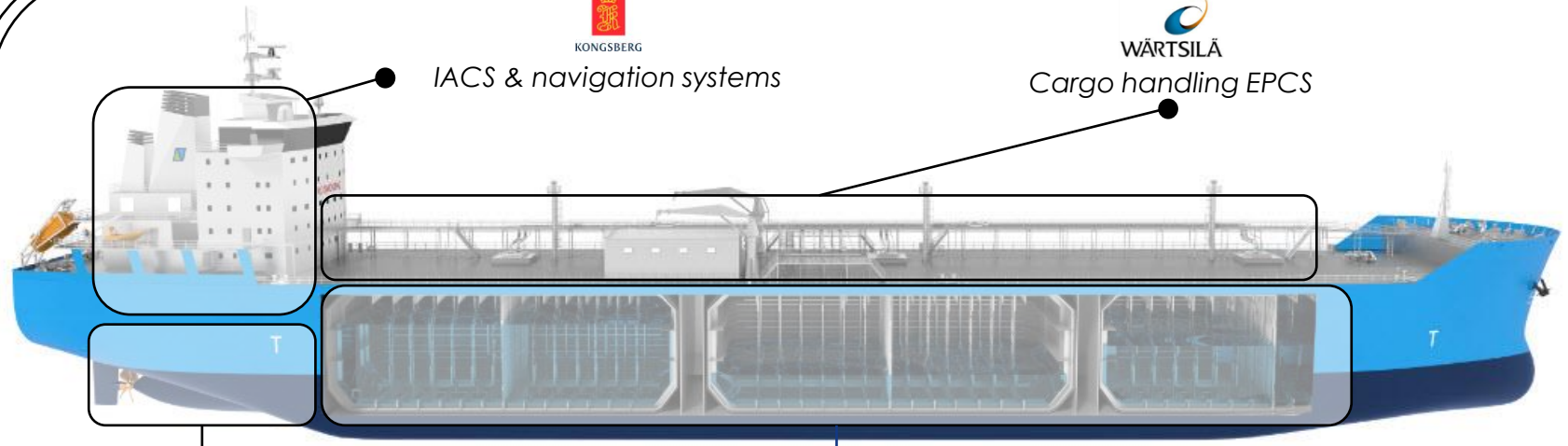
# THE FIRST PROJECT – SAGA DAWN (45,000m3 LNG CARRIER)

*LNT45 – 45,000m3 LNT A-BOX type LNG carrier*

# PROJECT PARTICULARS



KONGSBERG
*IACS & navigation systems*

WÄRTSILÄ
*Cargo handling EPCS*

WÄRTSILÄ
*Machinery & propulsion system*

LNT
LNT A-BOX®
***containment system***

FKAB MARINE DESIGN
*Basic design (ship)*

**China Merchants Heavy Industry (Jiangsu) Co,.Ltd.**
*Turn-key builder of the ship*

**Main Dimensions**

| | |
|---|---|
| Loa | 195.30 m |
| Lpp | 184.80 m |
| Beam | 30.00 m |
| Depth | 20.00 m |
| Design draught | 9.00 m |

**Service Speed**

| | |
|---|---|
| Service speed: | 16.5 knot |

**Machinery & Propulsion**

| | |
|---|---|
| DF main engine: | approx. 11,700 kW |
| Auxiliary engines: | approx. 2,500 kW |

**Cargo System**

| | |
|---|---|
| Containment system: | LNT A-BOX® |
| No. of cargo tanks: | 3 - |
| Total capacity: | 45,000 m3 |
| MARVS: | 0.4 bar g |
| Design density: | 0.6 ton/m3 |
| Min.temp.: | -163 °C |
| BOR: | 0.15 %/day |

# COMPLETE TANK READY FOR INSTALLATION

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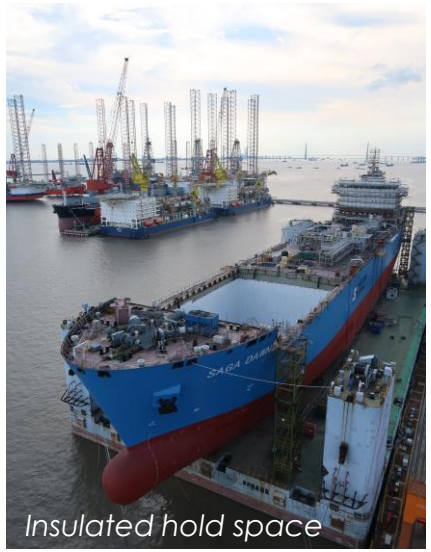
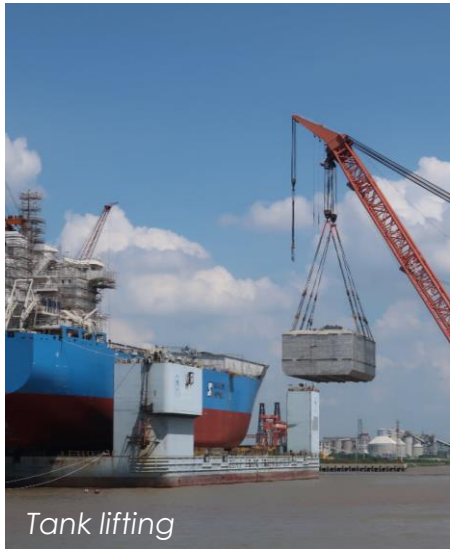
# INSULATED HOLD SPACE

Ready for tank installation

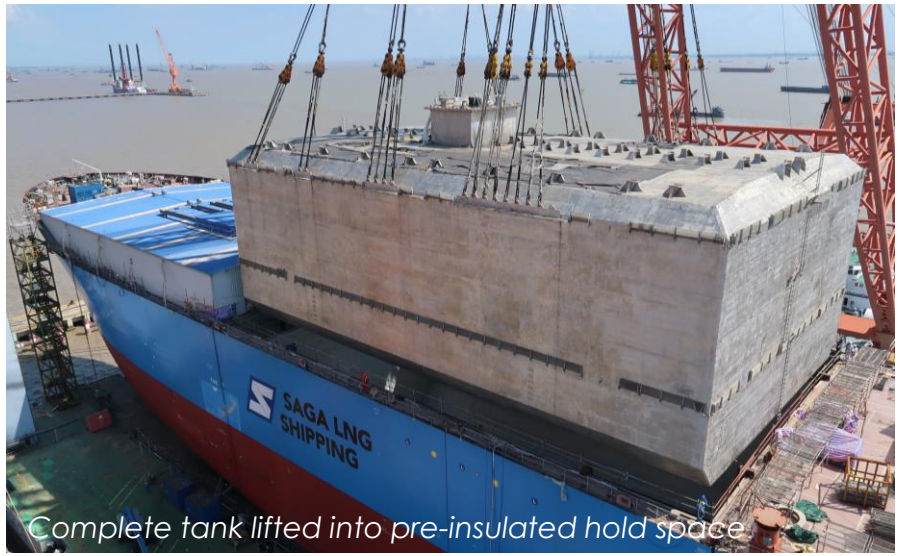
# TANK INSTALLATION PROCESS



Insulated hold space



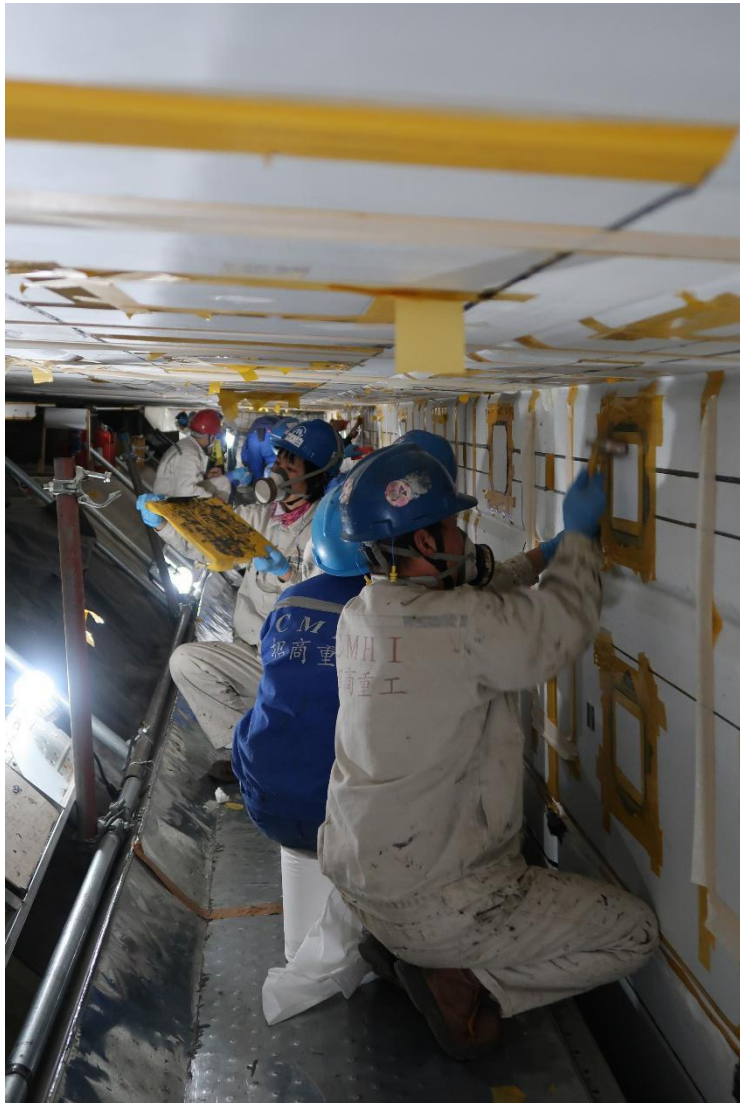
Tank lifting




Complete tank lifted into pre-insulated hold space


Closing of hold space with pre-insulated deck section

# VOID SPACE CLOSING AND FINAL INSULATION

# LNT45 / SAGA DAWN – PROOF OF CONCEPT

The first LNT A-BOX vessel

**Ship:** Saga Dawn, a 45,000m3 LNG carrier

**Builder:** China Merchants Heavy Industry (Jiangsu)

**Owner:** Saga LNG Shipping

**Delivered:** January 2020

**Commercial operation:** South East Asia

**Charter:** 1 year for trader. New 8 yrs TC confirmed.

*Vessel sold to Chinese interest in 2021.*


LNG World Shipping's Technology Award 2019


SRS Green Ship of the Year Award 2021

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# SAGA DAWN

Between 2020-2021, the world's first LNT A-BOX® type carrier safely and efficiently transported 23 cargos of LNG.

In only its first 15 months of trading, the 45,000m3 Saga Dawn frequented 6 different terminals in Southeast Asia, including large-scale LNG liquefaction plants, re-export hubs and medium-scale import terminals.

The vessel also carried part-cargos at around 50% loading and received 3 cargos via ship-to-ship transfer from a conventional-size carrier, exhibiting the full range of the vessel's capabilities!


**23** CARGOS

**425,000** TONS OF LNG

**6** TERMINALS

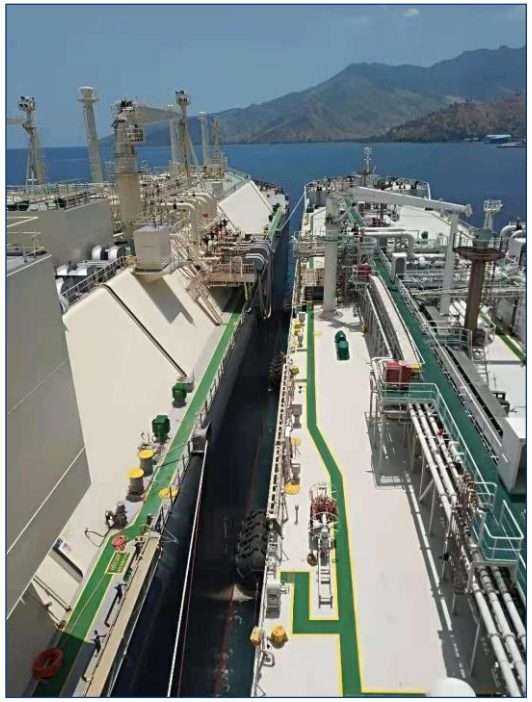
**0** ISSUES*

** Refers to the LNT A-BOX® containment systems*

*Courtesy of Saga LNG Shipping Pte.,Ltd.*

# SAGA DAWN – OPERATIONAL EXPERIENCE

- **No issues related to the containment system reported**
  - No abnormalities observed
  - No cold spots found
- **Loading performance as per specification**
  - The temperature stability has proven better than specification with the containment system in cold condition.
  - Loading rate faster than specification.
  - Tank design pressure (MARVS) of 0.4 bar g reduce challenges related to loading pressure peaks and instability of cargo after loading.
  - BOG compressors handle all return gas.
- **Smooth cargo operation cycles**
  - Robust tank design is proven in both cool down- and warm up phases.
  - The system proves stable in the operation phase with respect to temperatures and is rapidly ready for loading.
- **Stable operation of the containment system**
  - The nitrogen filled protection spaces around the tanks and the secondary barrier operates automatically with even pressure.



# SAGA DAWN – OPERATIONAL EXPERIENCE

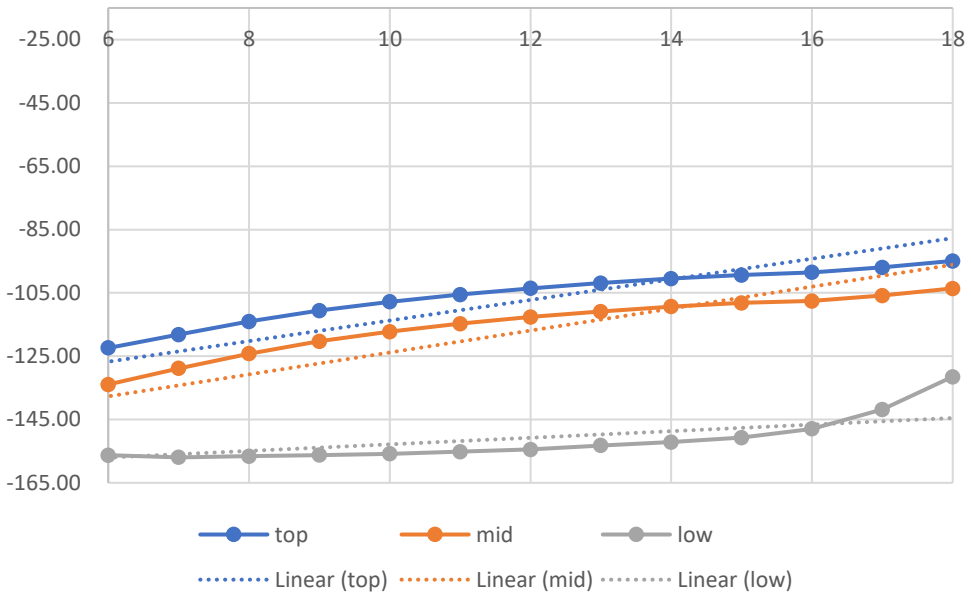
Monitoring of cargo tank temperatures during a ballast voyage on Saga Dawn:

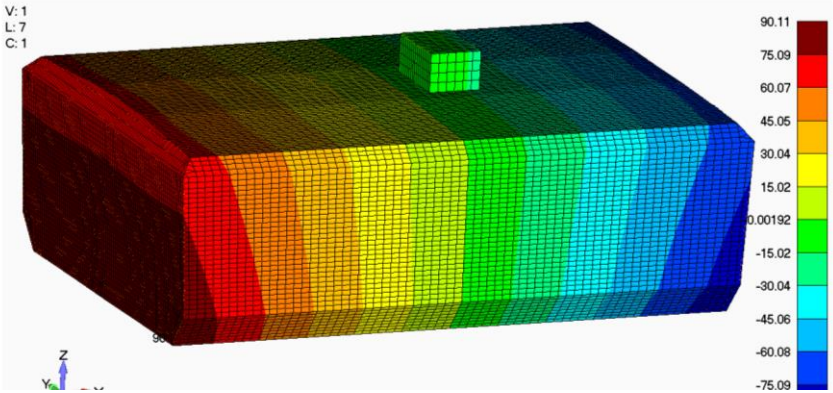
- Heel in tanks approx. **2%** after discharging
- Operating on LNG until tanks empty
- Natural warming up

- Bottom is warming up slowly due to low heat ingress in the bottom area.
- Steady temperatures in bottom for 6-10 days due to un-pumpable heel.
- Top area is faster in accordance with normal practice and thermodynamics.
- Tank is warming up after around 14 days and will need cooling down before new loading operation.

- Relative movements and stress level is acceptable with 50°C temperature difference between top and bottom.

Cargo tank temperature change per day



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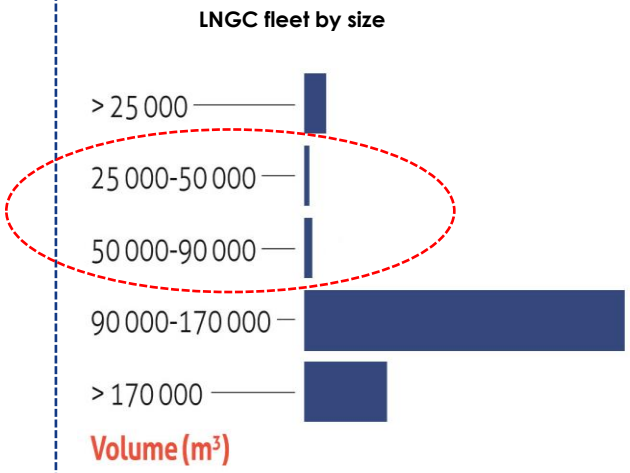
# MARKET SEGMENTS – LNT A-BOX®

## Mid-size segment

*79,900m3 LNG carrier*




## Large-scale segment


*174,000m3 LNG carrier*

# JOINT INDUSTRY PROJECT WITH QATAR ENERGY

…Enabling entry into the large-scale segment


**Qatar's huge LNG newbuilding plans inch closer on project sanction**

- Qatargas' major North Field Expansion Project, will increase their LNG production capacity from 77 mtpa to some 111 mtpa.
- The total cost of the project will be **$28.7 billion**, making it one of the industry's largest investments in the past few years and largest LNG capacity ever built.
- This will create a massive shipping demand, and Qatar Petroleum has already reserved yards slots for **up to 151 LNG carrier newbuildings**.

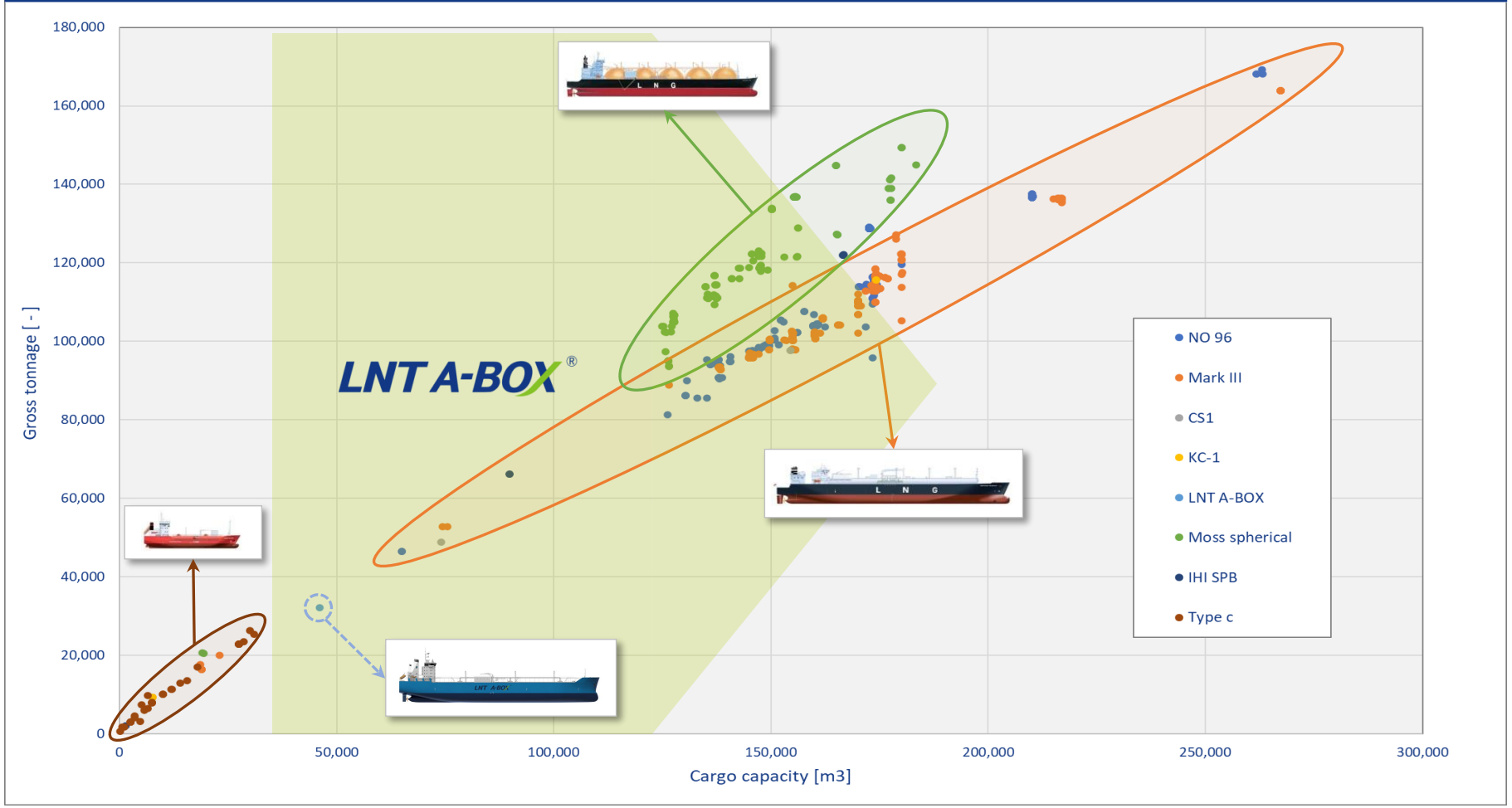

**Qatar Petroleum signs multi-party agreement to develop new medium and large LNG carrier designs.**

The Agreement paves the way for the establishment of a Joint Industry Project (JIP) that targets the development of new LNG carrier designs utilizing the LNT A-BOX® LNG cargo containment system. Other signatories to the Agreement include Qatargas and affiliates of ConocoPhillips, ExxonMobil, Shell and Total.

Source: TradeWinds February '21

# LNG CARRIER SEGMENTS & LNT A-BOX® POSITIONING

## LNG Carrier fleet




- The Moss type LNG carriers are famous in the traditional large scale LNG segment.
- This market has however been taken over by GTT membrane systems which today dominate the market for large scale LNG carriers.
- The small scale LNG fleet is dominated by type C vessels.
- In the mid-scale LNG segment, there is limited existing tonnage and no clear market leader.
- LNT A-BOX® has initially been developed for this market, with the 45,000m3 LNG carrier Saga Dawn as the pilot project.
- LNT A-BOX® is however well suited to be scaled-up.

Source: LNT Marine plots based on Clarksons fleet list

# THANK YOU

## LNT Marine

www.lntmarine.com

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