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Message from Jean-Baptiste Choimet, CEO of GTT

Since June 12th, I have had the honour of serving as the Chief Executive Officer of GTT. I would like to take this opportunity to express my deep appreciation for everything that has been achieved so far and, more importantly, for the strong relationships that have been built over the years between GTT and its various partners.

My commitment is to maintain and further these trustworthy relationships by supporting licensed shipyards in building ships with our technology, assisting ship-owners using our tanks, and collaborating with charterers who trust our technology for transporting their cargo. Additionally, I am dedicated to continuing our efforts in innovation.

In this issue of GTT Inside, we highlight some of our recent innovations. Firstly, we have improved our sump designs to facilitate construction in shipyards, thereby reducing their costs. You will also find an article on ULEC, where we, together with our partners, have developed a design for a 150,000-m^3 ethane carrier that significantly enhances the economics of ethane shipping. Lastly, we have secured General Approval for Ship Application (GASA) from both Lloyd’s Register and Bureau Veritas for GTT NEXT1, signifying the official commencement of this new technology's implementation.

I look forward to meeting with you to discuss these innovations in more detail, along with many other exciting developments.

A major qualification step for the GTT NEXT1 cargo containment system

In early June 2024, GTT achieved a significant milestone with the award of key approvals from Bureau Veritas and Lloyd's Register for its GTT NEXT1 LNG cargo containment system. These approvals mark a pivotal moment for GTT, affirming the system's compliance with international standards.

Bureau Veritas’ Design Approval and Lloyd’s Register’s General Approval for Ship Application, officially granted at the Posidonia 2024 maritime show in Athens, mark a major milestone for GTT NEXT1 technology. Bureau Veritas and Lloyd's Register confirm that the technology complies with all applicable rules and regulations, including the International Maritime Organization's International Gas Carrier Code (IMO IGC Code) and confirm that GTT NEXT1 is now ready for the next stage of the commercial implementation following detailed discussions with the shipyards.

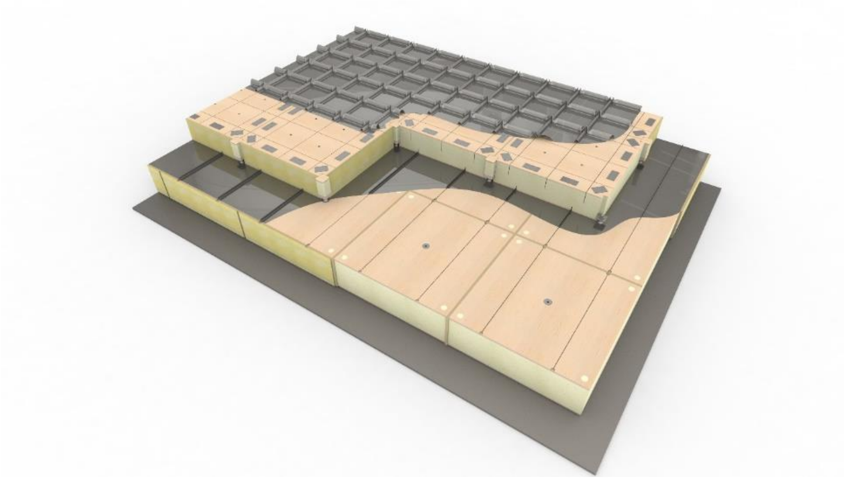

Illustration of GTT NEXT1’s double metallic barrier system

GTT NEXT1 technology incorporates a double metallic barrier system designed to achieve a level of thermal performance comparable to Mark III Flex+ technology. Thanks to its design features, GTT NEXT1 implements the advantages of proven materials and components, building on the strengths of the NO96 and Mark III technologies. The system utilises two proven metallic barriers: the first, based on a corrugated stainless steel concept similar to Mark technologies, and the second in Invar, similar to NO96 systems along with prefabricated panels of reinforced polyurethane foam, resulting in high levels of thermal efficiency and mechanical reliability.

GTT NEXT1’s qualification process included tests on a large ballasted tank mock-up, with insulation components at scale 1:1. Equipped with extensive instrumentation (more than 400 sensors), the GTT NEXT1 system mock-up has demonstrated its mechanical and thermal compliance when submitted to either representative or extreme load cases.

With these major approvals, GTT is now ready to collaborate with shipyards and ship-owners to develop LNG carrier designs incorporating the GTT NEXT1 system. This readiness marks an important step towards the commercialization of GTT NEXT1, expanding GTT's family of cryogenic membrane systems.

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Future Proofing Ultra Large liquefied Ethane Carrier Design: Leveraging LNG-Ready Advanced Membrane Technology

As the ethane market matures, industry stakeholders are increasingly focused on transporting larger volumes of ethane across the oceans. This trend has led GTT to develop designs for vessels with greater cargo capacities, particularly a 150,000-m³ Ultra Large Ethane Carrier (ULEC). This larger carrier enables a reduction of shipping cost per cubic meter while enhancing transported cargo volumes and improving petrochemical plant output. From an environmental perspective, large carriers also benefit from a reduced carbon footprint per cubic meter transported.

In response to the growing demand, GTT launched a study in 2020 to address limitations for ships calling at American terminals *Enterprise Morgan's Point* and *Nederland*. Interviews with pilot associations, export facilities and the US Coast Guard were conducted to identify channel restrictions and contextual factors that may influence ship design. Following the completion of the study, GTT began the development of ULECs, with shipyards and designers such as HD Samsung Heavy Industries, HD Hyundai Heavy Industries, Hudong-Zhonghua, Dalian Shipbuilding, Jiangnan, MARIC, and Deltamarin.

Operational and economic advantages of ultra-large-scale liquefied ethane transport

In the development of ULECs, a thorough understanding of industry requirements has been paramount. Through collaboration with the above mentioned industry stakeholders, key dimensions were established as the foundation of ULEC ship design. These include an overall length of 274.0 meters, a breadth of 42.0 meters, and a vessel draft of no more than 11.9 meters in seawater. This meticulous attention to dimensions ensures optimal manoeuvrability and cargo capacity, addressing the needs of both safety and efficiency in maritime transportation.

To further enhance operational performance, the proposed ULEC design is equipped with a main engine of relatively important maximum continuous rating, ensuring always-sufficient margin for long voyages. The reliquefication unit is sized with four trains, of 50% capacity each, allowing sufficient redundancy on the safety side, and enhancing liquefied ethane preservation to minimize losses during transit on the performance side. These enhancements deal with operational reliability and contribute to cost savings by maximizing cargo integrity.

In pursuit of enhanced volume efficiency, GTT has also validated two ULEC design variants: one with four cargo tanks, and one with only three cargo tanks. This innovative approach not only optimizes cargo capacity but also reduces shipbuilding costs, offering a compelling value proposition to ship owners and operators. Moreover, various Classification Societies have reviewed and granted approval in principle for the ULEC ship design, underscoring its compliance with international standards and regulations.

With options for either Mark III or Mark III Flex technology, the cargo containment system of ULECs offers flexibility. The latter, with its lower boil-off rate of 0.06% volume / day, and faster loading operations, presents a significant improvement in trade flexibility.

Bridging ethane and LNG: the versatility of the Mark III cargo containment system

In 2021, ABS unveiled at a joint event with GTT the first LNG Cargo Ready notation for ethane carriers. The notation confirms that an ethane carrier (whether a VLEC or a ULEC) outfitted with GTT Mark III technologies possesses the capability for future modification to facilitate the trade of LNG cargoes. GTT conducted a thorough evaluation of potential barriers and meticulously assessed the LNG capability of the carrier's equipment and systems. Subsequently, supplementary notations have been incorporated to validate the LNG readiness of systems, encompassing aspects such as piping, dual fuel systems, and other essential components.

Investing in ethane carriers equipped with Mark III technology allows owners to mitigate financial risks but also provides the flexibility to enter the LNG shipping market if required. This dual-cargo compatibility effectively addresses market uncertainties, offering a versatile solution to meet evolving market demands. The conversion process from an ethane carrier to an LNG carrier typically occurs at a specialized conversion yard. This involves primarily adapting the main engine, and possibly auxiliary engines, along with adjustments to the reliquefication unit.

Moreover, with the potential emergence of new trade routes, such as those from the Middle East to Northeast Asia, ULEC vessel design can be adapted to align with conventional 175,000 m³ LNG carriers, ensuring adaptability to evolving market dynamics. In addition, such ULEC could supply LNG cargoes to the existing FSRU and FSUs in service (more than 40 units), which look for cargo volumes between 140,000 and 160,000 cubic meters. Eventually the ULEC itself could also operate as an LNG FSRUs following reduced conversion work. All these possibilities significantly increase the residual value of such an asset.

These innovative ship designs have gained significant interest from stakeholders in the Natural Gas Liquids (NGL) and LNG shipping sectors. The synergy between the two industries, facilitated by larger ships and advanced technologies, leads to a substantial reduction in total supply chain costs, encompassing both capital expenditure and operational expenditure. This, in turn, lowers the break-even point for ethane feedstock competitiveness, thereby unlocking potential avenues for new projects and ventures.

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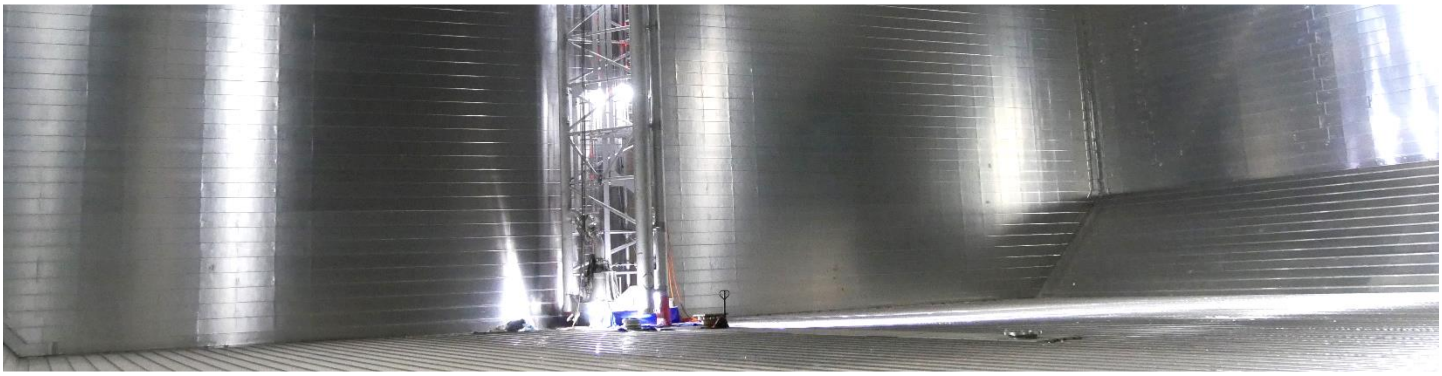
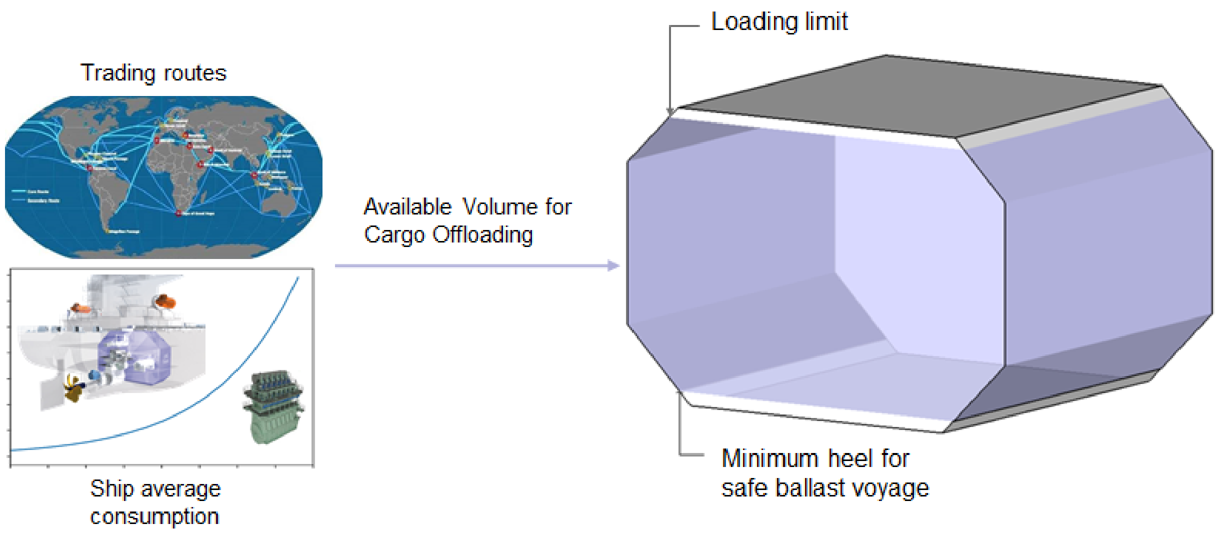


Enhancing LNG Pump Efficiency: GTT's Innovations in Sump and Bucket Solutions

The pumpable volume of liquefied natural gas (LNG) within cargo and fuel tanks plays a pivotal role in vessel design. For LNG carriers, it dictates the cargo quantity deliverable without compromising ballast voyages, while for LNG-fuelled vessels, it influences the navigational range achievable based on specific main engine consumption rates.



Recognizing this critical aspect, GTT has introduced enhancements to its sump solution. This upgraded system ensures the sustained operation of fuel pumps in LNG, irrespective of prevailing sea conditions, while simultaneously reducing the minimum heel required to operate the pump(s).

Optimized sump design

The process of adjusting the sump's height using shims was deemed time-consuming and labour-intensive. In response to these concerns, GTT has engineered a new design tailored to meet the specific needs of shipyard production departments.

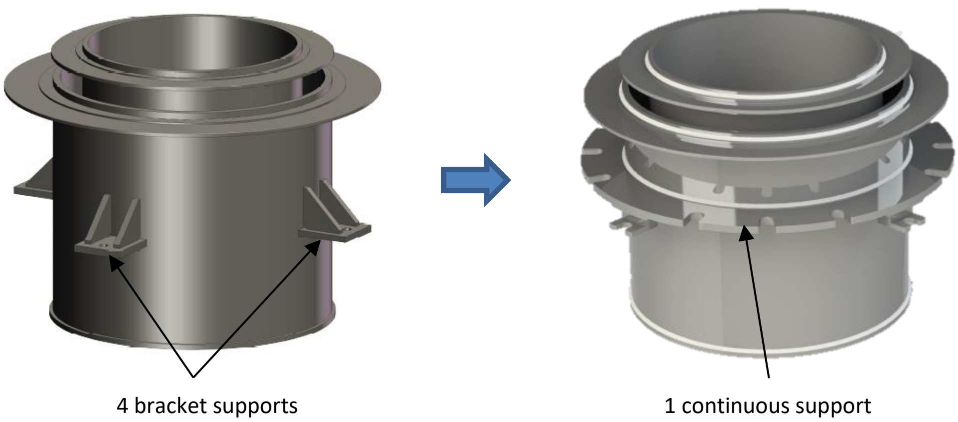


Figure 1 – old design versus new design

The upgraded design replaces the previous four supports with a continuous disc resting on four circular wooden beams. This modification not only distributes load more evenly but also ensures a more uniform heat distribution, contributing to improved operational efficiency. Height adjustment is now simplified, achieved with mastic, eliminating the need for on-board machining.

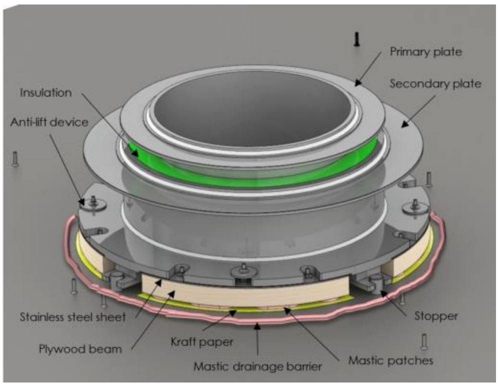


Figure 2 – New sump with mastic

This innovative design is projected to reduce installation time by at least 50%, with the first application anticipated in summer 2025. Furthermore, this solution is versatile, applicable to both MARK III and NO technologies, offering enhanced flexibility and reliability across different vessel configurations.

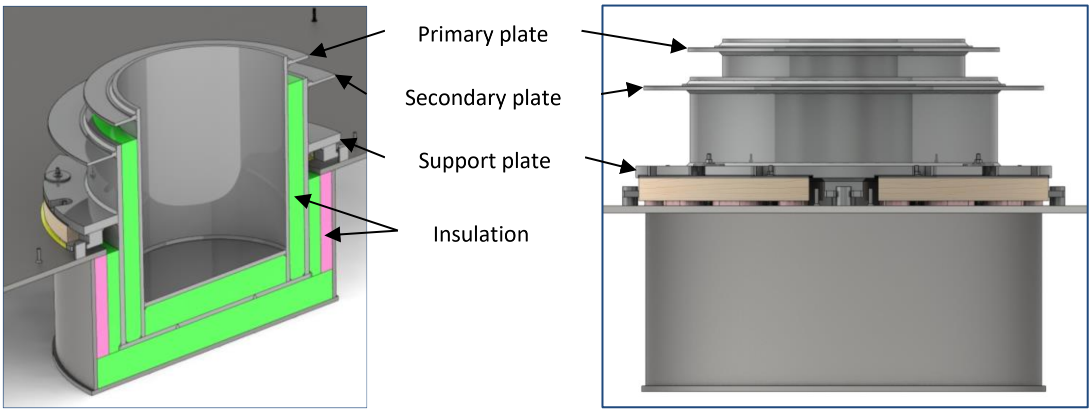


Figure 3 – At left, side view / at right, cross sectional view

Adaptation for NO96 Cargo Containment System (CCS)

In response to customer requests for a sump solution compatible with NO96 technology, GTT has recently conducted validation tests on the mechanical strength and fatigue of NO96 CCS with the integration of a sump. Given the technological characteristics of the NO96 CCS, the decision was made to position the sump strategically in front of the pump tower, as shown in figure 3.

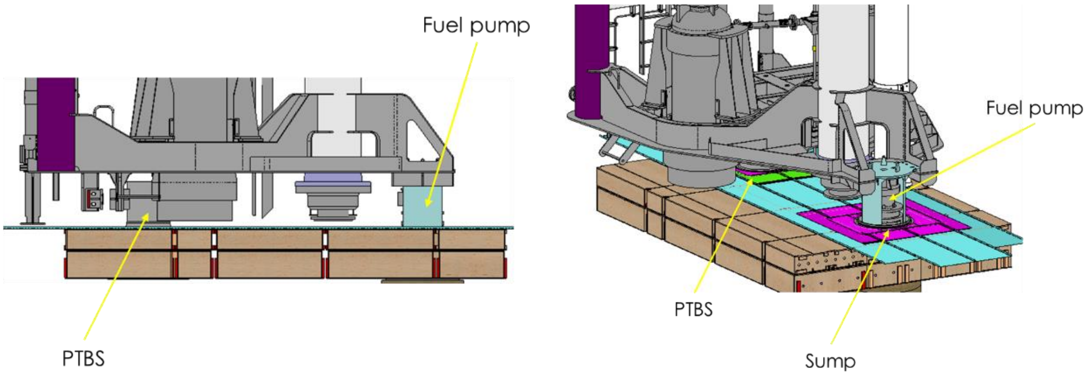


Figure 4 – Sump position with NO96 CCS

This positioning necessitates the application of a 20 mm seam weld locally around the sump, specifically at junctions measuring 1.5/1.0mm and 1.0/0.7mm. Additionally, the invar tongues need to be increased locally around the sump to ensure structural integrity and operational efficiency.

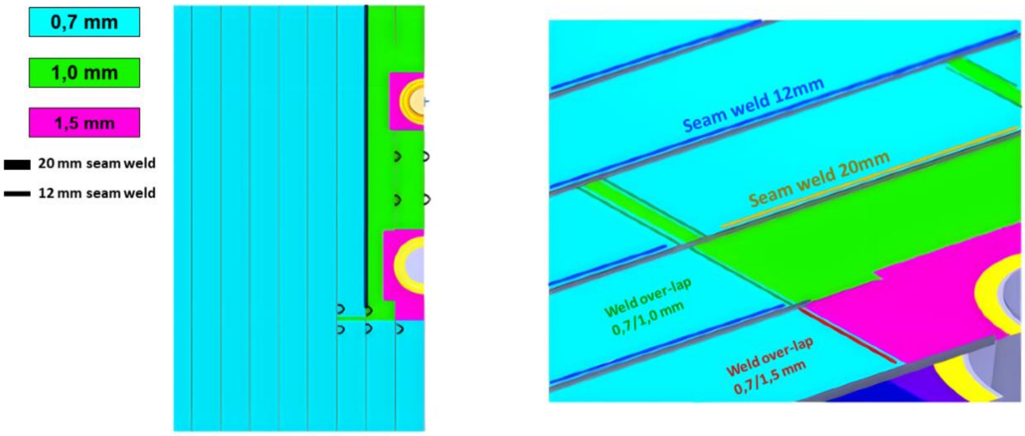


Figure 5 – Membrane arrangement (primary & secondary)

To address clearance considerations associated with the liquid dome, GTT has developed a design featuring a removable pump support, facilitating the installation of the tripod mast. The installation procedure involves fixing the first part (highlighted in green in below illustration) directly onto the emergency pipe in the workshop. Subsequently, upon insertion of the mast into the tank, the pump support and the pump are bolted securely into place.

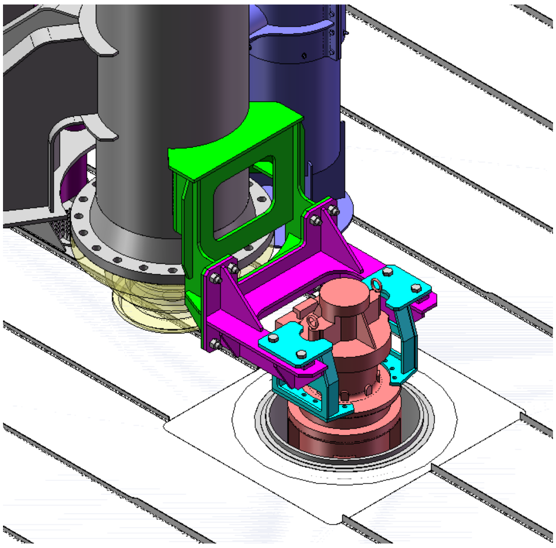


Figure 6 – Fuel pump on its removable support positioned in the sump

Furthermore, oblong holes integrated into the pump support, along with the use of shims between the pump and the support, enable adjustment in three directions, optimizing pump positioning and ensuring optimal performance in various operating conditions.

Dual sumps for Mark III rectangular reduced combined dome for LNG fuelled ships

GTT has recently introduced a reduced combined dome specifically designed for LNG-fuelled ships equipped with Mark III tanks. This innovative development capitalizes on the unique spatial challenges associated with such vessels compared to traditional LNG carriers. By integrating a reduced dome and a corresponding pump tower, GTT offers enhanced flexibility in tank design, containment system installation, and cost-effectiveness.

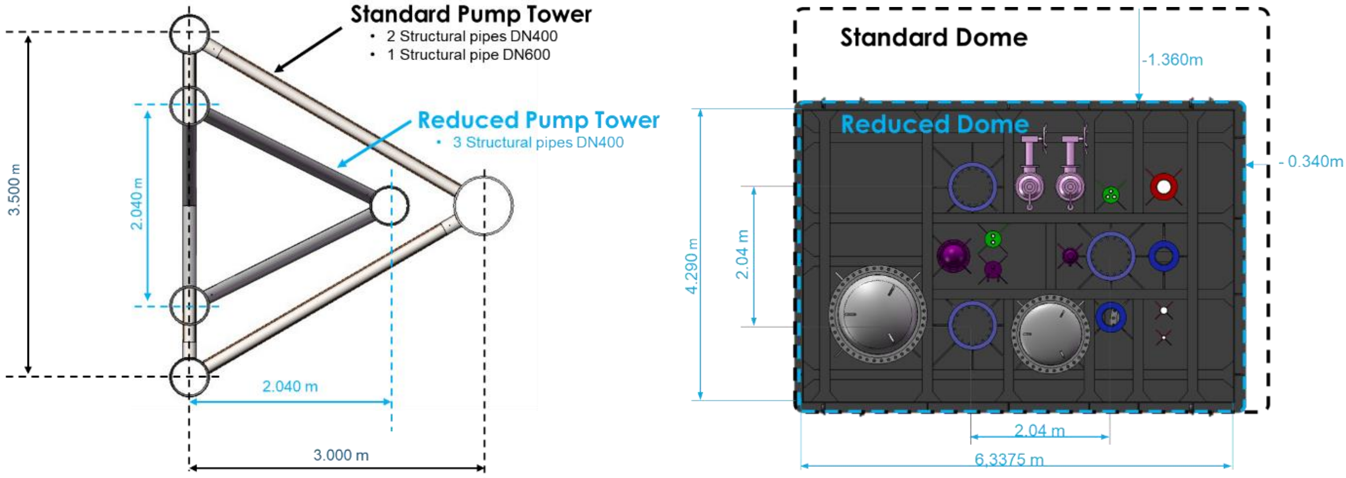


Figure 7 - Size reduction of rectangular combined dome and pump tower

The reduction in dome size, depicted in the above figure, optimizes space utilization without compromising operational efficiency, catering to the evolving requirements of LNG-fuelled vessels. In line with GTT's commitment to innovation and adaptability, the company is currently in the process of validating a new sump position for the reduced dome configuration.

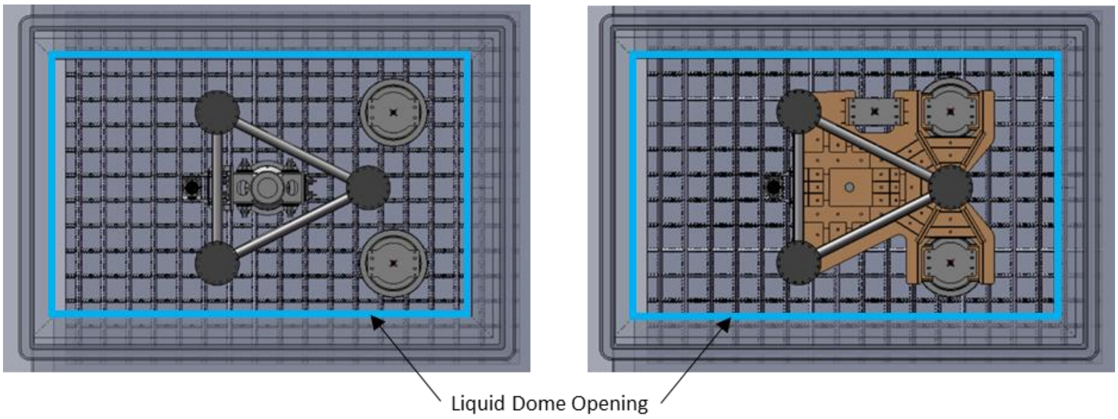


Figure 8 - Rectangular reduce combined dome and pump tower with 2 submerged fuel pumps in 2 sumps

This new sump position allows two submerged pumps to be directly fixed onto the mast without the requirement for removable parts. As illustrated in above picture, these pumps will be installed in two separate sumps, offering redundancy and minimizing operational constraints associated with submerged fuel pumps.

By offering dual sumps in the reduced combined dome configuration, GTT is addressing the requirements highlighted by customers regarding redundancy and fewer operational constraints in the use of submerged fuel pumps.

Revolutionizing Bucket Solutions

In scenarios where the traditional sump solution proves impractical, GTT offers an alternative: the bucket solution. This innovative approach aims to minimize the minimum heel required for pump operation whilst minimising the possibility of a pump tripping. The bucket solution involves the strategic placement of a retaining plate around the pump to retain LNG during periods of low liquid levels caused by ship movements.

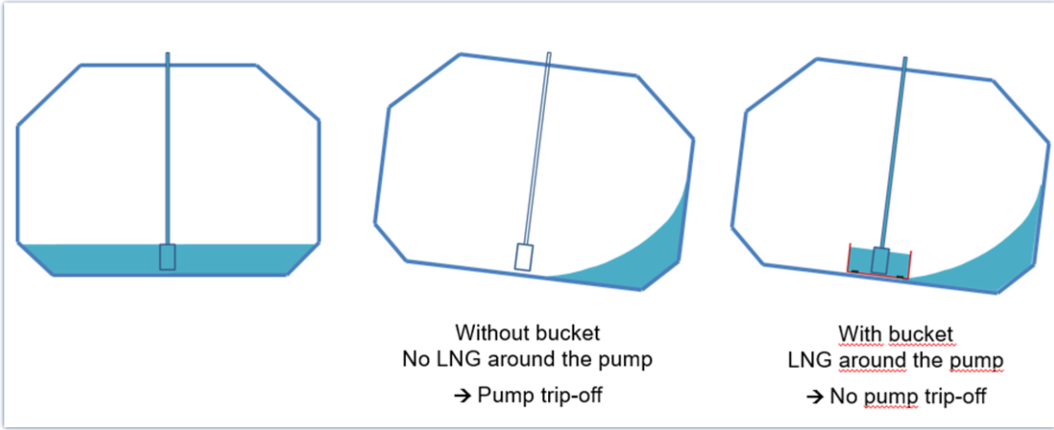
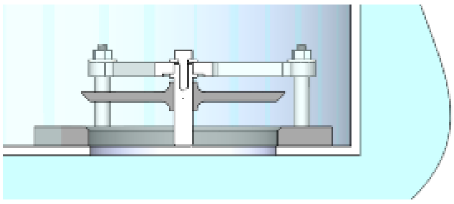


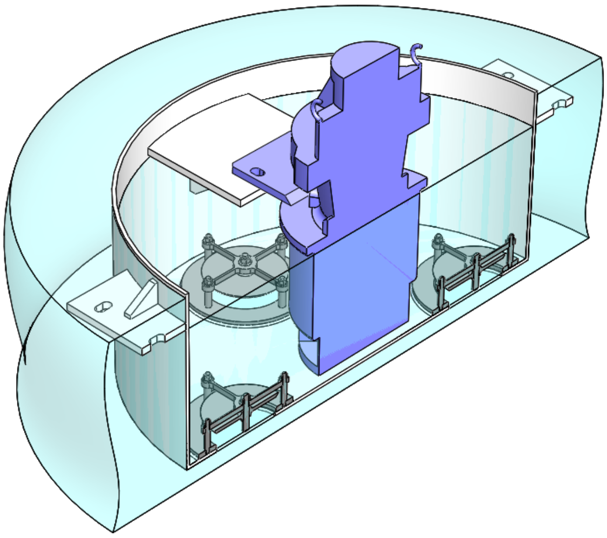
Figure 9 – Illustration of bucket principle

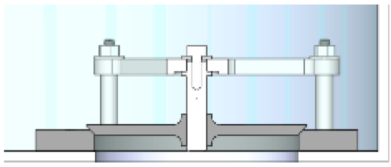
While conventional bucket solutions typically require top filling and a substantial heel to operate effectively, GTT has engineered a solution featuring a bottom filling capability.



LNG around the bucket

The non-return valve opens to fill the bucket





No LNG around the bucket

The non-return valve closes to keep the LNG in the bucket

<u>Figure 10 – Illustration of non-return valves in the bucket design</u>

By incorporating non-return valves into the bucket design, GTT enables bottom filling, reducing the height of the heel required for pump operation. This design innovation ensures uninterrupted pump operation, even when the liquid level falls below the height of the bucket, mitigating the risk of pump tripping.

The non-return valves are constructed from lightweight aluminium with excellent mechanical properties, ensuring durability and reliability. Supported by stainless steel valve supports, these valves are strategically positioned at the bottom of the bucket, preferably located at the rear of the pump mast.

In conclusion, GTT's innovative bucket solution represents a significant advancement in LNG pump efficiency, offering practical alternatives for seamless operation in diverse operating conditions. By leveraging cutting-edge design principles and materials, GTT continues to redefine industry standards and empower LNG vessel operators with reliable and efficient solutions.

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Enhanced Operations and Efficiency: introducing GTT's 'Ballast-Split' Design for LNG Carriers

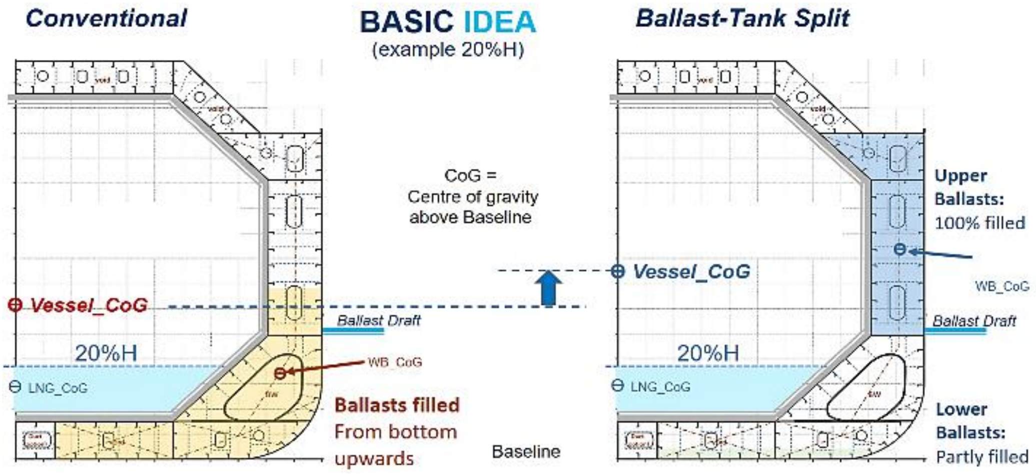
GTT's innovative 'Ballast-Split' design involves dividing ballast tanks to effectively reduce liquid motion and optimize boil-off rates. By strategically partitioning these tanks, GTT aims to address the challenges posed by partial cargo loading, particularly in the 10 to 40% tank height range where significant loads on the containment system are encountered. Through this article, we delve into the rationale behind the 'Ballast-Split' design, its operational implications, and its potential to set new standards for LNG carrier performance.

LNG carriers and liquefied gas carriers typically utilize ballast water when they are empty or partially loaded. While small vessels like LNG feeders or bunker vessels need to navigate with partial cargo loads, the impact on the containment system from liquid motions in some partially loaded scenarios can present greater challenges compared to fully loaded or nearly empty cargo situations. Typically, when the filling levels of tanks fall within the range of 10 to 40% of the tank height, they can exert significant loads on the containment system, thus requiring increased reinforcements. This condition also applies to ballast-water tanks, which are typically filled to about 70-80% of their capacity.

In scenarios of partial loading, both LNG and ballast-water masses are concentrated in the lower regions of the ship. This configuration increases vessel stability by increasing the metacentric height. However, this heightened stability results in shorter rolling periods but with more pronounced accelerations and consequent higher sloshing loads. To mitigate these challenges, established operational filling limits are adhered to on standard LNG carriers, ensuring optimal containment system performance for maximum cargo delivery. Nonetheless, certain vessels, such as LNG feeders or bunker vessels require the flexibility to operate at any filling level without restrictions.

The question arises: can we maintain standard hull and containment system reinforcements while allowing all tank filling levels?

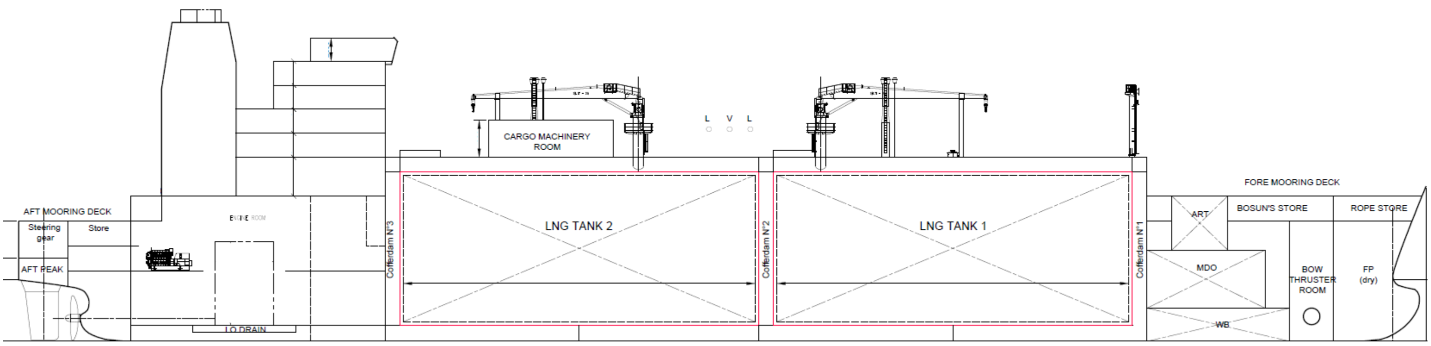
The concept revolves around maintaining the LNG tank centre of gravity while altering the arrangement of ballast-water tanks. Instead of conventional bottom-to-top ballasting, we propose a reverse method: filling the vessel downward, from top to bottom. This is achieved by dividing the ballast-water tanks into upper and lower sections and initially filling the upper tanks to the required level for achieving the appropriate navigating draft. LPG carriers are already operated in a similar way using what are termed as upper wing and double bottom tanks. With the Ballast-Split design, GTT is proposing now a comparable concept for LNG Carriers.



Schematic layout depicting the separation of ballast-water tanks into upper and lower parts.

This modification results in a vessel with a slightly elevated global centre of gravity, leading to a reduced metacentric height and subsequent dampening accelerations. This decrease in accelerations proves advantageous, particularly in mitigating severe cases of liquid motion. Consequently, we achieve a vessel design free from filling level restrictions. Moreover, the diminished sloshing loads on the membrane system permit a reduction in hull and containment system reinforcements compared to conventional designs, thereby lowering the boil-off rate and shipbuilding costs. Determining the necessary number of divided ballast tanks requires early investigations during the project design phase. Effective collaboration between GTT and the shipyard or designated designer is crucial to maximizing operational benefits with minimal design impact. The modified vessel stability poses no adverse effects. However, implementing this ballast-split solution requires a higher number of ballast tanks, resulting in some additional piping and corresponding valve arrangements. In spite of adding ballast-tanks, the vessel cost is expected to be similar or lower, due to potential gains for the cargo containment and reduction of steel scantlings.

Example: a new concept of 30k m3 LNG Feeder vessel proposed by GTT



New GTT 30k m3 LNG Feeder design

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GTT has recently designed a new 30k m^3 LNG Feeder vessel with two identical cargo tanks equipped with Mark III Flex. The ship has been designed for all LNG filling levels. In order to minimize hull and containment system reinforcements, the ballast-split principle has been applied.

The benefits of the new design are highly favourable with the implementation of the ballast-split solution significantly mitigating sloshing activity. The design's efficacy has been confirmed through validation under North Atlantic conditions across all filling levels, utilizing solely standard foam reinforcement (without the need for high-density foam).

Employing 100% standard foam translates to reduced costs and improved Boil-Off-Rate (BOR). Additionally, the adoption of two identical cargo tanks contributes to cost efficiency and streamlined operations. Similar promising findings have emerged from the application of these principles in the design of a new GTT 12k m^3 LNG Bunker Vessel. These results affirm the practical interest of the initial concept. It is worth noting that the ballast-split principle holds potential applicability beyond LNG tankers, extending to other liquid-gas or various tanker and offshore unit types.

Digital solutions for Smart Shipping: leveraging data analysis with VPS

Recently welcomed into the fold of GTT Group, VPS brings decades of experience and a suite of cutting-edge tools designed to enhance vessel performance, ensure compliance, and drive operational excellence.

VPS: turning performance data into decision support

At the heart of VPS offering is the VESPER software, a comprehensive platform that ensures operational efficiency through daily vessel monitoring and long-term trend analysis. It is the result of years of R&D supported by major innovation programs, top universities and industry leaders. With its web interface, VESPER creates custom dashboards tailored to track fleets from anywhere, providing access to analytical data via Excel, API, or users' own Business Intelligence tools. Offering seamless data feed options, including direct vessel delivery, FTP upload, or API integration, VESPER accommodates both daily reports and sensor data, empowering operators with actionable insights.

The software focuses on three main areas:

1. **Hull and Propeller** Performance Tracking**:** it emphasizes the importance of maintaining a clean hull for optimal performance, considering factors like paint quality, dry docking intervals, and operational patterns. VESPER offers tailored performance indicators derived from thorough data analysis, facilitating informed decision-making.
2. Main Engine Performance **Monitoring:** VESPER ensures efficient engine operation by monitoring Specific Fuel Oil Consumption (SFOC) and conducting performance tests. It compares engine performance against established benchmarks and sister vessels, enabling optimization across the fleet.
3. **Auxiliary** Engine **and** Boiler **Optimization:** efficient management of base load and boiler consumption is crucial for energy optimization. VESPER establishes targets, monitors performance, and identifies opportunities for savings, promoting energy awareness among crews. It allows for data-driven adjustments and continual improvement in efficiency.

In addition, VPS introduces the Crew Feedback module, emphasizing the pivotal role of effective communication with vessel operators in optimizing energy efficiency. This module offers interactive dashboards designed for on-board use, empowering crewmembers to monitor their performance Key Performance Indicators (KPIs) and benchmark against their peers. The Crew Feedback module incorporates several features, including a Vessel Dashboard for performance overview, Operational Data Quality alerts to ensure data reliability, Main Engine analysis focusing on propulsion consumption, Auxiliary Engine insights into electricity usage, and Boiler comparison for consumption at sea and in port.

Environmental Compliance

Growing environmental regulations, particularly from the European Union (EU) and International Maritime Organization (IMO), demand heightened transparency and action on energy efficiency and CO_2 reduction. VESPER alleviates the burden by automating report generation, ensuring accuracy and compliance. The Environmental Compliance module seamlessly produces EU Emissions Trading System (EU ETS), IMO Data Collection System (DCS), EU Monitoring, Reporting, and Verification (MRV), and Energy Efficiency Operational Indicator (EEOI) reports, with ongoing updates to meet evolving regulatory requirements and business goals.

Empowering Smart Shipping with Ascenz Marorka and VPS

Drawing on over two decades of expertise, Ascenz Marorka has been dedicated to providing tailored solutions that enhance operational efficiency, transparency, and sustainability for ship owners, charterers, and operators.

The collaboration between Ascenz Marorka and VPS offers a comprehensive one-stop-shop solution, encompassing a wide range of capabilities for any type of fleet:

- Reliable data collection methods, whether manual or automated logging.
- Expertise in various sensors, including Fuel Flow, Shaft Power, Direct Emissions measurement, Gas Composition, LNG Sloshing, and Motion reference units.
- Monitoring and optimizing ship commercial performance (e.g., Time Charter Equivalent (TCE)) and technical performance (e.g., Hull & Propeller, machinery).
- Specialized modules for specific domains such as LNG, Offshore Support Vessels (OSV), LNG-fuelled ships, and Wind propulsion.
- Utilization of Computational Fluid Dynamics (CFD) modelling for trim applications and hydrodynamic optimization.
- Weather Routing software and services for efficient voyage planning.
- Global presence and support.
- Additional services including Charter party (CP) evaluation, Fleet Benchmarking, Retrofit Analysis, and Voyage efficiency enhancement.

This collaboration represents a commitment to creating a comprehensive and advanced solution for ship performance management. GTT and its subsidiaries reaffirm their belief in the transformative power of technology, particularly digital solutions, in building a sustainable world.