GTT
Technology for a Sustainable World

GTT Inside

The GTT newsletter - March 2021 - n° 20

Message from David Colson, Commercial VP of GTT

I am very pleased to be able to present the first edition of GTT Inside of 2021.

First of all, I would like to send the best wishes from all at GTT for the health and well-being of all our friends and business partners. We sincerely hope that the difficulties of 2020 can soon be put behind us and that we can resume some normalcy in the near future.

In this issue, we will be concentrating on some new membrane system developments as well as our continued efforts to improve operational reliability and safety of our systems. You will find out more about the latest version of the NO96 system; the SUPER+ and its improved boil-off performance of 0,085% of cargo tank volume per day. On the subject of LNG fuel tanks for commercial vessels, we introduce our latest evolutions of the Mark III system, involving both an Ammonia-ready notation as well as an increased operating pressure on 1barg. Both improve flexibility of the system for carrying future fuels as well as enabling increased gas holding time in operations.

Finally, we will introduce improvements on the inspection and the fixation of the Whessoe float-level gauge.

David Colson

INNOVATION

First Approvals in Principle (AiP) from class for NH_3 Ready and 1 barg

The maritime sector faces new challenges with the evolution of environmental regulations towards carbon neutrality and the corresponding nascent supply chains. Ship-owners require more than ever a maximum flexibility over the lifespan of their next new-buildings.

GTT recently announced two innovations which will help ship-owners to future-proof their assets and investments. These innovations received the first Approvals in Principle (AiP) from Bureau Veritas, a world leader in testing, inspection and certification.

1 barg tank design pressure

GTT has developed, together with several yards, LNG fuel solutions with the Mark III containment system, in particular for Very and Ultra Large Container Vessels. The LNG tanks installed in those vessels usually have a design pressure or Maximal Allowable Relief Valve Setting (MARVS) of 0.7 barg in accordance with the IGF Code limitation for atmospheric tanks.

From our decades of experience of in-service vessels, this standard 0.7 barg design is compatible with the LNG supply chain and offers sufficient operational flexibility as long as the Boil-off Gas (BOG) and relative tank pressure can be reasonably managed. The recent ULCVs equipped with GTT membrane tanks are a good example of this.

However, most LNG fuel tanks being significantly smaller than LNG cargo tanks, there is a margin – an opportunity – to offer more flexibility to operators with a few modifications to the system.

Offering an increase pressure rating brings two main advantages:

- Bunker LNG with warmer temperatures (from “lower quality” supply chain),
- Increase pressure holding time (with and without gas consumption).

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Setting a membrane tank design pressure above 0.7 barg is beyond the stipulations of the IGF Code. However, the IGF Code allows modifications to the prescriptive requirements as long as the alternative design meets the goals and the functional requirements of the IGF Code and provides a level of safety at least equivalent to that of a prescriptive design.

Before GTT investigated the feasibility of increased design pressure for large LNG tanks on-board large merchant ships, GTT designed a containment system with higher design pressure for the exploration cruise vessel of Ponant with two LNG tanks with a total 4,500 m^3 capacity.

The alternative design process was successfully applied for Le Commandant Charcot of Ponant, which is currently close to completion. It mainly consisted in submitting a technical validation to the French Flag, with justification of the equivalent level of Safety between the new design and a conventional design at 0.7 barg. This dossier had been reviewed by the Class Bureau Veritas, and the design was approved by the Flag.

What happens with larger tanks?

The solution must accommodate several parameters/constraints:

- large tank volumes (up to 20 000 m^3) with significant height (high hydrostatic pressure),
- vessel accelerations equal or higher than LNGCs (higher dynamic pressure),
- necessity to keep overall maximum pressure equivalent to existing designs of LNGCs and FSRUs (0.7 barg),
- necessity to keep design of pump tower and liquid dome similar to existing designs on LNGCs and FSRUs.

To meet all these parameters, GTT opted for a new design pressure increased to 1 barg.

The first alternative design process for such a configuration will be performed during the next project. This process is expected to be fairly smooth, as most of the analyses carried out in the framework of the previous Alternative Design can be re-used. Due to the tank height difference (approx. 20m instead of 10m for the Ponant project), the only relevant gap identified for the 1 barg configuration is the use of a large *"seat dome"* (associated with a classical pump tower). This same type of design is seen on the LNG Carriers and the first ULCVs. The dome is the stainless steel piece located on top of the tank gathering all the pipe penetrations to the Fuel Gas or Cargo Handling System (FGHS / CHS). For the 1 barg concept, the dome stiffeners and welds will be adequately reinforced to sustain the increase of the vapour pressure.

Based on our preliminary design works, GTT presented the same concept to Bureau Veritas, who issued on February 15th 2021 an Approval in Principle related to the design pressure of "*1 barg"* for Mark III tank for LNG as fuel applications, such as large container vessels.

A small step in design, a major gain in operation!

NH_3 Ready

Although GTT is convinced that the LNG is the solution of choice to reduce ship emissions, widely available now, ammonia is considered as a credible alternative fuel in the medium term to enable further decarbonisation.

During 2020, GTT started the compatibility assessment of its technology with ammonia, looking at the potential for membrane tank to store liquid ammonia as a drop-in fuel with little or no cost of conversion.

Bureau Veritas is the first classification society to approve in principle this *"NH_3 Ready"* notation for the Mark III membrane tanks. The AiP recognises that Mark III technology is suitable for the containment of ammonia as a fuel, without major design changes compared with LNG fuel tanks. For this AiP, GTT has demonstrated the compatibility of the Mark III system and defined the methodology to address the necessary design adaptations. Among the items which have been reviewed:

- The chemical compatibility of Mark III stainless steel primary barrier with ammonia,
- The potential design adaptations of the containment system and the supporting hull structure in order to sustain the higher sloshing loads of liquid ammonia due to higher density (0.682) compared with LNG (0.470),

- The selection of the steel grade of the supporting hull structure to potentially sustain the low temperature (-33°C) of liquid ammonia.

At project stage, the granting of an NH_3 Ready notation may require an alternative design process since ammonia is not yet part of the IGF code. Interestingly, all major classification societies are currently working on their guidelines for NH_3 as a fuel, in order to ease the process. GTT is thus discussing similar approvals with the other classification societies to provide the best reactivity should a ship-owner request the notation.

In its recent past, GTT already validated the use of the same Mark III containment system for multi-gas applications, in particular denser liquid gas such as LPG and LEG. The first Very Large Ethane Carriers (VLEC) are equipped with Mark III and have the flexibility to carry LNG thanks to their LNG Ready notation.

Today, GTT can propose the only “real” NH_3 Ready notation for any type of LNG fuelled vessel, from Very Large Container vessels (VLCV), Tankers (VLCC), Bulkers (Newcastlemax) to smaller Car Carriers (PCTC) and Cruise vessels. Keeping the door open as well to carbon neutral LNG with bio-LNG and synthetic LNG later with no cost of conversion.

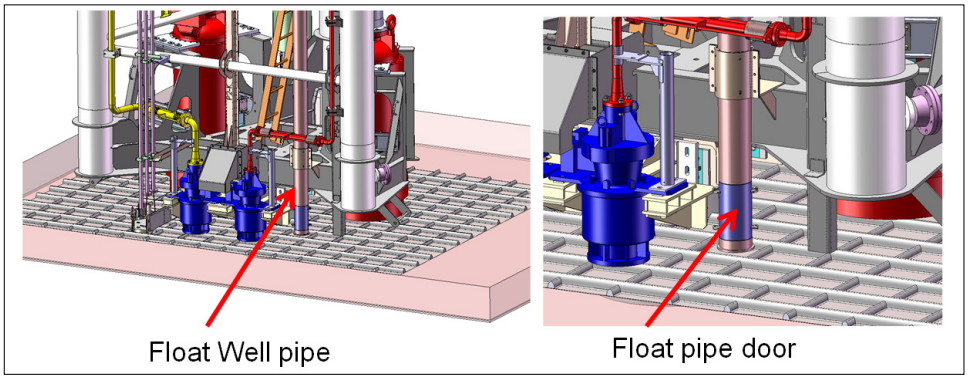
These recent innovations and first Approvals in Principle demonstrate GTT’s ability to offer a flexible and scalable solution that allows ship-owners securing their investment with respect to the potential evolution in the supply chain and environmental regulations.

OPERATIONS

Increased safety of tank operations: adaptation of the float-gauge door

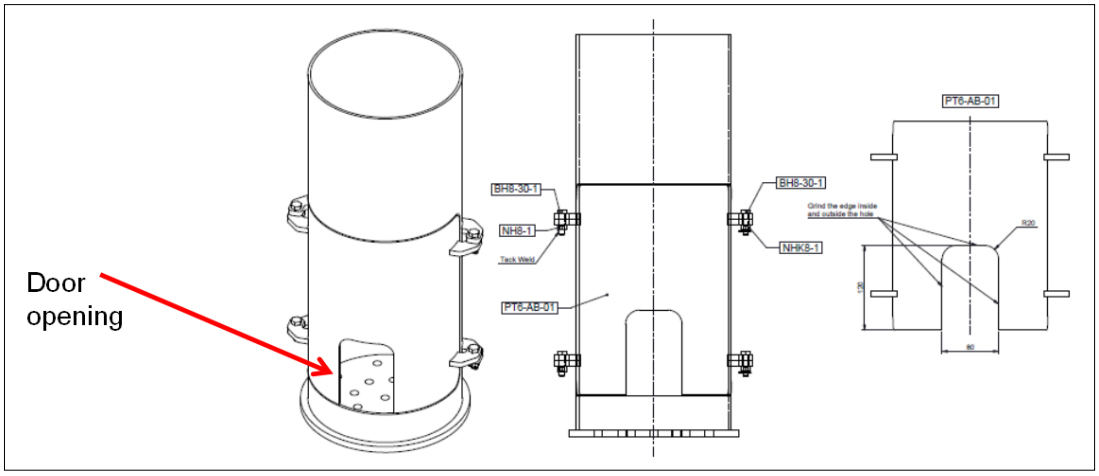
Pump towers are complex and key structures as far as operations of LNG cargo tanks are concerned. The main function of the pump tower is to load/unload the tanks. The tower is designed with a primary structure supporting the main pump wells and is reinforced by struts linking the primary structures together. The pump tower structure is so designed to withstand various combined loads such as thermal contraction, hydrodynamic forces, inertia, vibration, etc. Pump tower design also implements various fittings and instruments which are linked to the main primary structure. This equipment is essential for the good operations of the tank. One of which consists in measuring the cargo level in the tank to ensure the efficiency of commercial transactions. Each tank must be provided with a redundant measurement system for cargo level. The primary measurement system relies on radar type technology and secondary measurement systems were historically performed using a float gauging system.

The float gauging system is implemented thanks to a dedicated float well pipe which is properly fixed to the pump tower structures. One of the challenges for such a device is to keep the required accuracy over the ship lifetime. Regular calibration adjustment is carried out during the scheduled ship survey, taking place each five years. For any reason, the ship operator should also have the possibility to remove the float gauge from the float well pipe. The design and construction process have to take into account those constrains. In this respect a specific door has been integrated at the bottom of the float well pipe in the pump tower.



In order to secure the design and to facilitate dismantling operations, the door fixation was initially made with four bolts which are spot welded. Spot-welding means that the local welds on the bolts are definitive and have to be removed during dismantling. However, GTT has noticed that an incident could occur during the life of the vessels. During the last 10 years of operation for the fleet, 9 incidents have been reported to GTT. Among those 9 incidents, 5 were critical leading to the loss of the door fixation. The door is a 5 to 10 kg fitting and those incidents could lead to severe deformation of the primary membrane when the door was free to move inside the tank. It should be noted that no leak of primary membrane has been reported due to those incidents.

The main cause was an insufficient securing of door fixation and GTT has informed ship-owners with technical instructions to avoid such issue during operations. One of the main reason for an insufficient fixation is linked to regular door dismantling during ship dry-docking. GTT has adjusted the design by an additional opening in the float door. The purpose of the opening is to allow the calibration of the float gauge, which is regularly performed during ship survey, without having to dismantle the door.



A particular attention has been given to the design feature of that float door opening in order to:

- Fit with the various possible pipe diameters,
- Allow enough space for float gauge calibration,
- Keep sufficient strength against hydrodynamic forces.

This enhanced feature of the float door has been successfully put in place in January 2021 during a ship survey. GTT will contact the builders and the ship-owners to gradually adapt the float door of the ships under construction and in operation.

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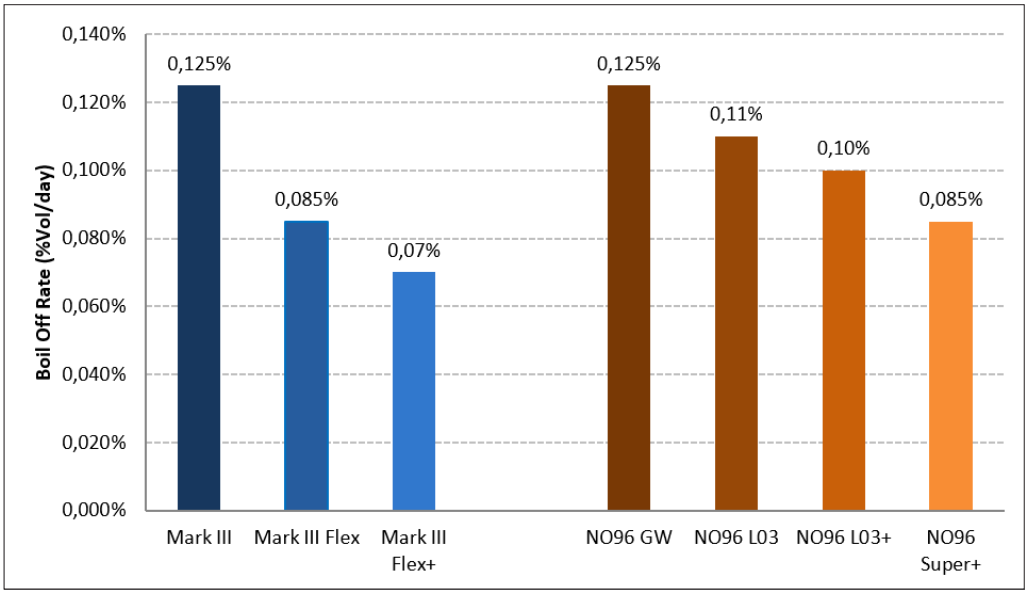
TECHNOLOGIES

NO96 Super+

GTT membrane technologies continue to evolve based on significant feedback from operational experience, in order to meet the requirements of ship-owners and shipyards, while also complying with regulatory changes affecting the industry.

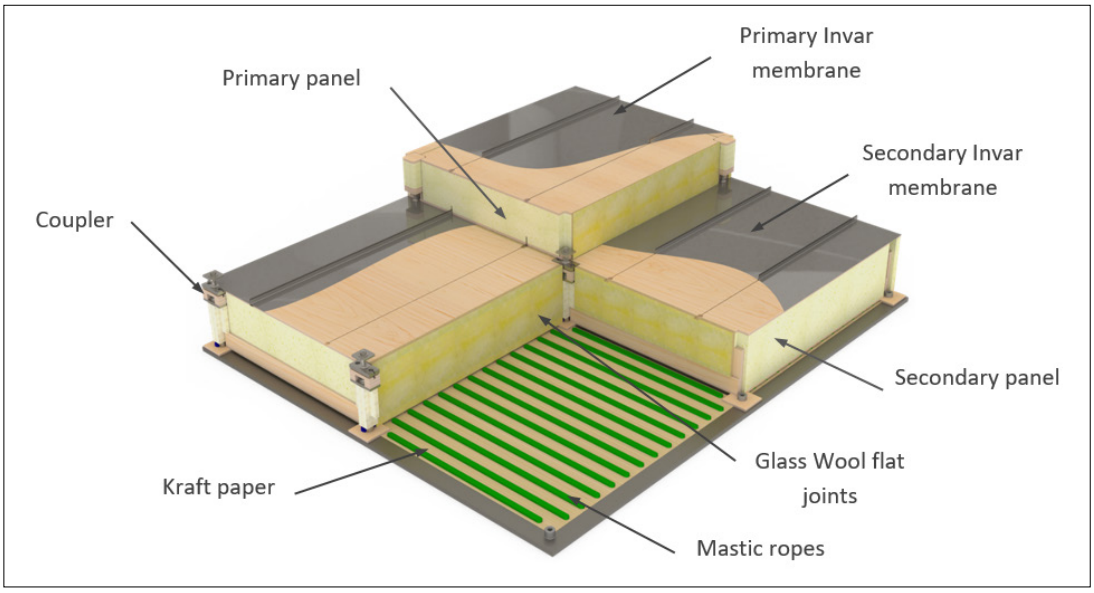
GTT has introduced several new technologies in order to minimise the evaporation of the cargo during operations. As highlighted on the below graph, since 2010, the guaranteed Boil-Off-Rate (BOR) achievable with GTT technologies has been significantly reduced from 0.15%V/day down to 0.07%V/day.



Boil Off Rate of Cargo Containment Systems on 174K LNGC

Currently the actual lowest passive BOR available with NO96 system is equal to 0.10%V/d using the NO96 L03+ system. In order to complete the NO96 family offer with a guaranteed Boil Off Rate equal to 0,085%V/d GTT has recently developed a new Cargo Containment System named NO96 Super+.

This new CCS NO96 Super+ maintains the main features of the NO96 technology that have been key factors in its success, in particular the double Invar metallic membranes. As initiated with NO96 L03 and NO96 L03+ technologies, the integration of insulating R-PUF panels is further pursued to take advantage of the continuous improvement in thermal performance of R-PUF material. With NO96 Super+ system, R-PUF panels are used for the primary insulation space (Inter Barrier Space) as well for secondary (Insulation Space), for insulating purposes and to support the two metallic membranes.



Boil Off Rate of Cargo Containment Systems on 174K LNGC

The erection philosophy is identical to NO96 systems: the anchoring of the insulation panels is made with couplers to take advantage of the excellent feedback from years of use on NO96 ships. The global arrangement of panels inside the tank, the corner and special areas designs are kept identical to the sea-proven NO96 system.

Glass Wool flat joints are inserted between adjacent foam panels to optimise the thermal behaviour of the system and propose the best thermal performance.

GTT has been granted with *"Approval In Principle"* by Bureau Veritas in September 2020. The involvement of classification societies will continue in 2021 to review for this system all the required validation studies (numerical analyses and experimental tests on components). Final class approval should be obtained by mid-2021 and this new system will then be available for newbuilding LNGC projects.