GTT Inside

DIGITAL EDITION

January 2023 - N°27

Message from Anouar Kiassi, Vice-President Digital & Information

Over the last years and months, we have witnessed an unprecedented pressure on the maritime industry to adopt environmentally friendly measures. In this respect, 2023 is a turning point with entering into force of the CII regulations. Yet, this year is just one among many others still to come with all the new regulations already adopted or being adopted (EU ETS, Fuel EU Maritime…).

Judging by the conclusions of the latest Intersessional Working Group on Greenhouse Gases (ISWG) and Marine Environment Protection Committee (MEPC), the industry is expected to adopt an even more ambitious GHG reduction strategy in the coming years.

These are exciting but challenging changes. However, experience has shown us that the most efficient way to drive the change, is to align environmental and economic considerations. In this issue, dedicated to our latest digital innovations, we showcase three software solutions that answer these two concerns with clear benefits.

I hope you will enjoy the articles. I also take this opportunity to wish you, on behalf of the GTT Group a wonderful new year for 2023!

ROUTE OPTIMISATION

Route-planning and optimisation involves juggling many constraints related to safety, operations and compliance. For ship captains, this is an essential and complex task that requires the aid of a decision-supporting tool to give them confidence in their decisions and support execution.

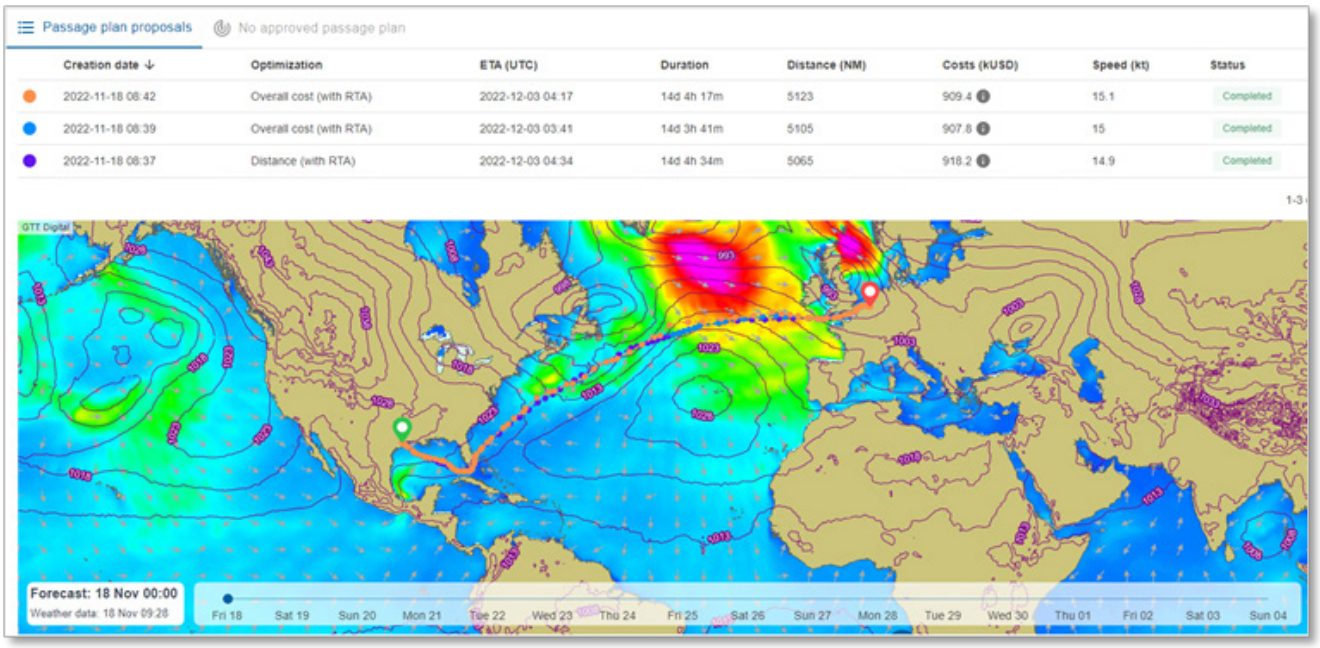
GTT has developed an advanced route optimisation solution that is capable of advising the best route by optimising numerous parameters and respecting a large number of operational constraints. The solution is suitable for all types of vessels (tankers, bulkers, container vessels) and all types of propulsion and fuel. Furthermore, combined with the other features of GTT's Digital Platform, it offers a powerful tool for all the stakeholders to collaborate to reach the organization's operational and economic objectives.

Among the optimisation options, we can highlight optimisation of:

- Voyage duration
- Voyage distance
- Fuel consumption
- Cost (including fuel, daily cost, canals, carbon tax…)
- Emissions (taking into account the conversion factor of each fuel)
- Ship motions (Parametric / Asynchronous rolling, surf-riding/broaching-to, successive high-wave attack…)

For LNG carriers, there are specific advanced features:

- Sloshing prediction
- LNG cargo loss prediction (while complying with the discharge terminal constraints)



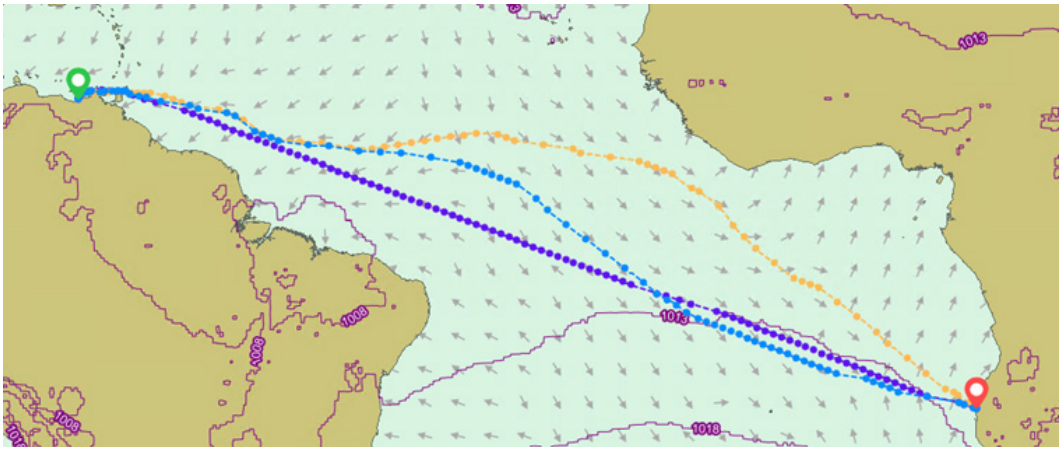
The algorithm is highly flexible and can be customised with any cost function in order to be optimised. Furthermore, the algorithm takes into consideration many constraints:

- Ship dimensions for navigational constraints
- Weather limitation (wave height and wind speed)
- Forbidden Power/Speed ranges
- Cargo types (for international and local routes restrictions)
- Specials areas (with maximum or minimum speed, no-go area)
- Traffic Separation Schemes
- Maximum CII (Carbon Intensity Index)

As far as CII is concerned, the route optimisation module in particular, and overall platform in general, offer all the features requires to manage the operational implications for the different stakeholders. Indeed, the new regulations require the ship owner and the charterer to collaborate closely not only to monitor but also to optimise the CII score of the vessels. Special contractual clauses will have to be activated in case the CII score starts falling below the agreed limit obliging the two parties to agree on operational corrective measures. Thanks to its predictive capabilities (fuel consumption, CII, distance…), the route optimisation module can play a key role in that framework by offering a collaborative platform for all the parties.

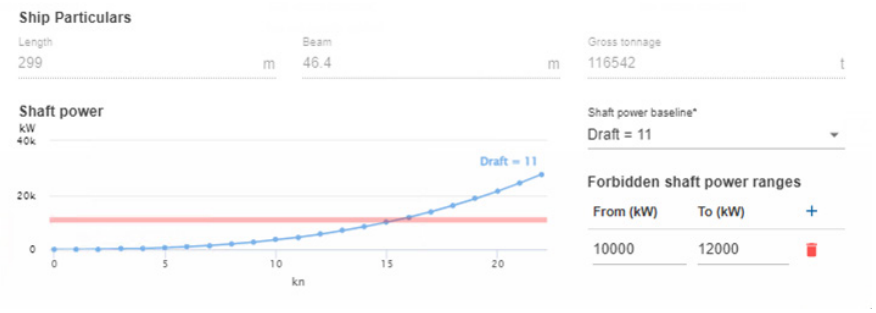
Depending on the optimisation criteria selected by the user, the routes can be very different. In the above example, we see three routes corresponding to three differents criteria:

- Least fuel in orange
- Shortest distance in purple
- Lowest total cost in blue



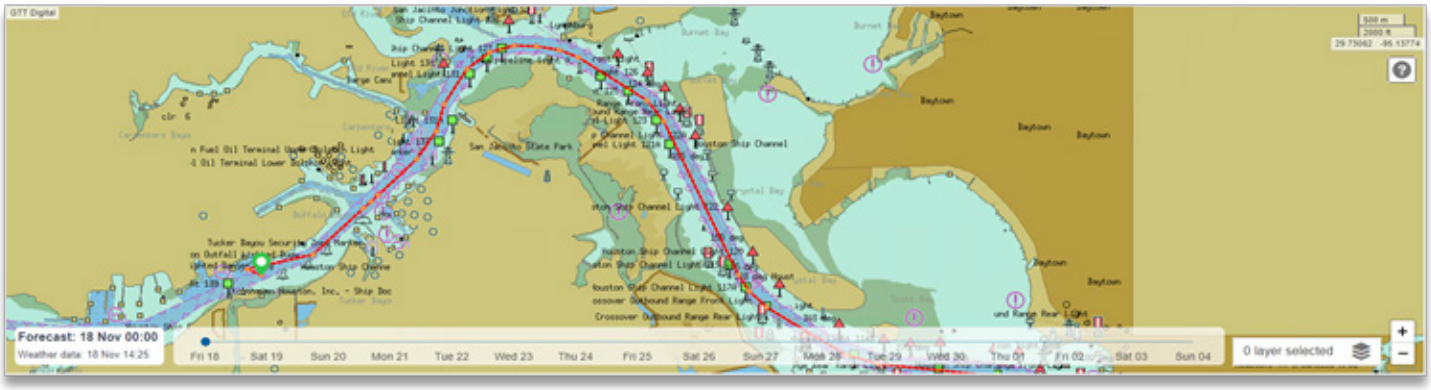
In this simulation, other parameter have been set and taken into consideration like the daily costs, the fuel costs, the minimum speed and maximum speed. In this example, the savings achieved in the “lowest cost” scenario in comparison with the “shortest distance” scenario is about 10%.

In order to provide the most accurate advice, the software uses the vessel’s digital twin built based on the available vessel data and parameters. It takes into account the sailing conditions (e.g. draft, speed, fuel…) and the environmental conditions (e.g weather factors). This can include the vessel’s dimensions, sea trials, noon reports, maintenance records, sensor data…



To deliver the best performance, the algorithm favours constant power profiles. In fact, when a vessel meets adverse weather conditions, such as high significant waves, strong wind and currents, it must output more power and thus consume more fuel to maintain its speed and revolutions per minute (RPM). Rather than allowing the power and the fuel consumption to spike, the software recommends a RPM that stabilizes them while respecting the voyage commercial constraints.

Last but not least, up-to-date Traffic Separation Schemes (TSS) are taken into account to offer the most realistic route possible, ready to be used by the crew. In fact, this reduces the captain's burden adapting the route to navigational constraints and increases the trust in the suggested routes and the overall solution. Furthermore, the more the route is amended for commercial or safety reasons, the higher the risk of deviation from the performance optimum.



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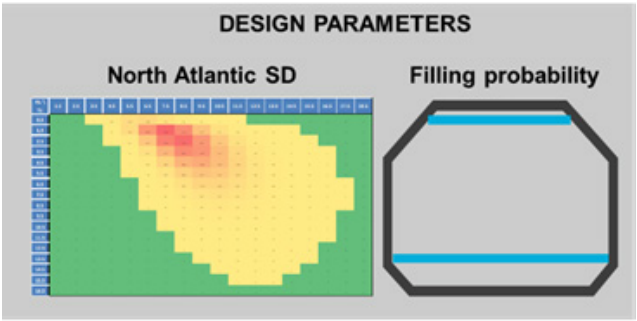
CARGO TANK ENTRY EXTENDED PERIODICITY OF LNG CARRIER

The regulations require the LNG carriers owners to inspect all the tanks every 5 years regardless of their operational profile:

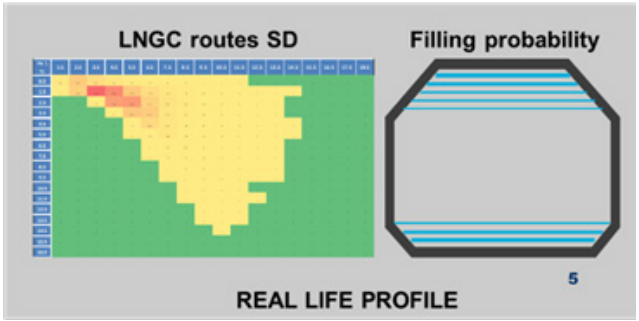
- **IACS UR Z16 §2.2.1:** All cargo tanks are to be examined internally.
- **2016 IGC Codes §1.4.2.2:** A renewal survey at intervals specified by the Administration, but not exceeding five years.

The objective of the survey is to identify and eventually repair potential defects or damage on the Cargo Containment System (CCS), and the Pump Tower (PT). Such defects are generally associated with the liquid motion in the tanks.

In order to ensure the highest level of operational flexibility while meeting the safety standards, the CCS and the Pump Tower are designed according to North Atlantic conditions and worst low and high filling levels. However, the real life profile of the vessel is generally less severe, both from the sea conditions and the filling level standpoints.



5 years risk



7,5 years risk

Thus, by monitoring the vessel's real life profile, we can demonstrate, in many cases, that the five years damage risk considered under the design assumptions may be equivalent to the risk of a longer period (e.g. 7.5 years or even more) in actual operational conditions. This equivalence principle is permitted by the IGC code provided that it can be demonstrated with a proper risk assessment and mitigation plan. The overall process is subject to Flag approval.

From the financial, operational and ESG[1] points of view, the benefits of such an extension for the LNGc owners and the charters are numerous. Hence, a working group including GTT, ship owners, charterers, classification societies and Flag states defined a rigorous systematic process to build a survey extension dossier for an LNGc in order for the Flag to approve it. The process steps are:

- **Hazard Identification (Owner / Class / GTT):** Identify the key parameters / critical failure modes that require specific monitoring in view of extending inspection cycle.
- **Risk Management:**
  - o Build a justification dossier to demonstrate that the design can be validated for extended duration,
  - o Ensure that alternative methods can provide equivalent safety as for a conventional internal cargo tanks Survey,
  - o Establish recommendations and mitigation measures to minimize risks in accordance with As Low As Reasonably Practicable (ALARP) principle.

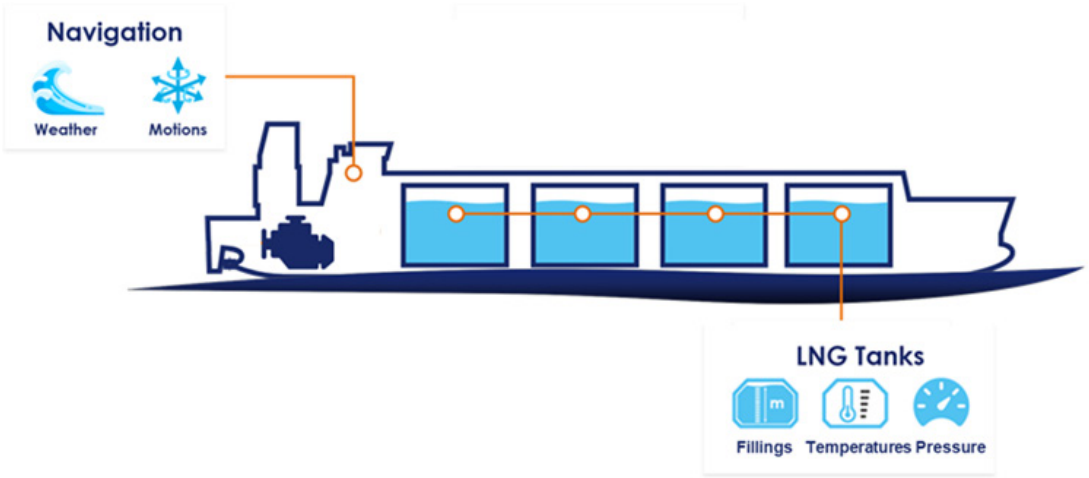
1 ESG = Environnemental, Social and Governance (non-financial KPI)

- **Inspection Strategy:**
    - o Define an initial Inspection Strategy
    - o Define the logic to update this inspection plan

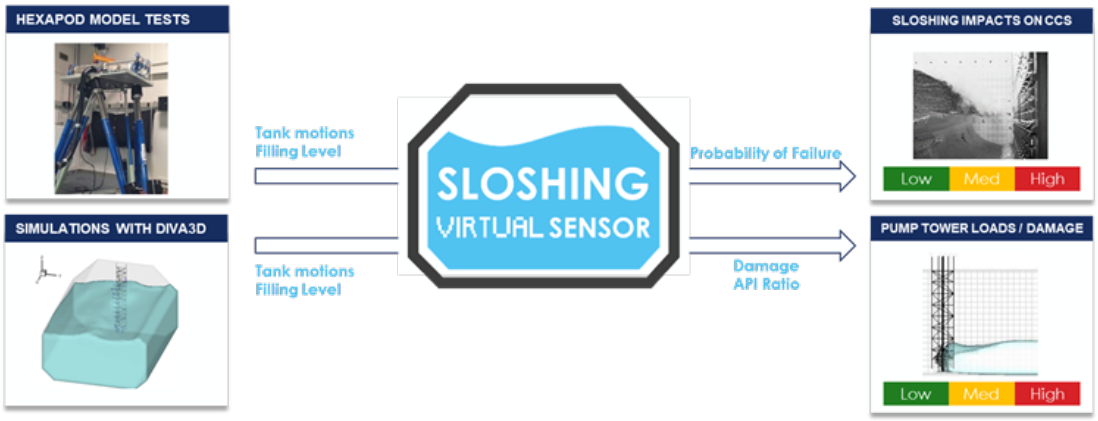
GTT has developed two innovative real time monitoring tools to support the continuous demonstration of the equivalence principle based on the actual vessel operational profile:

- Sloshing Virtual Sensors
- Cargo Tank Health Monitoring

With the **Cargo Tank Health Monitoring**, all the relevant parameters identified through a HAZID are monitored in real time. Any abnormal deviation is automatically detected by the supervisory rules in GTT Monitoring and Emergency Response Centre (HEARS) and double-checked by an officer on duty 24/7. If any risk is confirmed, the appropriate stakeholders are informed for immediate action.



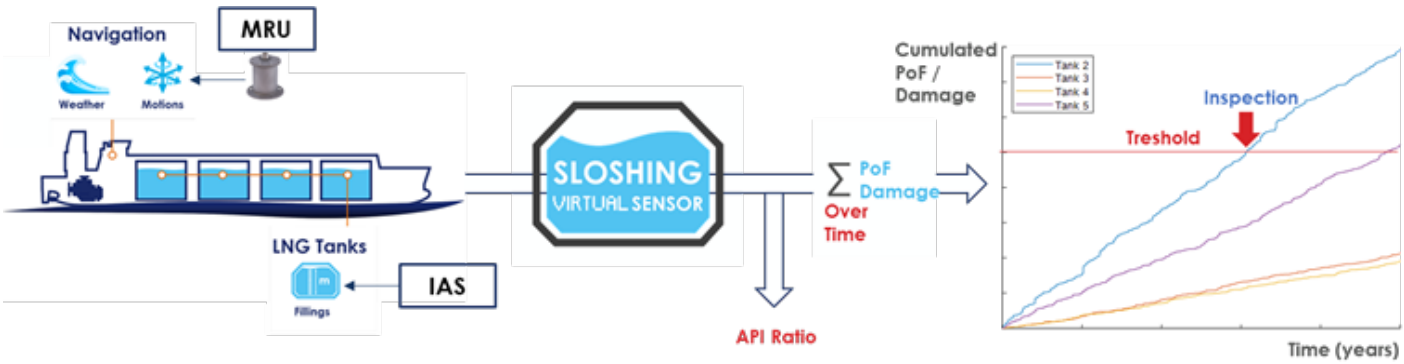
The **Sloshing Virtual Sensor** is a Machine Learning algorithm trained on model tests and numerical simulations. It makes the link between the tank motions, the filling levels and the loads on the CCS & the PT.



At sea, the application allows real-time monitoring of the cumulated damage on the PT and the Probability of Failure (PoF) of the CCS.

When design values are reached (equivalence principal) then appropriate stakeholders are informed to take appropriate action with regard to inspection plan defined during the risk assessment process.

The Sloshing Virtual Sensor requires the installation on-board of 2 components:



• Motion Reference Unit (MRU) to measure the vessel motions

• Real Time Processing Server: to collect the MRU high frequency data, pre-process it, collect the cargo tank critical parameters, mainly from the Integrated Automation System (IAS), and send the data to the shore for real-time evaluation and monitoring.

CARGO CONDITIONNING

LNG carriers have to meet the terminal requirements in order to be allowed to unload the cargo. The requirements define acceptable ranges for different parameters like LNG composition, Gross Heating Value, Wobbe Number, LNG density, Saturated Vapour Pressure, Temperature…

During the laden journey, new commercial instructions might be received leading to a change in the time of arrival and/or the discharge port. When this happens, the LNG cargo may be in unacceptable condition for the new discharge terminal.

GTT has developed a new module for cargo conditioning for LNG carriers based on GTT's expertise in the LNG process and experience in helping captains deal with these situations. The tool calculates from expected unloading condition (e.g. LNG temperature/ saturated vapour pressure), the amount of LNG that requires to be evaporated, **minimizing the cargo loss and thus the emissions**. Once the Boil-off-Gas (BOG) flow is required to is known, the cargo can be reconditioned to satisfy the charterer's request.

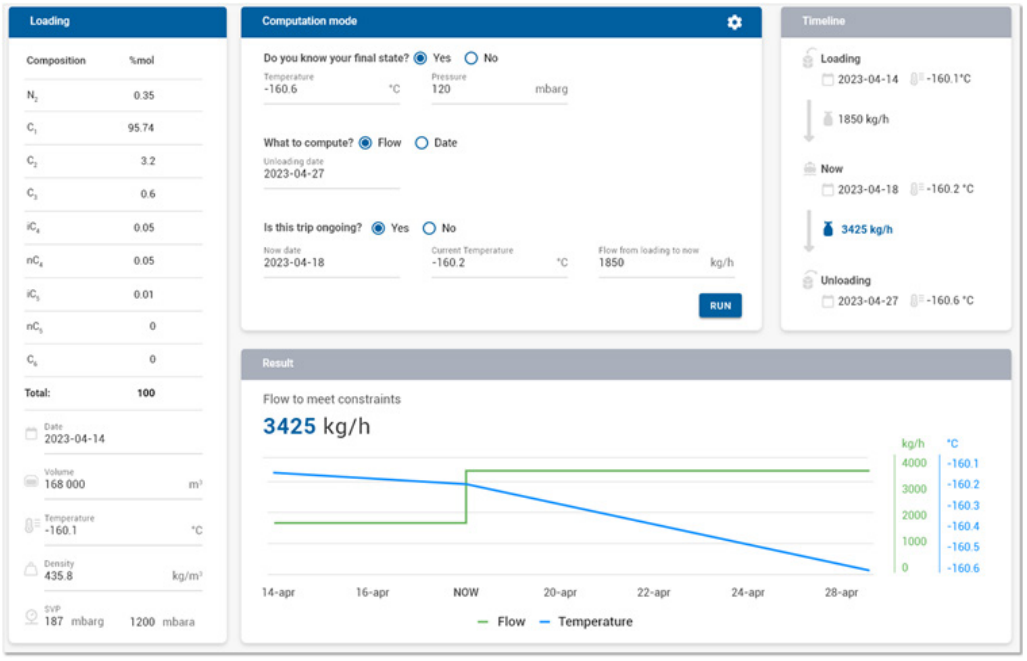
The LNG cargo loss means:

• BOG required to condition the cargo

• LNG used for propulsion

• LNG used for the hotel load

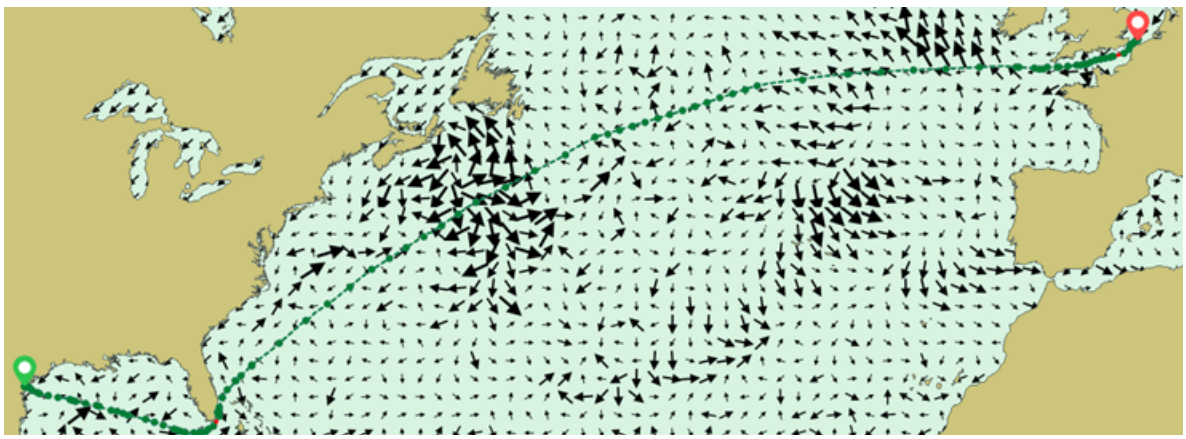
• Reliquefaction plant own consumption (if any)



The section “Loading” contains the cargo loading date, volume and thermodynamic properties. The section “Computation mode” is used to configure the prediction model (unloading conditions, desired output and voyage constraints). The section “Results” displays the simulation outcome (the BOG flow to be extracted from the tanks and the summary of the expected cargo loss by consumer).

Use case:

Route	USCRP → FRDKK
Distance (nm)	5027 (constant in this use case)
Volume_i (cbm)	171 340
Loading temp (°C)	-160.2
LNG comp (%mol)	C1 : 96.4 / N2 : 0.04



Four different speed profiles are explored:

	Unit	Slow	Mid-speed	High speed	Very high speed
Avg. Speed	kn	11.5	14.1	16.2	18.6
ETD		14/12/2022 00:00	14/12/2022 00:00	14/12/2022 00:00	14/12/2022 00:00
ETA		01/01/2023 04:26	28/12/2022 21:21	26/12/2022 22:46	25/12/2022 05:59
Duration	d	18.2	14.9	12.9	11.2
Speed_actual	kn	11.5	14.1	16.2	18.6
ME	MT	282.8	442.61	504.98	665
DG	MT	207.3	169.7	147.6	128.2
Total conso	MT	490.1	612.4	652.6	793.2
Distance	nm	5027	5027	5027	5027

Each speed profile is studied according to cargo conditioning to meet different unloading temperatures (considered within the terminal acceptable range):

- -159.4 °C
- -159.6 °C
- -159.8 °C
- -160.0 °C
- -160.2 °C

Result: Cargo loss expected based on discharge constraints

The charts below show the total cargo lost for a given laden speed (from the table above) and a given unloading temperature.

- **Reliquefaction plant OFF**

When the reliquefaction plan is off, Cargo Loss is indicated below

	Speed (kn)			
Unl. Temp. (..	11.5	14.1	16.2	18.6
-159.4	1 241	832	585	424
-159.6	1 576	1 168	921	760
-159.8	1 911	1 503	1 256	1 096
-160.0	2 245	1 838	1 591	1 431
-160.2	2 579	2 172	1 926	1 766

- **Reliquefaction plant ON**

When the reliquefaction plan is on, Cargo Loss is indicated below.

	Speed (kn)			
Unl. Temp. (..	11.5	14.1	16.2	18.6
-159.4	1 140	1 404	1 497	1 819
-159.6	1 187	1 404	1 497	1 819
-159.8	1 233	1 418	1 497	1 819
-160.0	1 280	1 465	1 510	1 819
-160.2	1 326	1 511	1 556	1 819

Result analysis

Of course, the flexibility of the unloading time and temperature is subject to commercial considerations. Moreover, the sensitivity analysis can be pushed further by taking into consideration other parameters like the distance (route).

However, the use case shows that the variation of key parameters can result in big difference in cargo loss:

- In the first scenario (reliq OFF), the difference between the two extremes is (2579 – 424) = 2155 cbm = 482 720 USD[1]
- In the first scenario (reliq ON), the difference between the two extremes is (1819 – 1140) = 578 cbm = 152 096 USD[1]

The Cargo Conditioning module helps the operator assess the cargo loss beforehand and defines the correct parameters (unloading temperature, speed…) to minimize it.

1 Market assumption: 10 USD/MMBtu