

**Economic Commission for Europe**

**Inland Transport Committee**

26 November 2019

English

**Working Party on the Transport of Dangerous Goods**

**Joint Meeting of Experts on the Regulations annexed to the  
European Agreement concerning the International Carriage  
of Dangerous Goods by Inland Waterways (ADN)**

**Thirty-sixth session**

Geneva, 27-31 January 2020

Item 4 (b) of the provisional agenda

**Implementation of the European Agreement concerning the International  
Carriage of Dangerous Goods by Inland Waterways (ADN):  
special authorizations, derogations and equivalents**

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**Request for a derogation for the construction of a LNG  
Bunkering vessel with tanks bigger than 1000 m<sup>3</sup>**

**Transmitted by the Government of Belgium**

# M&M Shipping

REASONING REGARDING FEASIBILITY OF BIGGER LNG TANKS THAN 1000m<sup>3</sup>

TECHNICAL ADVANTAGES, INCREASED SAFETY AND ENVIRONMENTAL BENEFITS

NAVAL ARCHITECTS



5000 M<sup>3</sup> LNG Sea-Going Bunkering Vessel

28.10.2019.

## SUMMARY:

1. SCANTLING DIMENSIONS SHIP WITH 4 x 1250m<sup>3</sup>
2. 3D SHIP'S LAYOUT – 4 x 1250m<sup>3</sup>
3. COMPARISON of TWO Ships Concepts
4. TECHNICAL ADVANTAGES and BENEFITS of BIGGER TANKS
  1. IMO+IGC+ADN Concept – Highest Safety Standards
  2. Double Hull Layout according to IGC
  3. Specially Strengthened Outer Shell
  4. Type C, Double walls, Vacuum Insulated Tanks
  5. Services only in Ports
  6. Environmental Benefits
    1. Energy, Pollution for steel production
    2. Paints
    3. Installed Power and Consumption
5. REQUEST FROM CHARTERERS and OWNERS

MAIN PARTICULARS	Loa=	120.00 m	-	Maximal length
	Boa=	18.80 m	-	Maximal width
	H=	9.50 m	-	Maximal height
	D=	6.50 m	-	Scantling
	D=	4.00 m	-	Operational
	Airdraught=	10.00 m	-	In Ballast draft 2.70m
	Speed=	11.00 kn	-	15% Sea State; 100%MCR
	Speed=	6.00-9.00 kn	-	In Port
	Number of LNG Tanks=	4 x 1250 m <sup>3</sup>	-	Type C, Vacuum
CLASS NOTATION	Class Society-	Bureau Veritas		
	Class Notation -	I ☒ Hull, ☒ MACH, ESP, ☒ AUT-MS, AVM-APS, +SYS-NEQ-1 Unrestricted Navigation, Clean Ship (C), Geen Passport, IWS, LNG Bunkering Ship, type 2G (-163 <sup>o</sup> ; 500kg/m <sup>3</sup> 4barg), Dual Fuel, BOG, Initial-CD, IG Supply, RE. Ice Class 1A or 1B (Optional)		
		Class Notation Inland - (Optional)	ADN2019, Estrin, Atex Stage V Engines	



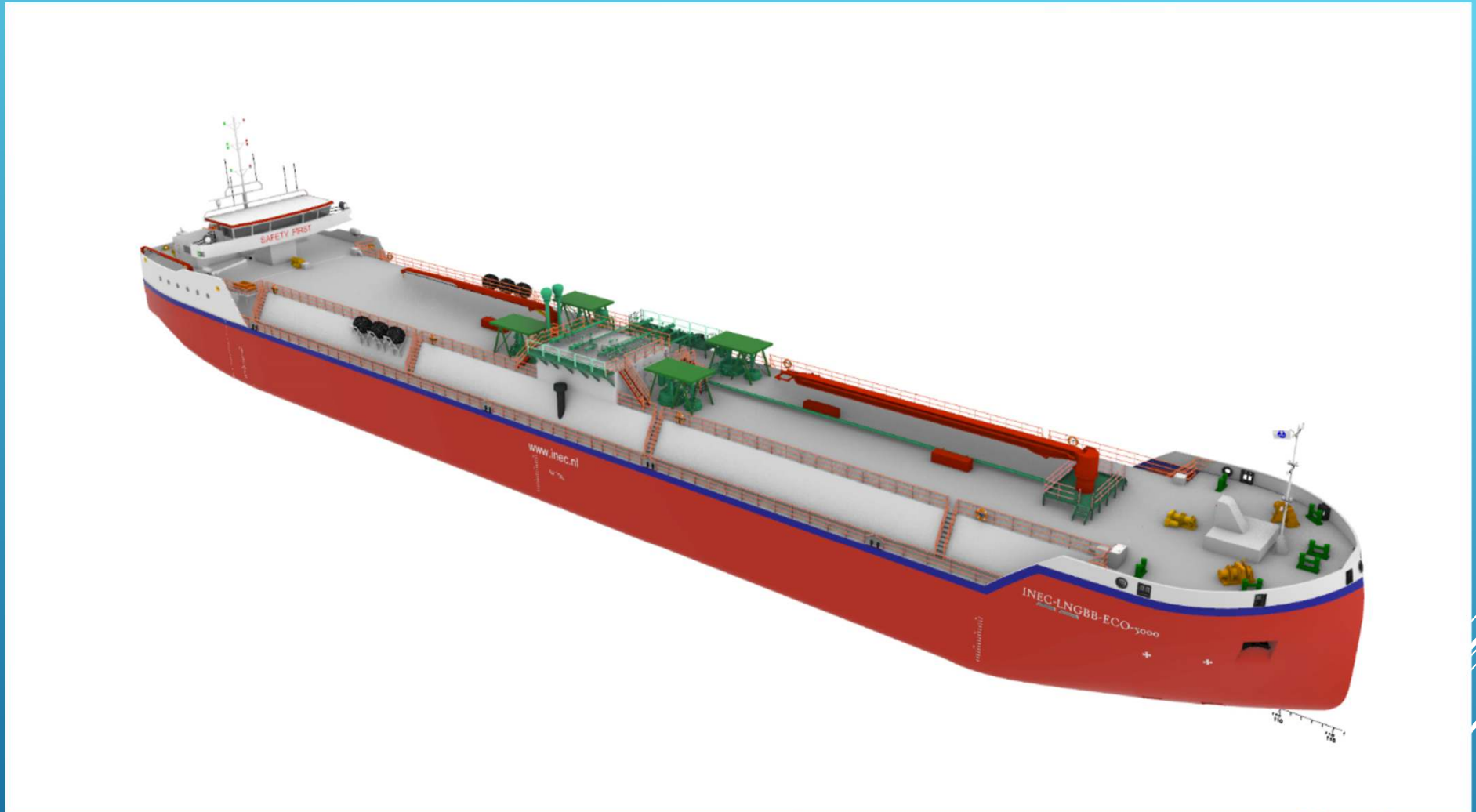
3D

5000 M<sup>3</sup> LNG

Real Design Layout

Sea-Going Bunkering Vessel

Ship with 4 x 1250m<sup>3</sup> LNG Tanks

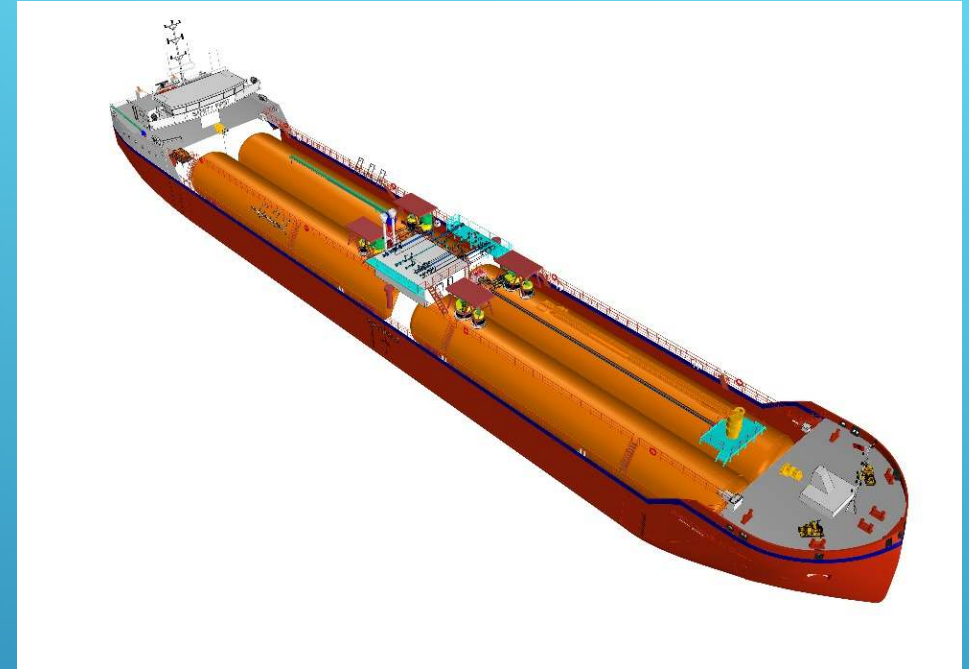
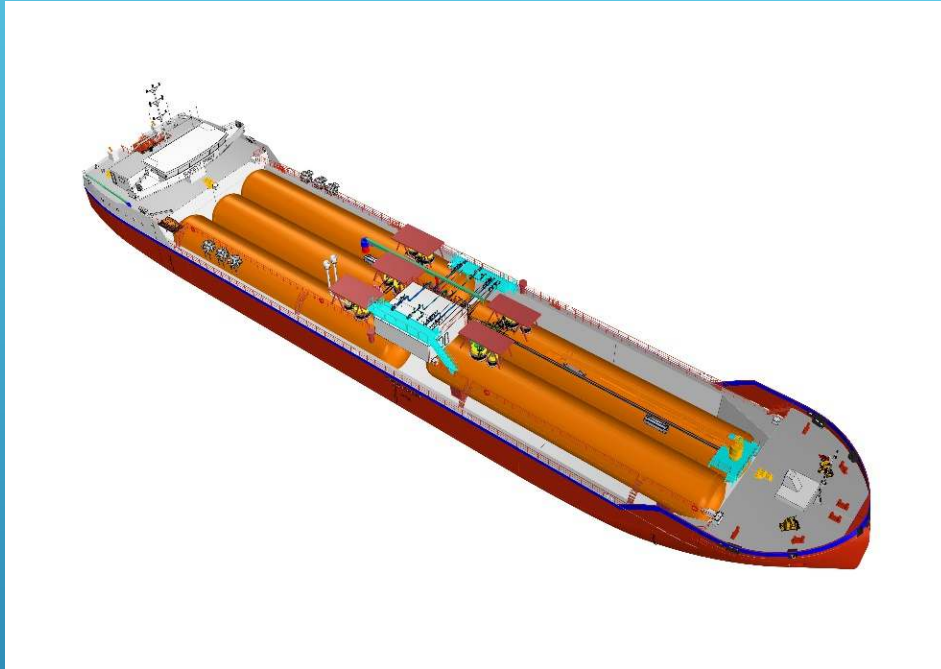


- Proven design based on the concepts of LNG Bunkering Vessel “LNG London”
- Proven Safety
  - Fully Enclosed Main Deck, protecting Cargo and Equipment of all Types of possible Calamities



# COMPARISON OF OUR CONCEPT WITH THE ACTUAL ADN

5000 M<sup>3</sup> LNG  
Sea-Going Bunkering Vessel



- Layout of 3 + 2 tanks of 1000 cbm is inevitable
- LARGER DIMENSIONS 118.00 x 22.80m
- Due to layout of 3 tanks in aft cargo hold, ships overall width is 22.80m, with as the consequence of reduced distance to outer shell (less safety).
- Due to higher displacement and concentrated weights in hold 2, with safety issues, heavier steel structure.
- Small distances between tanks, require heavier construction of trunk deck (very big span length)
- High demand for installed power

- Layout of 2 + 2 tanks of 1250cbm
- 121.00 x 18.70m
- Bigger distance between outer shell (collision zone) and inner LNG Tank wall.
- Better weight distribution from LNG Cargo tanks and cargo to overall ships construction
- Smaller span length and bigger distance between tanks provide basis for lighter deck construction

## Technical Advantages and Benefits

### Implementation of the bigger LNG tanks than 1000 m<sup>3</sup>:

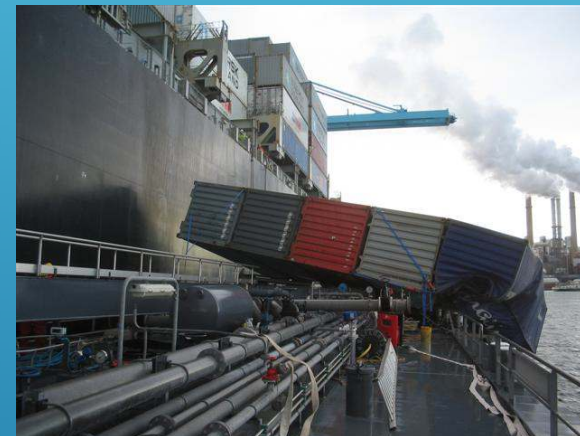
- **TECHNICAL ADVANTAGES:**
  - A Seagoing ship according to IMO / IGC with an ADN certificate for bunker service of LNG
  - Double hull layout according to IGC
    - Double hull width 1.5 m
    - Double bottom according to IGC
    - Damage Stability according to IGC
  - Special Strengthening of double hull:
    - Reinforced double hull (Anti-Collision system according to Chapter 9 – ADN)
    - ADN crash investigation according 9.3.4
  - Type C, Vacuum Insulated LNG Tanks
    - Double walled construction with Inner tank from Stainless Steel
    - Reinforced construction for seagoing accelerations
    - Min Safety factor ratio  $1250/380 = 3.28$  (increasing to mitigate the bigger tanks)
    - Possibility to increase safety factor to 3.5
  - Providing bunkering only in Ports
    - Sailing between ports: Amsterdam/ Rotterdam/ Antwerp/ Gent/ Vlissingen/Zeebrugge
    - No Rhine river trade (Germany)
- **ENVIRONMENTAL BENEFITS:**
  - **Bigger Tanks – Smaller Ships – Reduction of Impact on the Environment**



- **TECHNICAL ADVANTAGES:**

- A Seagoing ship according to IMO / IGC with an ADN certificate for bunker service of LNG

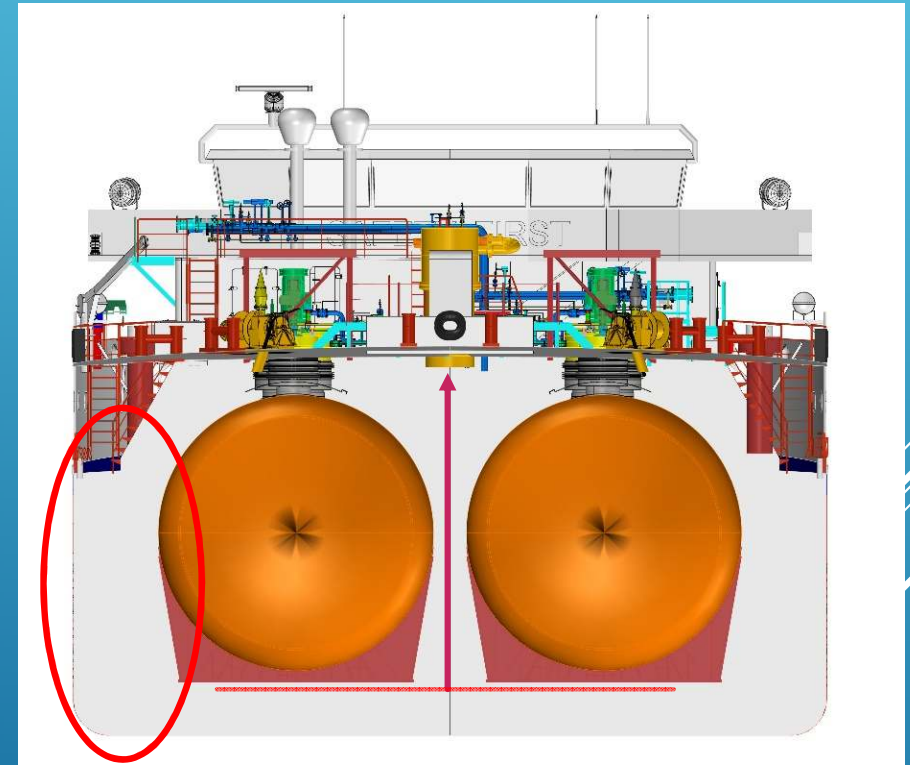
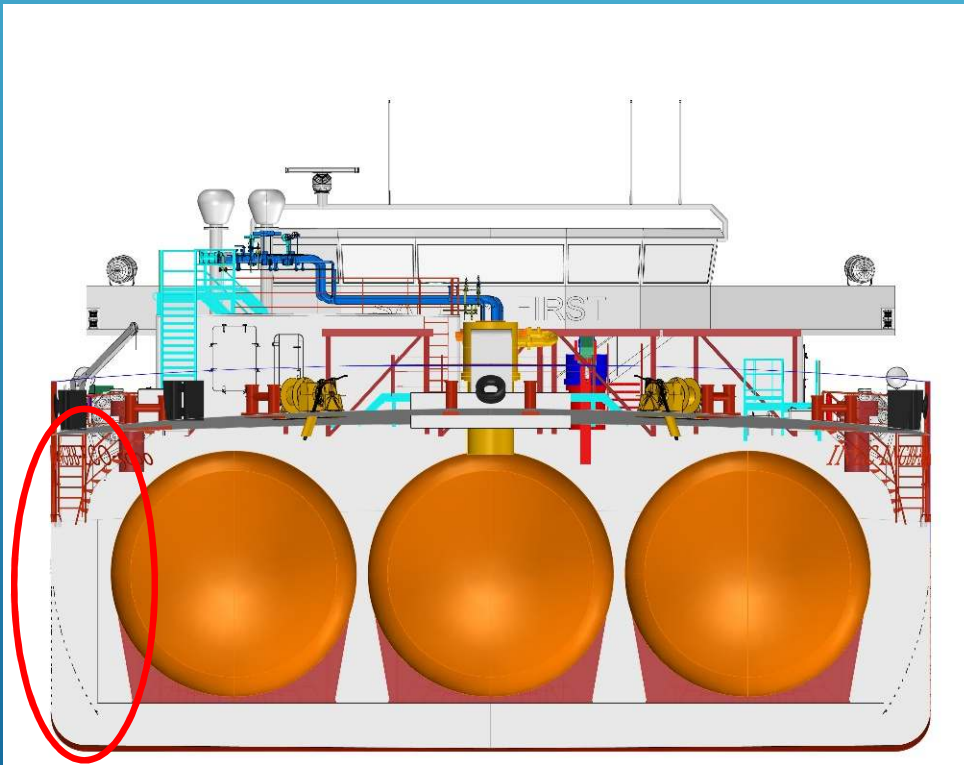
- Combination of IMO+IGC+ADN provides up to now, highest standards for such type of vessel.
- It is proven design based on the successful concepts of LNG Bunkering Vessel “LNG London”
- Proven Safety
  - Fully Enclosed Main Deck, protecting Cargo and Equipment of all Types of possible Calamities
  - Innovative Side Shell Construction, Strengthened to minimize impact of Ship-2-Ship Collisions



- Double walled LNG Tanks with StSt Inner Tank strengthened for Sea-Going Accelerations
- Proven Reliability
- Proven Operational Performances
- Safety and Automation Systems from Maritime Industry, applied and adapted to inland requirements

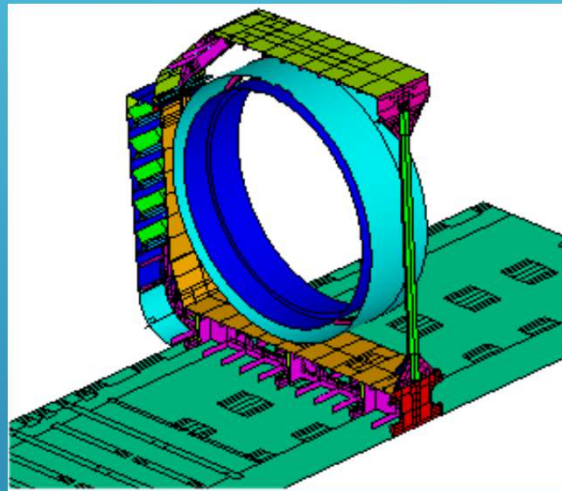


- **TECHNICAL ADVANTAGES:**
  - Double hull layout according to IGC
    - Width of wing tanks is 1.5 m
    - Distance from outer Shell to LNG tanks is bigger than at ship with 5 x 1000m<sup>3</sup> – Much higher Safety
    - Double bottom according to IGC
    - Damage Stability according to IGC



- **Bigger LNG tanks have lower BOG rate**

- **TECHNICAL ADVANTAGES:**
  - **Special Strengthening of double hull:**
    - Reinforced double hull (Anti-Collision system according to Chapter 9 – ADN)
    - ADN crash investigation according 9.3.4



Collision in busy ports is a daily present danger. There are plenty of collisions or collision related damages. Implementation of ADN Rules (Chapter 9) in Combination with IGC Layout creates the vessel of **highest safety standards**.





- Reinforced double hull (Anti-Collision system according to Chapter 9 – ADN)
- ADN crash investigation according 9.3.4

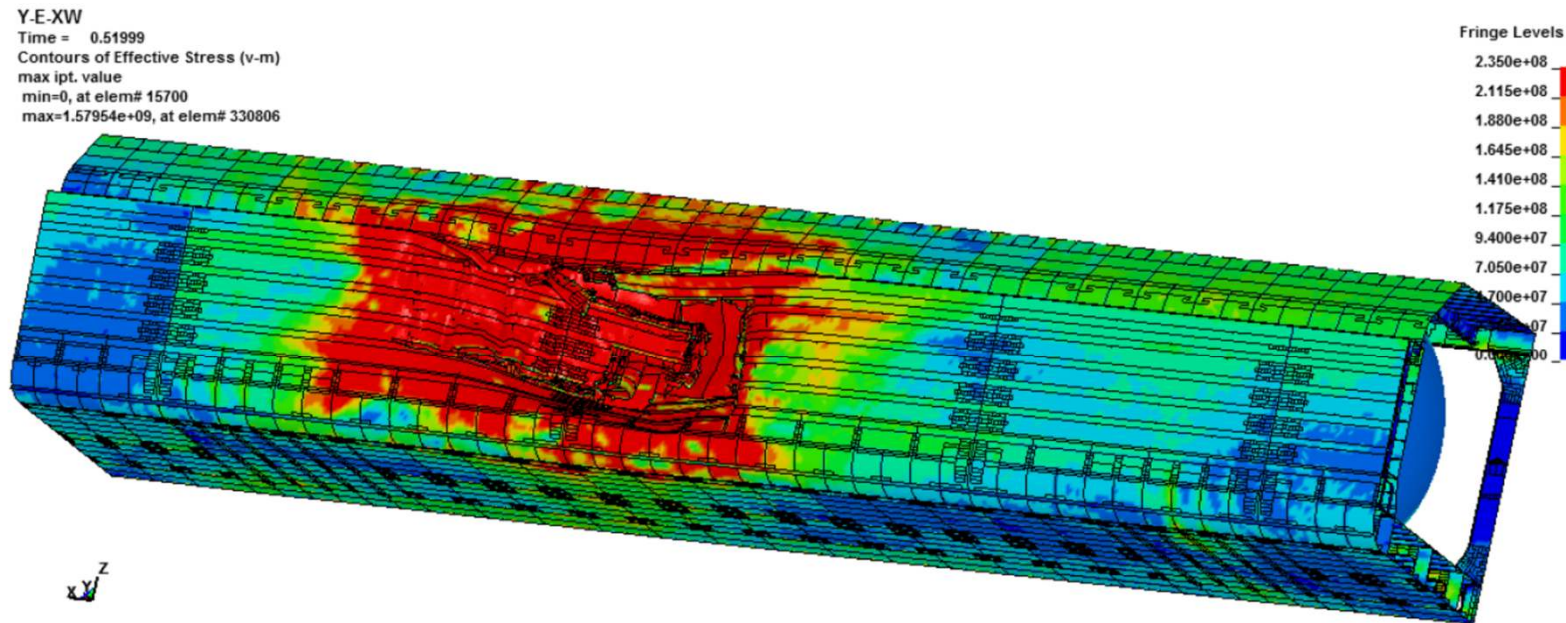


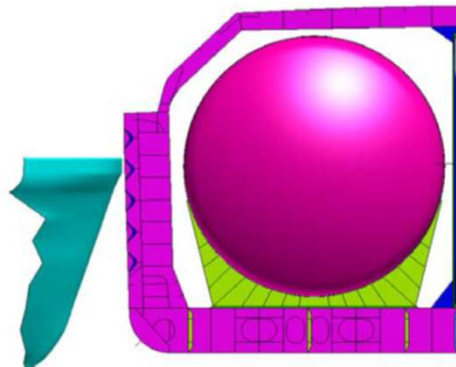
Figure 20 Global deformation at 5.20 [m] of indentation just before penetration of tank boundary. View on outer hull and bottom, plotted is Von Mises stress.

Appendix A Results Alternative Structure

reference E10226-80-AppA  
revision

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- Double walled LNG Tank construction with Inner tank from Stainless Steel
- Reinforced construction for seagoing accelerations
- Min Safety factor ratio  $1250/380 = 3.28$  (increasing to mitigate the bigger tanks)
- Possibility to increase safety factor to 3.5

**Requirement from owner and charter:**

It is proven, beyond reasonable doubt, that the vessel with 1250m<sup>3</sup> LNG Bunkering Tanks provides:

**1. Higher Safety,**

1. Lower BOG, resulting longer holding time and less energy consumption
2. BOG is allowed to be used as fuel as per new ADN2019. This is significantly reducing cost and environmental impact
3. Less equipment and piping
4. LESS TANKS , LESS OPERATION = LESS RISK

**2. More flexibility,**

1. Smaller width, provides better possibilities on terminals and receiving ships

**3. Better manoeuvring and operation**

1. Less required power for same speed.

**4. Significantly less impact on the Environment (which we proudly stress and underline)**

than the same vessel and same cargo capacity, with 1000m<sup>3</sup> LNG Bunkering Tanks.

Based on all, stipulated in this presentation, Owners and Charterers, humbly require long term derogation for the life time of the ship to sail with 4 x 1250 m<sup>3</sup> LNG Bunkering Tanks:

**Additional information, supporting the request:**

- At the moment full IGC ships are bunkering in Rotterdam ( Cardissa / Coral Methaan)
- These ships load at Gate terminal in Rotterdam and bunker in the port of Rotterdam
- In the near future more seagoing ships will provide LNG Bunkering in Inland Ports.
- New LNG INGC Bunker Ships have tanks of 9000 m<sup>3</sup> ( Mol bunker ship is even 18000 m<sup>3</sup>)



- ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment

**INTRODUCTION:**

- Ships in General, are One of The Bigger Pollutants
- According to Official Statistics, 16 biggest ships in The World, powered with HFO, were bigger pollutants than all cars together. New IMO Legislations reduced that impacts, but still ships continue to harm The Earth.
- When reasoning about pollution from the ships, men think mostly about emission from combustion engines
- Unfortunately, ships are influencing our Environment, as well The Earth in many other ways:
  - They are the biggest transporting objects on the Earth and are made from steel
  - For their anti-corrosive protection, tens-of-thousands of litres of paint are used
  - For furnishing and insulation, we used ton's of plastic
  - We still burn fissile fuels to propel the ships (that will not change for longer time)

QUESTION: HOW THE BIGGER LNG TANKS CAN CONTRIBUTE TO BETTER ENVIRONMENT?

ANSWER: BIGGER LNG TANKS – COMPACTER SHIPS (FOR SAME CARGO CAPACITY)

QUESTION: ARE THERE RELIABLE NUMBERS PROVING ABOVE STATEMENT?

ANSWER: YES THEY ARE



- **ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment**

## **STEEL**

Example is 5000m<sup>3</sup> LNG Bunkering Vessel, for which are analysed:

- a. Vessel 1 - 5 x 1000m<sup>3</sup> LNG Tanks,
- b. Vessel 2 - 4 x 1250m<sup>3</sup> tanks,

The ships dimensions are:

- 5x1000m<sup>3</sup> – ships dimensions are: 115.00 x 22.80m....., Weight = 2150ton
- 4x1250m<sup>3</sup> – ships dimensions are: 121.00 x 18.80m....., Weight = 1950ton

What are the consequences of the compacter vessel and less steel weight?

*It is not possible to take all factors into account. There are many level in the production chain; from the moment of the mining of Iron-Ore, till production of the 1000kg of steel at Steel Factory as well installation into the ship.*

To fabricate 1000tkilograms or tons of steel, we need the following activities:

- mining
- transportation of ore, from the mine to the trains, trucks and ships (very long distances usually)
- transportation from Sea-Ports till steel factories (by trains and Inland Barges)
- production of steel in steel factory,
- storage and transport of produced steel-sheets or profiles
- transportation to the end users (shipyards)
- fabrication and installation of steel material into ship

**All these activities consume huge energy and provide significant pollution to the environment.**

Further in this presentation, we will mention just two: energy consumption and CO<sub>2</sub> emission.



- **ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment**

### 1. HOW MUCH ENERGY WE USE IN STEEL FACTORY TO PRODUCE 1000kg of STEEL?

Steel is made in Steel Factories from Iron-Ore. Most common way is to use COKE.

Around 0.6 tonnes (600 kg) of coke produces 1 **tonne** (1000 kg) of **steel**, which means that around 770 kg of **coal** are used to **produce 1 tonne of steel** through this production route. Basic Oxygen Furnaces currently **produce** about 74% of the world's **steel**.

**Conclusion: In case of the ship, which is 200tons lighter, we will spare 155tons of coal.**

### 2. SOMEBODY CAN ARGUE, THAT INSTEAD OF COAL, WE CAN USE ELECTRICITY.

To produce a ton of **steel** in an **electric** arc furnace requires approximately 400 kilowatt-hours per short ton or about 440 kWh per metric tonne; the theoretical minimum amount of energy required to melt a tonne of scrap **steel** is 300 kWh (melting point 1520 °C/2768 °F).

**Conclusion: In case of the ship, which is 200tons lighter, we will spare 88.000kWh of electricity. In Holland, average usage of electricity per family, per year is 3.500kWh. It means, that "our compacter ship" will spare electricity for 25 families for a whole year.**

### 3. WHAT IS THE CO<sub>2</sub> EMISSION IN THE PRODUCTION OF 1000kg of STEEL?

Most of the CO<sub>2</sub> generated by today's steel industry comes from the chemical interaction between carbon and iron ore in blast furnaces. This process, known as iron reduction, produces molten iron which is converted to steel.

On average for 2017, 1.83 tonnes of CO<sub>2</sub> were emitted for every tonne of steel produced. The steel industry generates between 7% and 9% of direct emissions from the global use of fossil fuel.

**Conclusion: In case of the ship, which is 200tons lighter, we will remove 366tons of CO<sub>2</sub> from our atmosphere.**



#### 4. EXCEPT CO<sub>2</sub>, DOES COAL BURNING RELEASE ANYTHING ELSE IN THE AIR?

Coal combustion releases nitrogen oxides, sulphur dioxide, particulate matter (PM), mercury, and dozens of other substances known to be hazardous to human health.

Sulphur dioxide (SO<sub>2</sub>) emissions, primarily the result of burning coal, contribute to acid rain and the formation of harmful Particulate.

#### GENERAL CONCLUSIONS RELATED TO THE IMPACT OF STEEL PRODUCTION ON ENVIRONMENT

- The Compacter Ship, with 200tons of less steel, will:
  - Require 155tons of coal less for steel production, or
    - Will provide 88.000kWh reduction in electricity usage
  - Will keep our air cleaner by not contributing to the discharging of 366tons CO<sub>2</sub> into the atmosphere
  - Will significantly contribute to the reduction of the quantities of harmful elements in the atmosphere



- ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment

## PAINT

When calculating the quantity of paint in ships design, common practice is to use 20-22.00kg of paint per 1000kg of fabricated steel.

The ships dimensions are:

- 5x1000m<sup>3</sup> – ships dimensions are: 115.00 x 22.80m....., Weight = 2150ton
- 4x1250m<sup>3</sup> – ships dimensions are: 121.00 x 18.80m....., Weight = 1950ton

It means that the vessel with 200tons less steel, has also 4.000ltr less paint on board.

### 1. WHAT MATERIALS ARE USED FOR PAINT FABRICATION?

Raw materials are divided into three major groups, namely, pigments (**titanium dioxide, zinc oxide etc.**), solvents (mineral turpentine) and resins and additives. Pigments are finely ground solids of different shades to give colour, durability, consistency and other properties to **paint**.

Pigments used in paints: The most common inorganic pigment is white titanium dioxide (titanium(IV) oxide) which provides over 70% of total pigments **used** (Unit 51). It has a high refractive index and gives a 'gloss' to the **paint**. Another widely **used** inorganic pigment is finely divided calcium carbonate.

VOCs (Volatile Organic Compounds) are solvents that get released in paint as the paint dries. They are **dangerous** for a couple of reasons. First, many VOCs are known carcinogens. A typical bucket of **paint** contains **chemicals**, such as benzene, methylene chloride and others, that have been linked to cancer [source: United States Environmental Protection Agency].

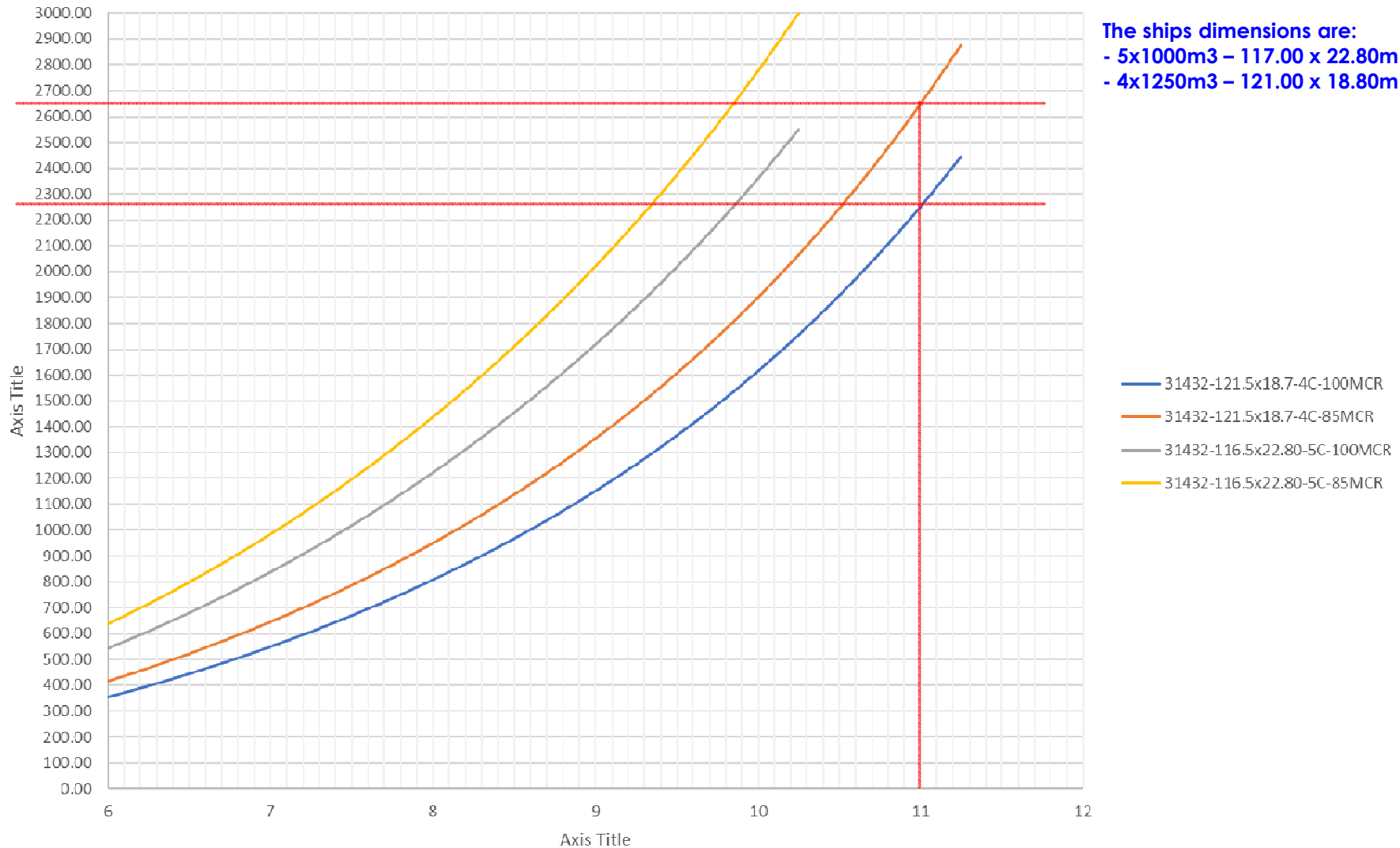
Although harmful substances in paint are reduced, the paint remains dangerous product for our Environment.



- ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment**

## **PROPULSION: POWER CURVES – VESSEL 1 vs VESSEL 2**

Speed-power curve comparison at 4.00m draught, twin propellers 1.800m diameter



- **ENVIRONMENTAL BENEFITS: Bigger Tanks – Smaller Ships – Less Impact on Environment**

## **PROPULSION: POWER CURVES – VESSEL 1 vs VESSEL 2**

The ships dimensions are:

Vessel 1: 5x1000m<sup>3</sup> – ships dimensions are: 115.00 x 22.80m

Vessel 2: 4x1250m<sup>3</sup> – ships dimensions are: 121.00 x 18.80m

Assumptions for the presented Power – Curves:

1. Calculations were made with real ships forms
2. Software used is proven in practice
3. The power curves are made for same draught (4m) and with same propellers (2x1.8m diameter in nozzle).
4. The curves are drawn all the way to cavitation point.
5. Possible cavitating range is not drawn on the chart.
6. Dual-Fuel – Electric Propulsion is assumed (losses in propulsion line)

### **CONCLUSIONS:**

1. The advantage is clearly in favour of Vessel 2: 4C concept.
2. For same input parameters and same speed, Vessel 1 needs far more installed power:
  1. For 6kn speed, at 85%MCR: V1 requires 637kW, while V2 requires 1355kW (almost 53%)
  2. For 9kn speed, at 85%MCR: V1 requires 2020kW, while V2 requires 1355kW (almost 50%)
  3. For 10kn speed, at 85%MCR: V1 requires 2777kW, while V2 requires 1900kW (almost 46%)

**It is more than obvious that narrower vessel, at same draught, with same propellers is more environmental friendly than wider and shorter vessel.**

