Hydrogen-fueled Vessel Wins AiP Towards Demonstration Operation 3

Mitsui O.S.K Lines, Ltd.
MOL Drybulk, Ltd.
Onomichi Dockyard Co., Ltd.
Kawasaki Heavy Industries, Ltd.
Japan Engine Corporation

Mitsui O.S.K Lines, Ltd. (MOL), MOL Drybulk, Ltd., Onomichi Dockyard Co., Ltd., Kawasaki Heavy Industries, Ltd. (Kawasaki) and Japan Engine Corporation (J-ENG) conducted a risk assessment of a Multi-Purpose Vessel powered by hydrogen, zero-emission fuel and has been granted Approval in Principle (AiP) of parcel layout concept (*1) from Nippon Kaiji Kyokai (ClassNK).

This is the world's first AiP certification for a ship equipped with a low speed two-stroke hydrogen-fueled engine as the main propulsion engine.

Demonstration operation of the vessel will be conducted for two years from around FY2027 as part of the "Development of marine hydrogen engines and MHFS (*2)" which was adopted by Green Innovation Funding Program of the New Energy and Industrial Technology Development Organization (NEDO). Prior to the demonstration operation, J-ENG's large low-speed two-stroke hydrogen-fueled engine and Kawasaki's MHFS will be installed in the vessel by FY2026. MOL and MOL Drybulk will be in charge of ownership and operation management of the vessel and Onomichi Dockyard will be in charge of the development and building of the vessel, and they will cooperate toward the demonstration operation.

Image of Hydrogen-fueled Multi-Purpose Vessel (D/W 17,500 M.T.)

The five companies held a Pre-HAZID meeting (*3) on June 28-29, 2023, together with ClassNK and the National Maritime Research Institute, National Institute of Maritime, Port and Aviation Technology. The parties completed identification of the risks and issues to be considered in further design for the

Hydrogen-fueled Vessel Wins AiP Towards Demonstration Operation 3

parcel layout concept of liquefied hydrogen fuel tank and fuel supply system, and confirmed that the design of the vessel can proceed further based on the current parcel layout.
MOL, MOL Drybulk, Onomichi Dockyard, Kawasaki and J-ENG will contribute to reducing GHG (Greenhouse gas) in the maritime industry and achieving carbon neutrality by 2050 through the demonstration operation of the vessel.

***1 Parcel layout concept：**
Proposed layout of liquefied hydrogen fuel tank and other hydrogen fuel related equipment onboard and the design concept.
***2 MHFS：**
Marine Hydrogen Fuel System（Marine Hydrogen Fuel Tank and Fuel Supply System）
***3 Pre-HAZID meeting：**
Risk assessment meeting held to review the parcel layout concept of the marine hydrogen fuel tank and the fuel supply system prior to the HAZID (Hazard Identification Study) meeting that will be held for whole vessel in this project.
HAZID meeting：Risk assessment meeting in which experts discuss the magnitude and frequency of potential system hazards to ensure that the system as a whole is sufficiently safe.

Related press release

“Development of marine hydrogen engines and MHFS” is adopted by NEDO, part of Green Innovation Funding Program ～ Moving to Realize a Zero Emissions Vessel ～
(Oct. 26, 2021)
MOL, MOL Drybulk, J-ENG Sign Agreement for Trial of Hydrogen-fueled Engine equipped Onboard ～ Aiming to Realize a Zero Emissions Vessel ～ (Nov. 9th, 2021)
https://www.j-eng.co.jp/en/news/2021/te8a720000000mjj-att/J-ENGPressRelase20211109_EN.pdf
Testing of hydrogen fuel injection device for a large low-speed two-stroke engine has begun. (May 16, 2023)
https://www.j-eng.co.jp/en/news/20230516.html

AiP Certificate Handover Ceremony
(From left)
Hiroyuki Motoya, Executive Officer/General Manager, Design Department, Onomichi Dockyard
Terumi Moriguchi, Managing Executive Officer, MOL Drybulk
Yoshihiko Sugimoto, General Manager, Technical Division, Technology Innovation Unit, MOL
Masaki Matsunaga, Corporate Officer/Director of Plan Approval and Technical Solution Division, ClassNK
Hideaki Murata, Associate Officer/General Manager, Marine Machinery Business Division, Kawasaki
Seiji Shindo, Representative Executive Managing Director of Technology, J-ENG

Kawasaki Completes Hybrid Propulsion System Using Gas Engine for Bulker 4

Kawasaki Heavy Industries, Ltd. (Kawasaki) has completed a hybrid propulsion system using a natural gas-fueled engine for a limestone bulk carrier operated by NS United Kaiun Kaisha, Ltd. of Japan. This hybrid propulsion system consists of a natural gas-fueled engine and a large capacity battery, and is the first such installation on a bulk carrier.

This hybrid propulsion system uses a gas-fueled engine as the main engine. The gas-fueled engine can achieve approximately 24% reduction of CO_2 emissions when compared with the conventional heavy-oil-fueled diesel engine installed on a ship of the same type. Furthermore, emissions of SOx and NOx in the engine exhaust can be greatly reduced.

The limestone bulk carrier is scheduled to enter service in February 2024, and will operate with the hybrid propulsion units consisting of the gas-fueled main engine and 2,847kWh lithium-ion battery. The LNG fuel tank for the main engine has been designed using 7%-nickel steel developed by Nippon Steel Corp for the first time for ships.

Limestone bulk carrier image

During navigation, the Kawasaki main gas engine generates the propulsion force and inboard electric power. With only natural gas fuel, the ship can cruise over long distances and extended service under high power. When entering and leaving a port, the ship is operated by electric propulsion mode using the battery. This mode achieves ship operation with zero-emission of greenhouse gases (GHGs).

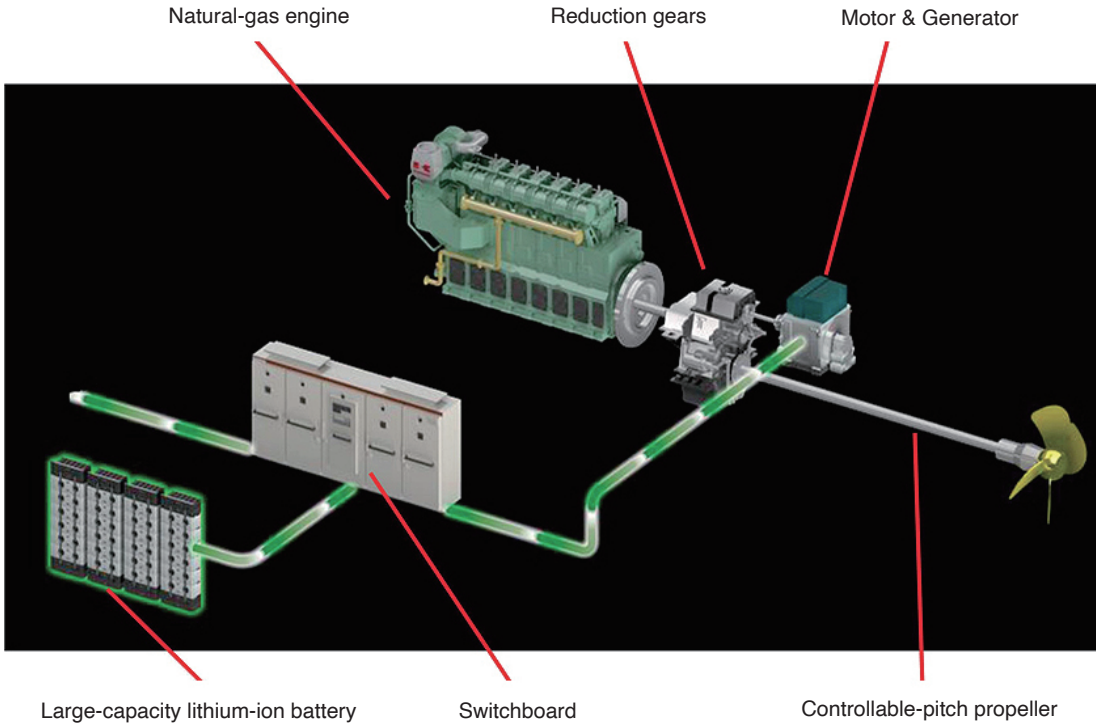
Emissions control of the main engines will become more severe in international ship operation, so main engines must adapt to the requirements for environment conservation. Gas-fueled engines can surmount such severe emission control requirements without treating the exhaust gas.

Kawasaki has developed the marine gas engine, model L30KG, based on the technology accumulated through manufacture of gas engines for electric generator use, which demonstrate the highest power-generation efficiency in the world. The Kawasaki marine gas engine has obtained a Type Certificate of the DNV and is now marketed worldwide. Moreover, Kawasaki is now preparing the acquisition of a Type Certificate for the control system, same as the gas engine, within 2024

Emission control reinforcement of GHGs has been promoted by the International Maritime Organization (IMO) in the

Kawasaki Completes Hybrid Propulsion System Using Gas Engine for Bulker 4

Gas-engine hybrid propulsion system



Gas-engine hybrid propulsion system

marine transportation area as well. Kawasaki, as an integrator of ship propulsion systems, will continue to develop superior propulsion systems in the environmental performance by optimal combination of the gas-fueled engine and propulsion components to contribute to reduction of load on the environment.

Outline of limestone bulk carrier

Deadweight: Apporx. 5,549 t
Length (o.a.): 94.0 m
Width (mld.): 18.2 m
Depth (mld.): 9.90 m
Main service route: Coastal line between Shiriyasaki Port and Muroran Port
Cargo: Limestone

Kawasaki Successfully Completed Verification of Automated Berthing and Unberthing Operations with Advanced Safety Berthing/Unberthing Assistance System

Safety and Efficiency Improvements for In-Port Vessel Maneuvering, Berthing, Unberthing and Mooring Operations 5

Kawasaki Heavy Industries, Ltd. announced today its success in automated in-port vessel maneuvering, berthing and unberthing operations*1 using Advanced Safety Berthing/Unberthing Assistance System, for which research and development are being carried out jointly with Kawasaki Kisen Kaisha, Ltd. ("K" Line) and Kawasaki Kinkai Kisen Kaisha, Ltd. ("K" Line Kinkai). The operations were conducted as part of system verification tests in real-life operating environments. Following confirmation of successful automated operations, Kawasaki began accepting customer orders for the system. During development of the Advanced Safety Berthing/Unberthing Assistance System, issues were raised in regard to the technically challenging task of keeping the vessel attitude parallel to the berthing quay amid varying wind conditions and other external influences while maneuvering the ship laterally toward the berthing location. The Kawasaki-developed "Advanced Berthing/unberthing Assistance System - Display Unit"*2 and "Advanced Berthing/unberthing Assistance System - Control Unit"*3 were utilized during verification tests to enable the test vessel to automatically follow a preset course amid winds and waves, from harbor entry to berthing(fender touch). Automated berthing and unberthing operations were successfully completed during both entry into and departure from port, moving ahead and astern.

Normally, berthing and unberthing operations are carried out by skilled crew with thoroughgoing knowledge and experience in vessel maneuvering technique, as well as the specific maneuverability characteristics and mooring equipment features of their own vessel. However, increasing ship sizes have made vessel maneuvering more sophisticated and challenging, while shortages of crew personnel have become a widespread problem throughout society. These have led to demands for improvements in terms of labor savings, reduced skill-level requirement and improved safety management in vessel maneuvering and mooring operations. The introduction of Kawasaki's Advanced Safety Berthing/Unberthing Assistance System will contribute to significant improvements in the efficiency and safety of these challenging in-port vessel operations. Moreover, the system can be installed on any type of vessel. Kawasaki has applied for Approval in Principle (AiP) from Nippon Kaiji Kyokai (ClassNK) for the system, and approval is on going .

Vessel used for verification tests

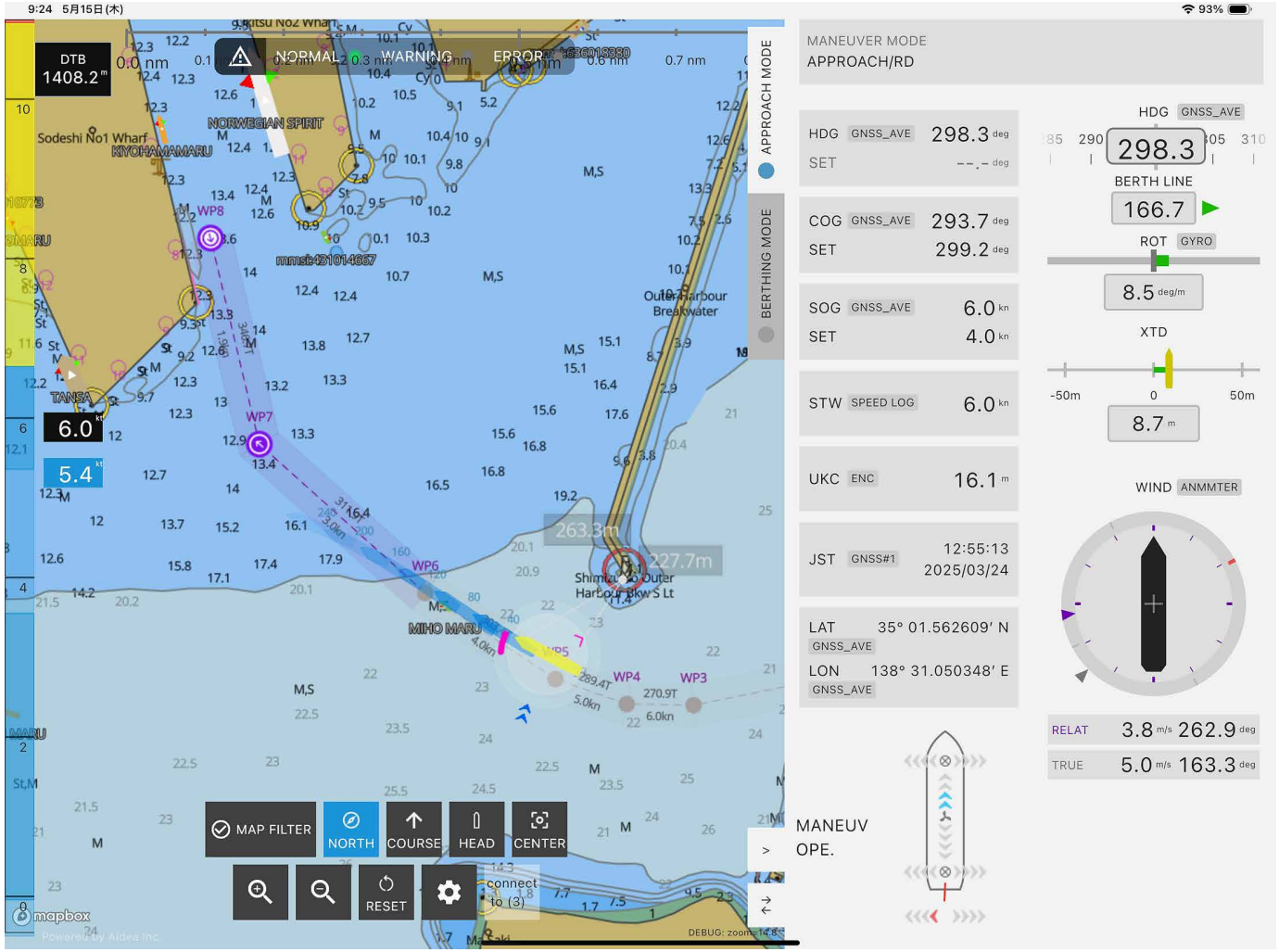
Chart: Vessel Specifications

Length overall: 173.34 m
Molded breadth: 26.6 m
Gross tonnage: 13,950 tons

Kawasaki is Japan's only domestic manufacturer involved in engineering for everything from ship propulsion to mooring systems, and works with propulsion equipment, a dynamic positioning system (DPS)*4 for automated ship control, steering gear, deck machinery and more. The company will continue making improvements to the Advanced Safety Berthing/Unberthing Assistance System, supporting all operational areas from berthing and unberthing to ship mooring and mooring

Kawasaki Successfully Completed Verification of Automated Berthing and Unberthing Operations with Advanced Safety Berthing/Unberthing Assistance System

Safety and Efficiency Improvements for In-Port Vessel Maneuvering, Berthing, Unberthing and Mooring Operations 5



On-screen display for "Advanced Berthing/unberthing Assistance System - Display Unit"

management, while deploying the system in an increasing range of real-life applications, in order to drive further advances in the marine shipping industry.

*1 Automated berthing and unberthing operations: A ship maneuvering method in which the captain sets vessel speed only, after which the system carries out automated navigation along a preset course to the berthing quay, automatically controls headings, and maintains the ship facing parallel to the quay during berthing. The system is also equipped with features that enable automated deceleration, stopping and heading change operations in response to quay and stopping point distances.

*2 Ship Maneuvering Support Information Display System: A system that provides ship movement prediction information relating to the future course, speed, stopping position and so forth through utilization of ship movement prediction models and the latest sensing technologies. This system provides ship movement predictions with wind effects factored in, as well as ultra-precise information on distances between the ship and quay (down to the centimeter) and berthing speeds during berthing and unberthing operations. Kawasaki has applied for and is awaiting the results of ClassNK Products & Solutions (P&S) certification for this system.

*3 Ship Maneuvering Support Control System: A system that optimally controls ship speed and attitude in response to constantly changing weather conditions, sea conditions and other external factors based on ship movement prediction information. It enables automated maintenance of attitude, positioning and course adherence to ensure that actual ship operations match the operator's defined course and speed settings, supporting the entire ship maneuvering operations up to berthing. The system can also be used in berthing and unberthing operations in coordination with tugboats, and in berthing operations using integrated control of propulsion and mooring equipment.

*4 A dynamic positioning system, or DPS, utilizes vessel position measurement equipment such as GPS to measure vessel positions in real time, and provides automated control of propulsion systems and rudders to prevent the ship's straying from its intended position.

Joint Study on the Construction Scheme for Liquefied Hydrogen Carriers 6

Kawasaki Imabari Shipbuilding Co., Ltd. JMU Japan Marine United

June 02, 2025
Kawasaki Heavy Industries, Ltd.
Imabari Shipbuilding Co., Ltd.
Japan Marine United Corporation

Joint Study on the Construction Scheme for Liquefied Hydrogen Carriers

Kawasaki Heavy Industries, Ltd. (Kawasaki), Imabari Shipbuilding Co., Ltd., and Japan Marine United Corporation are due to commence a joint study (Study) to establish a construction scheme for liquefied hydrogen carriers.

This Study examines the feasibility of a collaborative construction scheme that efficiently utilizes their respective resources, such as facilities and human resources, for the construction of liquefied hydrogen carriers following the first commercial carrier to be designed and built by Kawasaki.

Liquefied hydrogen carriers are expected to play an essential role in the establishment of a liquefied hydrogen supply chain by enabling the transport of large volumes of hydrogen.

This Study will reinforce the cooperative relationship between each company for the commercialization of a liquefied hydrogen supply chain who will work toward the realization of a carbon-neutral society.

Ammonia Fueled LPG/Ammonia Carrier Vessel Granted Approval in Principle 7

Ammonia Fueled LPG/Ammonia Carrier Vessel Granted Approval in Principle 7

ClassNK
NIPPON KAIJI KYOKAI

Document No. 25HE01164
Date: 8 August 2025

APPROVAL IN PRINCIPLE

AMMONIA FUELLED LPG/NH_3 CARRIER
developed by Kawasaki Heavy Industries, Ltd. and MITSUI E&S Co., Ltd.

THIS IS TO CERTIFY THAT Approval in Principle is granted to Kawasaki Heavy Industries, Ltd. as a shipyard and MITSUI E&S Co., Ltd. as a supplier of ammonia fuel supply system and ammonia fuel consumer.

The AiP is for the design concept of the ammonia fuelled LPG/NH_3 carrier, and it is based on "Part C-2 : Guidelines for the Safety of Liquefied Gas Carriers Using Ammonia as Fuel (Edition 3.0.2)" and "Part C-3 : Additional Safety Measures for Engine Rooms (Edition 3.0.2)".

The documents/drawings specified in the annex to this letter have been reviewed and it is verified that the conceptual design of the system is feasible for the intended application.

Conditions on this approval are set out in the Annex to letter 25HE01164.
For final approval of the system, a complete set of documentation is to be approved by the Society in accordance with relevant class rules.

(Akio Usami)
General Manager of Hull Department
NIPPON KAIJI KYOKAI

Form CL8 (21.01)

DAiP certification

Kawasaki Heavy Industries, Ltd. announced that in collaboration with MITSUI E&S Co., Ltd., a supplier of ammonia fuel engines and ammonia fuel supply systems, it has been granted Approval in Principle (AiP) from Nippon Kaiji Kyokai (ClassNK) for a LPG/ammonia carrier that can use liquid ammonia as the ship's fuel.*1

Ammonia is a green fuel*2 that emits no CO_2 when burned, and like hydrogen is attracting interest as a next-generation fuel at a time when the International Maritime Organization (IMO) is strengthening restrictions on gas emissions from ships. With regard to the ammonia fuel supply system, safety has been evaluated by a HAZID risk assessment meeting of experts and necessary measures have been taken. When they confirmed the design safety of the carrier to be compliant with ClassNK criteria, the AiP was granted.

In pursuit of carbon neutrality by 2050, Kawasaki is developing and supplying environmentally-friendly ship technologies, such as LPG-fueled LPG carriers, LNG-fueled vessels, and equipment linked to the attractive new energy sources hydrogen and ammonia, that comply with stricter global environmental regulations, to help bring about the transition from a low carbon to a decarbonized society.

The main advantages of the ammonia fueled LPG/ammonia carrier are as follows:

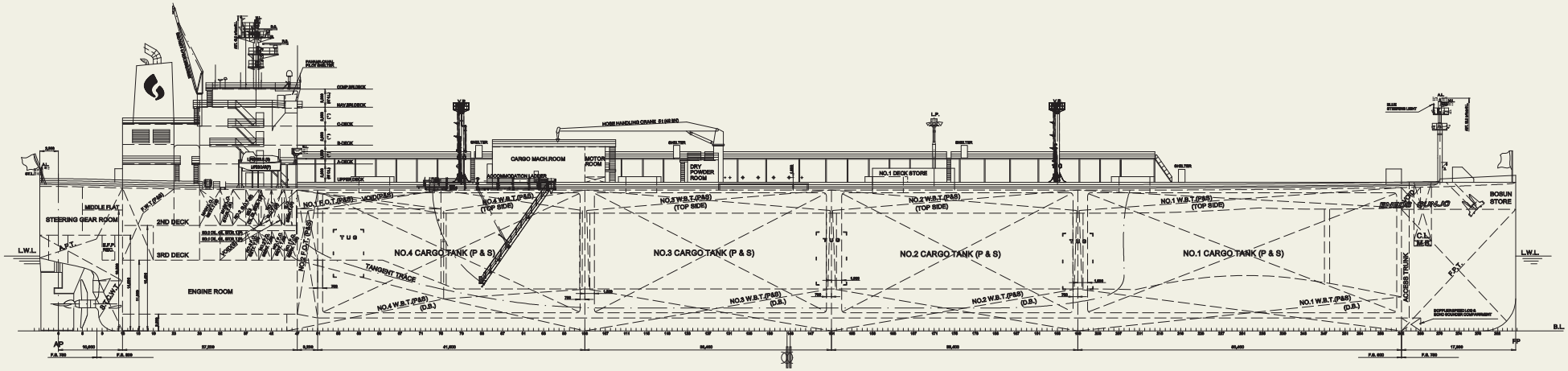
1. The fuel is drawn from the liquid ammonia cargo, so the installation of dedicated fuel tanks is not required.
2. Ammonia gas released into the atmosphere during maintenance or other work on the fuel supply system can be rendered harmless by pollution control equipment installed on the ship.
3. By reinforcing the ship's construction, full tanks of ammonia can still be transported despite the fuel being denser than LPG.

***1 Compliant with the general requirements of the ClassNK guidelines stipulating safety requirements for ships using alternative fuels (Part C-2), and for additional safety measures (Part C-3).**

***2 Assuming the CO_2 emission per unit of energy obtained from fuel oil is set as 1.0, LPG has an approximate value of 0.85. In contrast, ammonia, like hydrogen, does not emit CCO_2 when burned, so the CO_2 per unit energy is 0.**

ENEOS GUNJO 86,700m³ LPG-fueled LPG/NH3 Carrier 21

ENEOS GUNJO 86,700m³ LPG-fueled LPG/NH3 Carrier 21



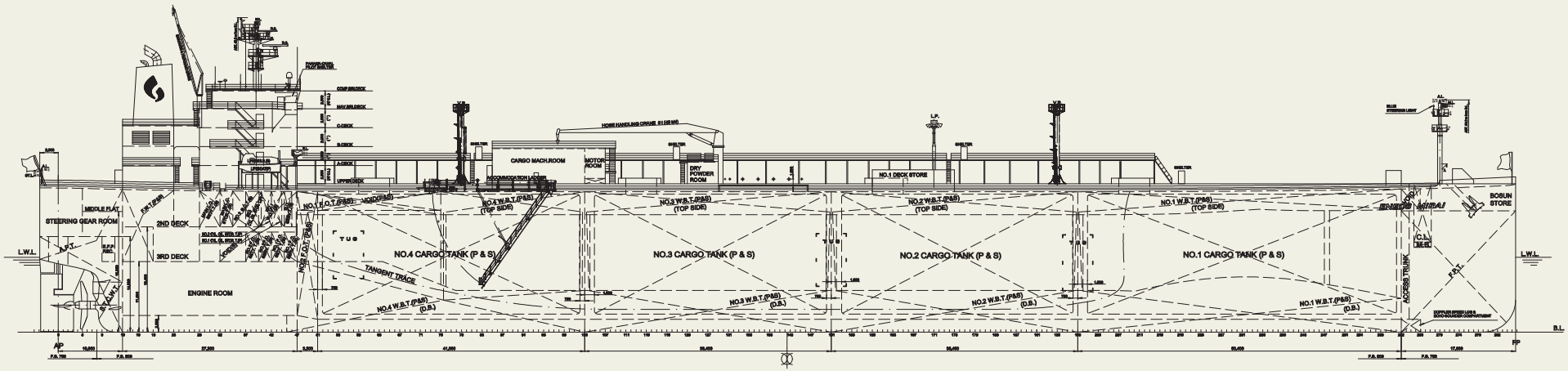
PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,531 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	29 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,904.2 m³
Gross tonnage	49,541	Builder	Kawasaki Heavy Industries, Ltd.

ENEOS MIRAI 86,700m³ LPG-fueled LPG/NH3 Carrier 22

Kawasaki Heavy Industries, Ltd.

ENEOS MIRAI 86,700m³ LPG-fueled LPG/NH3 Carrier 22

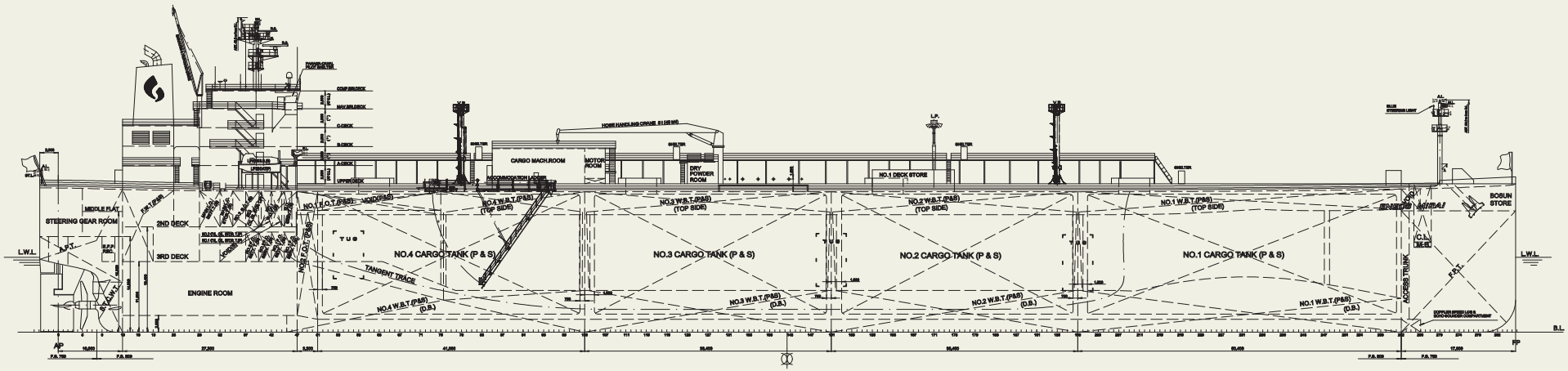


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,519 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	29 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,911.4 m³
Gross tonnage	49,541	Builder	Kawasaki Heavy Industries, Ltd.

GAS GARNET 86,700m³ LPG-fueled LPG/NH3 Carrier 23

GAS GARNET 86,700m³ LPG-fueled LPG/NH3 Carrier 23

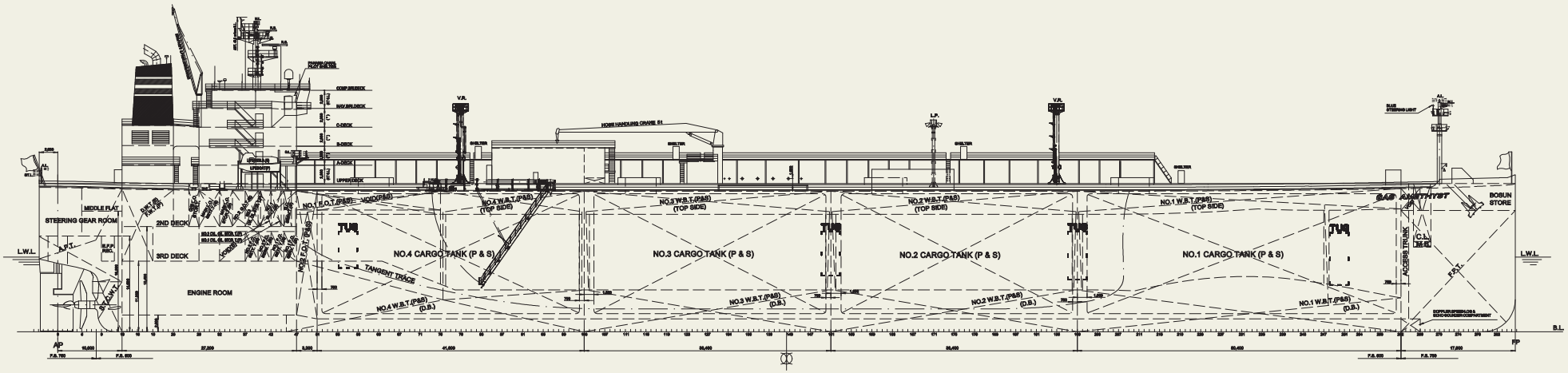


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,360 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	30 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,953.5 m³
Gross tonnage	49,561	Builder	Kawasaki Heavy Industries, Ltd.

GAS AMETHYST 86,700m³ LPG-fueled LPG/NH3 Carrier 24

GAS AMETHYST 86,700m³ LPG-fueled LPG/NH3 Carrier 24

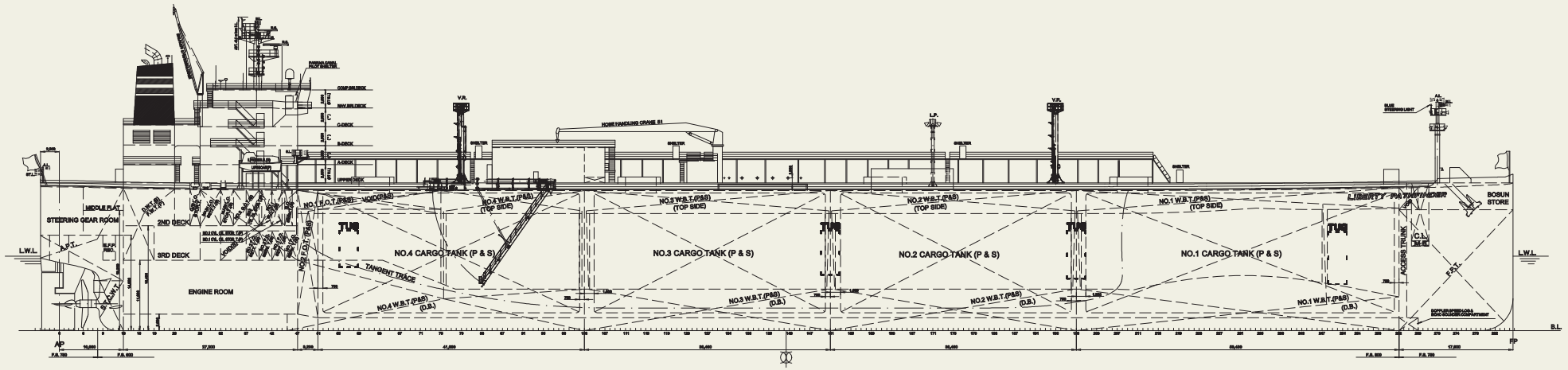


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,337 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	30 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,935.8 m³
Gross tonnage	49,561	Builder	Kawasaki Heavy Industries, Ltd.

LIBERTY PATHFINDER 86,700m³ LPG-fueled LPG/NH3 Carrier 25

LIBERTY PATHFINDER 86,700m³ LPG-fueled LPG/NH3 Carrier 25

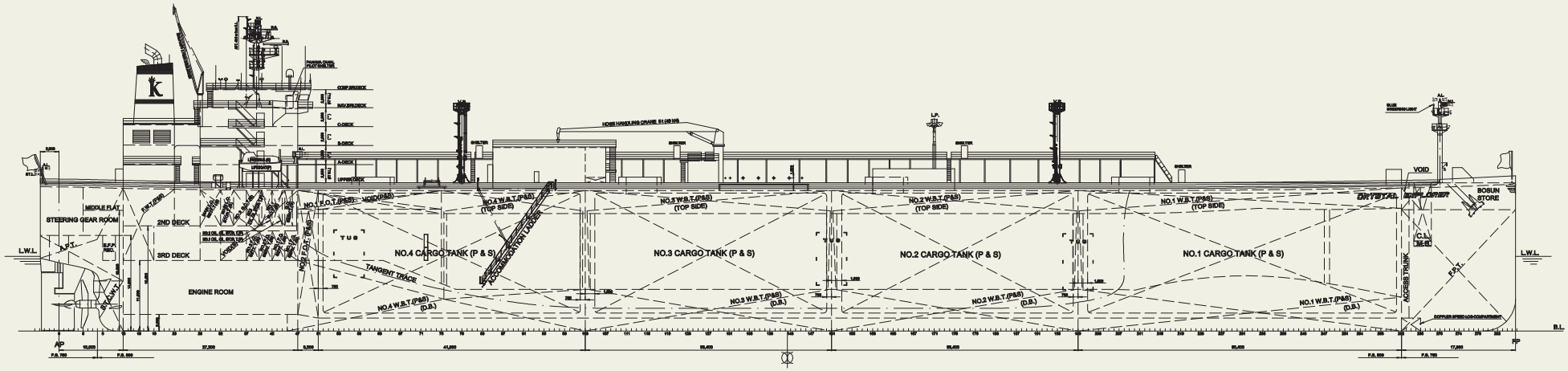


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,392 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	30 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,920.2 m³
Gross tonnage	49,541	Builder	Kawasaki Heavy Industries, Ltd.

CRYSTAL EXPLORER 86,700m³ LPG-fueled LPG/NH3 Carrier 26

CRYSTAL EXPLORER 86,700m³ LPG-fueled LPG/NH3 Carrier 26

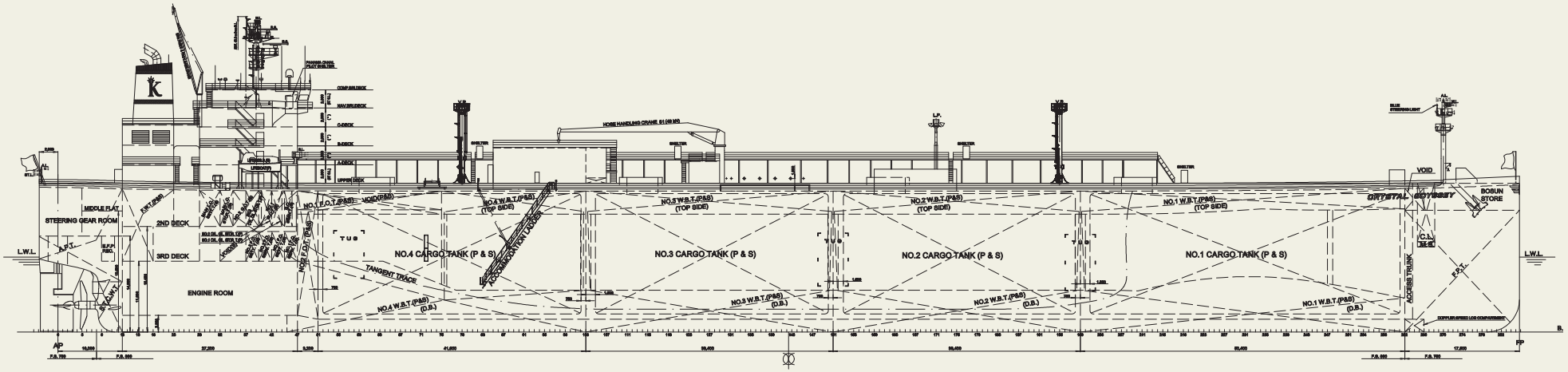


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,415 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	29 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	87,106.4 m³
Gross tonnage	49,561	Builder	Kawasaki Heavy Industries, Ltd.

CRYSTAL ODYSSEY 86,700m³ LPG-fueled LPG/NH3 Carrier 27

CRYSTAL ODYSSEY 86,700m³ LPG-fueled LPG/NH3 Carrier 27

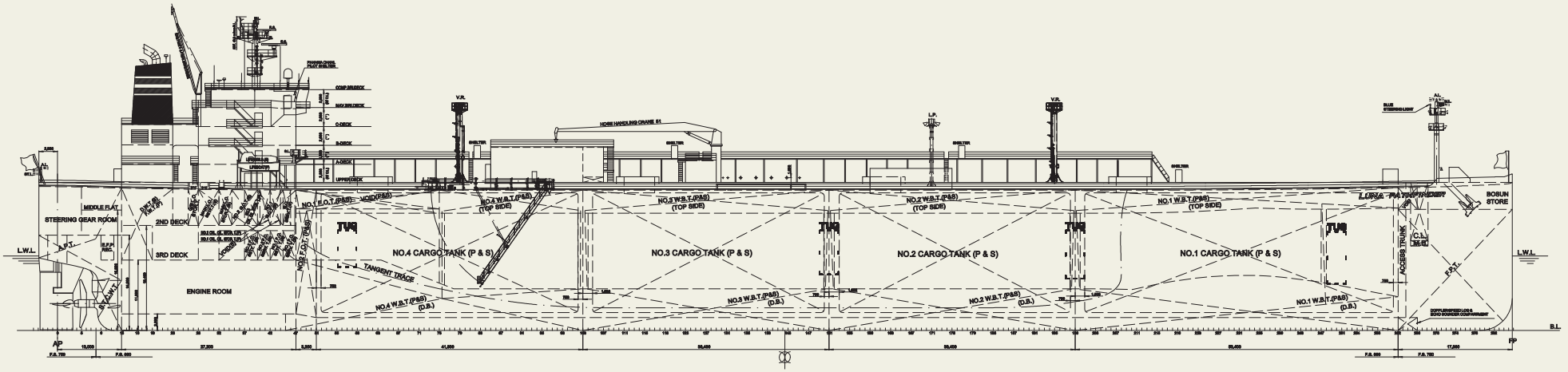


PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,331 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	29 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	87,098.6 m³
Gross tonnage	49,561	Builder	Kawasaki Heavy Industries, Ltd.

LUNA PATHFINDER 86,700m³ LPG-fueled LPG/NH3 Carrier 28

LUNA PATHFINDER 86,700m³ LPG-fueled LPG/NH3 Carrier 28



PRINCIPAL PARTICULARS

Length (o.a.)	229.90 m	Deadweight	56,380 t
Length (b.p.)	227.00 m	Main engine	KAWASAKI-MAN B&W 6G60ME-C10.5-LGIP
Breadth (mld.)	37.20 m	Complement	30 persons
Depth (mld.)	21.90 m	Classification	Nippon Kaiji Kyokai (Class NK)
Draft (mld.)	11.65 m	Loading capacity	86,946.7 m³
Gross tonnage	49,561	Builder	Kawasaki Heavy Industries, Ltd.