SEVEN ISLAND YUI 241 High-speed Passenger Ship

Kawasaki Heavy Industries, Ltd.

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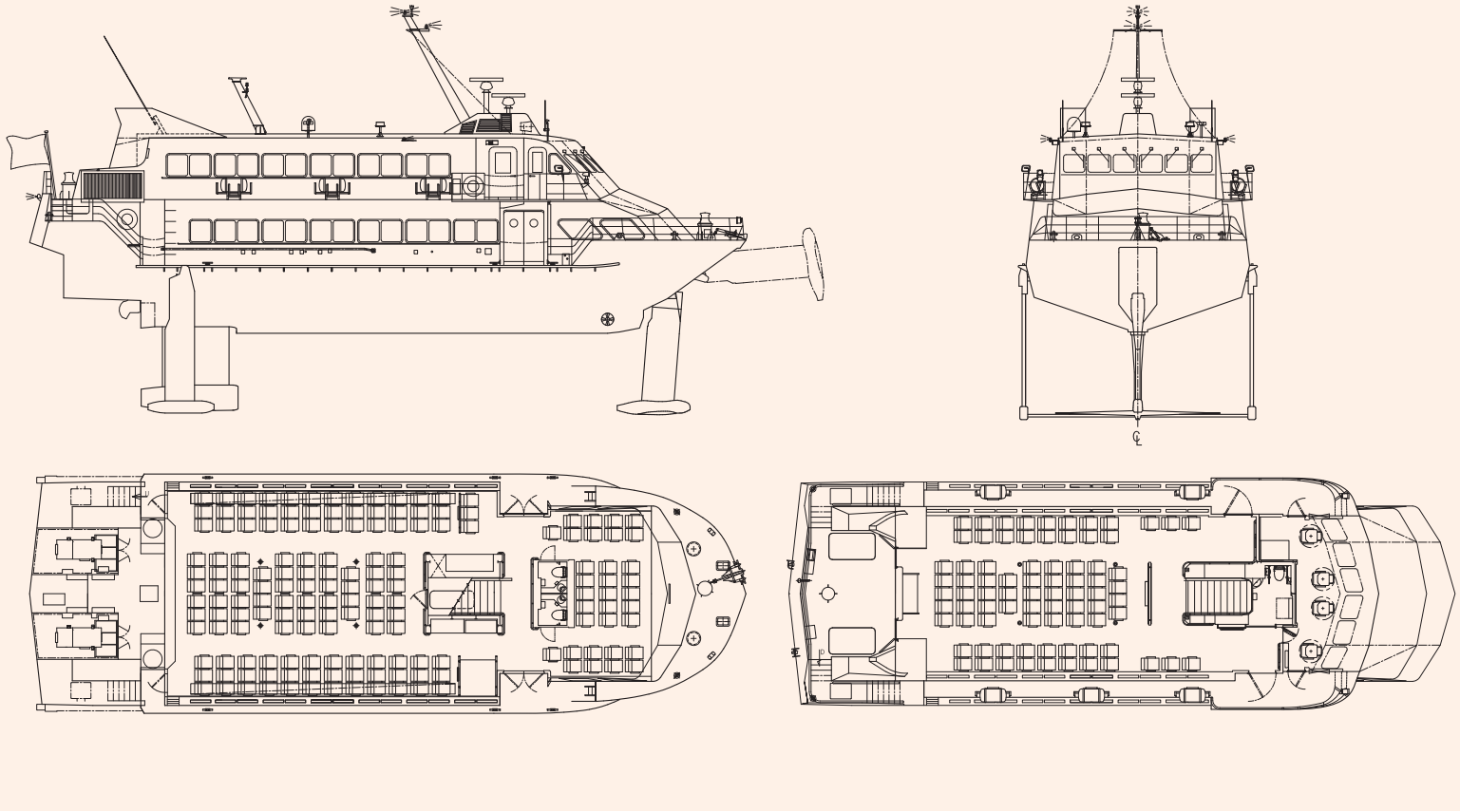
SEVEN ISLAND YUI 241 High-speed Passenger Ship 6

Kawasaki Heavy Industries, Ltd. delivered the SEVEN ISLAND YUI, a super-high-speed passenger ship, to the co-owners, Tokai Kisen Co., Ltd. and the Japan Railway Construction, Transport and Technology Agency (JRTT), on June 30, 2020. This passenger ship is the Kawasaki JETFOIL type, the first built in the last 25 years, and was put into regular service between the Tokyo Takeshiba Terminal and the Izu Islands on July 13. Kawasaki concluded a manufacturing license agreement by taking over the rights to produce and sell JETFOILs from The Boeing Company in 1987, and previously built 15 JETFOILs between 1989 and 1995. The JETFOIL utilizes fully submerged foils at the fore and aft of the hull to lift the hull over the sea surface. Two waterjet propulsors driven by two gas turbine engines discharge seawater from jet nozzles at the tail end of the aft JETFOIL. This allows the ship to travel at speeds of over 80 km/h. The JETFOIL can provide passengers with a comfortable ride even in waves as high as 3.5m and change direction smoothly by banking inward like an aircraft so that passengers can enjoy seasickness-free travel. Moreover, the SEVEN ISLAND YUI is the first JETFOIL coping with requirements for the disabled and the aged by providing various barrier-free facilities.

PRINCIPAL PARTICULARS

Length (o.a.): ..... 27.4m (with hydrofoils down)
Breadth (mld.): 8.5m
Speed (service): 43kt
Accommodation capacity: .....241 passengers
Nationality: ..... Japan
Builder: ..... Kawasaki Heavy Industries Ltd.



MARVEL PELICAN 155,000 m³ LNG Carrier 16

Kawasaki Heavy Industries, Ltd.

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MARVEL PELICAN 155,000 m³ LNG Carrier 16

Kawasaki Heavy Industries, Ltd. has delivered the MARVEL PELICAN (HN: 1729), a 155,000m³ capacity LNG transport vessel, for use by Mitsui & Co., Ltd. The MARVEL PELICAN is the second of Kawasaki's line of 155,000m³ LNG carriers to be commissioned, and is designed to enable passage through the newly expanded Panama Canal, which opened for full operations in 2016. Kawasaki will continue to pursue shipbuilding operations in the future with the anticipated rise in demand for LNG and other clean-energy fuels.

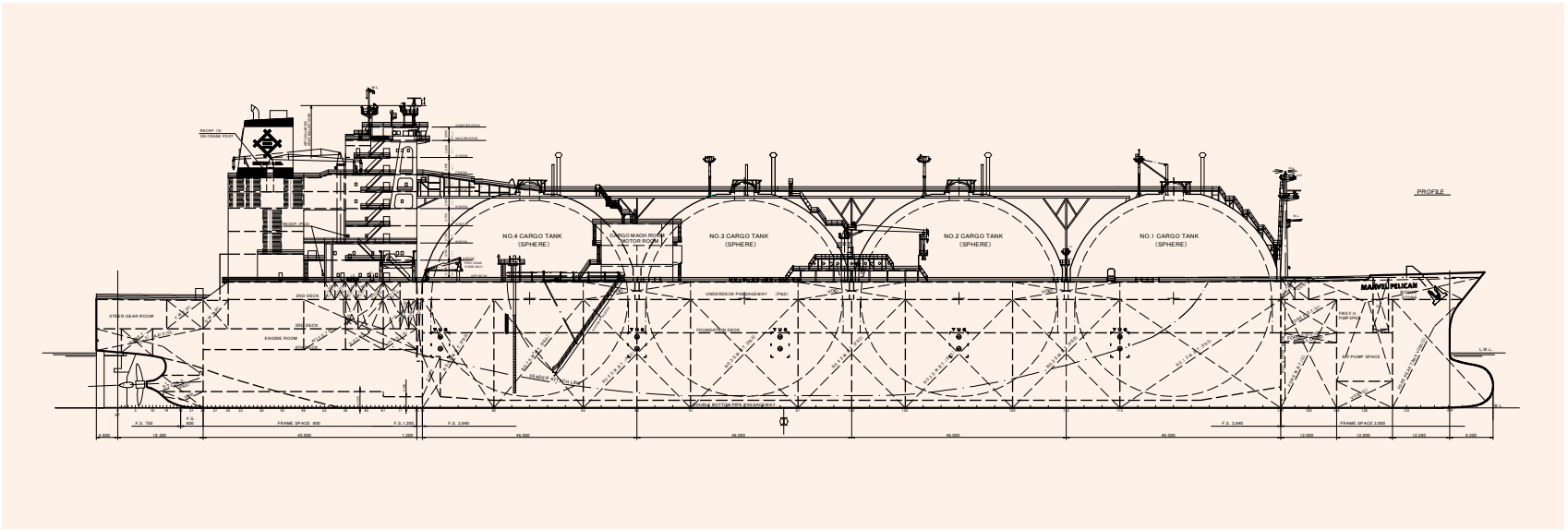
The MARVEL PELICAN will be used by Mitsui & Co., Ltd., primarily to transport LNG procured via the American Cameron LNG Project. Kawasaki has retained the hull dimensions to enable docking at major LNG terminals around the world, but has also optimized the hull structure to decrease overall ship weight. This LNG carrier is equipped with four independent Moss LNG tanks for a total cargo capacity of 155,985m³. The thermal insulation system of the LNG tanks adopts the proprietary Kawasaki Panel System, which offers outstanding heat insulation performance for an LNG boil-off rate of no more than approximately 0.08% per day.

The MARVEL PELICAN uses a dual fuel diesel (DFD) electric propulsion system,* which enables greater fuel efficiency than the existing steam turbine plant design. The DFD engine can consume both oil and gas, whereas a conventional generator engine can only burn oil for fuel. The propulsion system comprises multiple generator diesel engines and variable-speed propulsion motors. Either gas or oil is supplied to the engines to generate electricity, which drives the propulsion motors that power the propeller. The two-motor, twin-screw propulsion system enables high propulsive performance at a wide range of speeds.

The cargo tank section is protected by a double-hull and double-bottom design, so even if the carrier's hull were to sustain damage the LNG tanks within would remain safe and undamaged. The bridge is designed with state-of-the-art electronic navigation equipment concentrated in one location for greater ease of operation as well as panoramic windows offering a 360-degree view to the outside.

PRINCIPAL PARTICULARS

Length (o.a.):	299.90 m
Length (b.p.):	286.00 m
Breadth (mld.):	48.90 m
Depth (mld.):	27.00 m
Draft (mld.):	11.80 m
Gross tonnage:	128,917
Deadweight:	74,787 t
Main engine:	2 propulsion motors, 2 reduction gears
Speed (service):	Approx. 19.5 kt
Complement:	44 people
Classification:	Class NK
Loading capacity (tank)	155,985 m³ (at -163°C, 100% capacity)
Builder:	Kawasaki Heavy Industries Ltd.



KAGUYA 3,500 m³ LNG Bunkering Vessel

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Kawasaki Heavy Industries, Ltd.

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KAGUYA 3,500 m³ LNG Bunkering Vessel

Kawasaki Heavy Industries, Ltd. has held a naming ceremony for the LNG (liquefied natural gas) bunkering vessel, KAGUYA (HN: 1744), at the Sakaide Works. The vessel is being built for Central LNG Shipping Japan Corporation (a corporate joint venture owned by Nippon Yusen Kaisha, Kawasaki Kisen Kaisha, Ltd., JERA Co., Inc. and Toyota Tsusho Corporation).

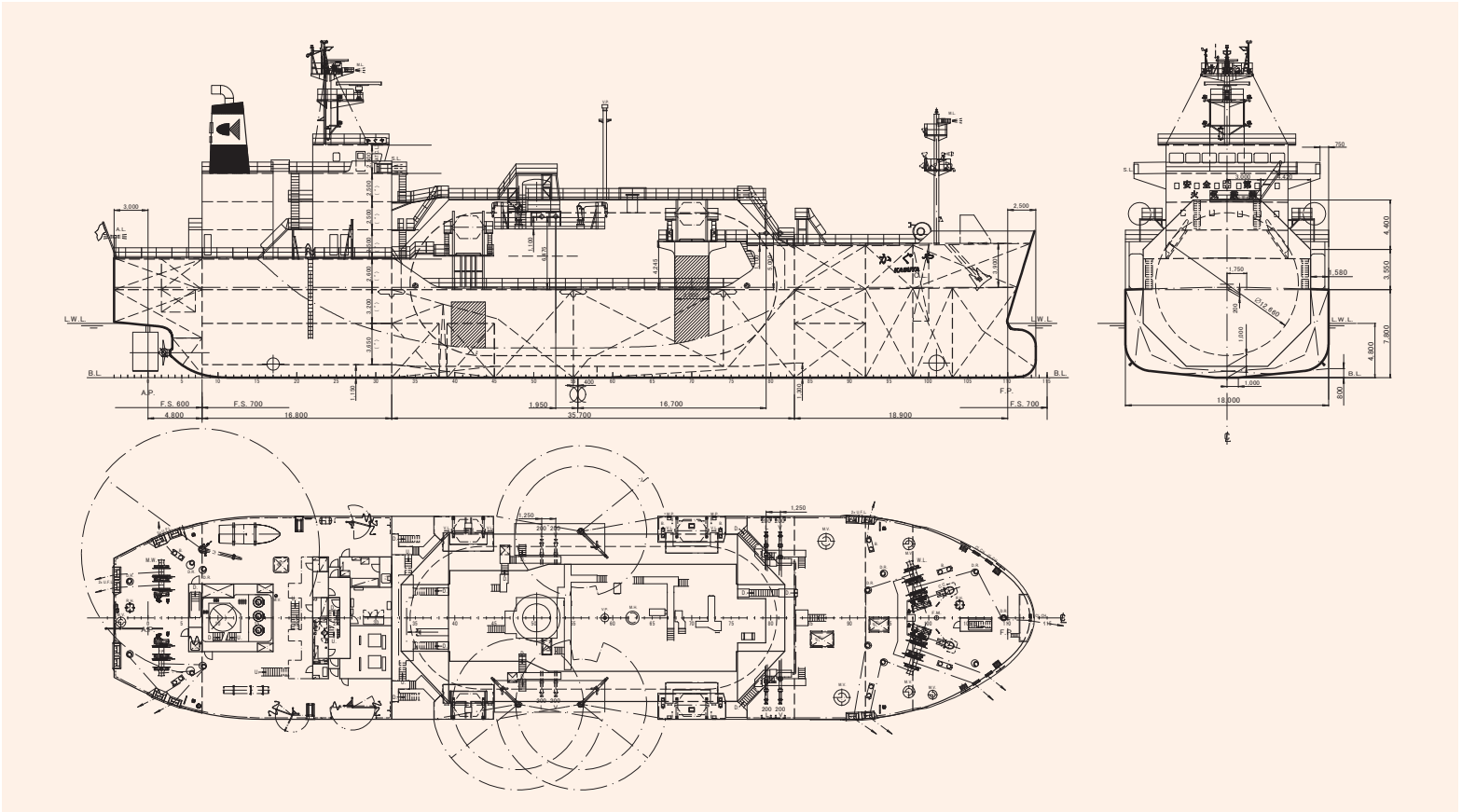
Vessels fueled by LNG instead of heavy fuel oil have been progressively introduced throughout the world as an effective measure in response to exhaust-gas emission regulations for vessels, which have been tightened since 2020. The KAGUYA will be Japan's first LNG bunkering vessel outfitted with facilities for supplying LNG-fueled ships with LNG at sea. Hitoshi Nagasawa, President, Representative Director of Nippon Yusen Kaisha, and Yukikazu Myochin, Representative Director, President and CEO of Kawasaki Kisen Kaisha, Ltd., named the vessel KAGUYA at the ceremony. Following this, Sunao Nakamura, Managing Executive Officer of JERA Co., Inc., and Toshiro Hidaka, CEO for Machinery, Energy & Project Division of Toyota Tsusho Corporation performed the rope-cutting ceremony.

The vessel will be delivered after various tests using actual LNG. Once construction is complete, the vessel will be based at JERA Kawagoe Thermal Power Station and used to supply LNG fuel to LNG-fueled ships in the Chubu region (Central Japan).

Kawasaki says that it will continue to actively work on the construction of various types of liquefied gas vessels including LNG, as demand is expected to increase as a clean form of energy.

PRINCIPAL PARTICULARS

Length (o.a.):	81.70 m	Draft (mld.):	4.80 m
Breadth (mld.):	18.00 m	Loading capacity (tank)	3,500 m³
Depth (mld.):	7.80 m	Builder:	Kawasaki Heavy Industries Ltd.



PHOENIX GAIA 82,200 m³ LPG Carrier 18

PHOENIX GAIA 82,200 m³ LPG Carrier 18

Kawasaki Heavy Industries, Ltd. has delivered the PHOENIX GAIA (HN: 1742), an 82,200m³ capacity LPG carrier, to Phoenix Tankers Pte. Ltd. This is the 60th LPG carrier and the 11th vessel of the same type built by the company.

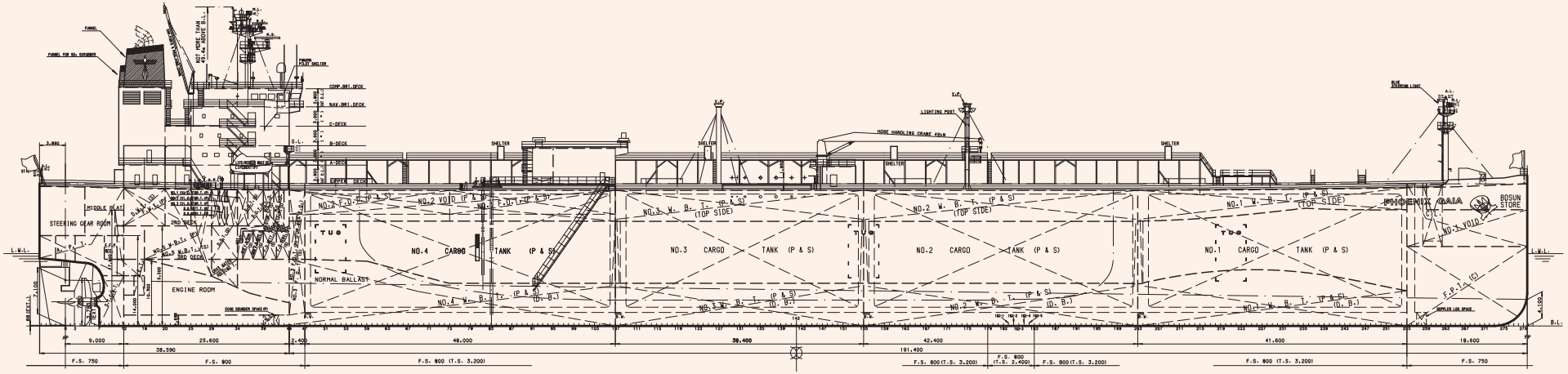
This vessel adopts Kawasaki's uniquely developed bow shape called SEA-Arrow, which significantly improves propulsion performance by minimizing bow wave resistance. The main engine is an energy-efficient, electronically-controlled, ultra-long-stroke, two-stroke low-speed diesel engine. In addition, the Kawasaki rudder bulb system with fins (RBS-F) and the semi-duct system with contra fins (SDS-F) contribute to reducing fuel consumption.

Four independent cargo tanks are installed in the cargo holds for carrying LPG. The tanks are designed to provide optimal thermal insulation and absorb low-temperature contraction. The cargo tanks are constructed with special cryogenic steel for loading LPG with a minimum temperature of -46° C. The tanks are wrapped in urethane foam for thermal insulation.

The vessel is designed to navigate the newly expanded Panama Canal, which was completed in June 2016.

PRINCIPAL PARTICULARS

Length (o.a.):	229.90 m
Length (b.p.):	226.00 m
Breadth (mld.):	37.20 m
Depth (mld.):	21.00 m
Draft (mld.):	11.20 m
Gross tonnage:	47,231
Deadweight:	53,928 t
Main engine:	Kawasaki-MAN B&W 7S60ME-C8.2 diesel x 1 unit
Cargo hold capacity:	82,416 m³
Complement:	29 people
Classification:	Class NK
Builder:	Kawasaki Heavy Industries Ltd.



CRYSTAL ANGEL 82,200 m³ LPG Carrier 19

Kawasaki Heavy Industries, Ltd.

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CRYSTAL ANGEL 82,200 m³ LPG Carrier 19

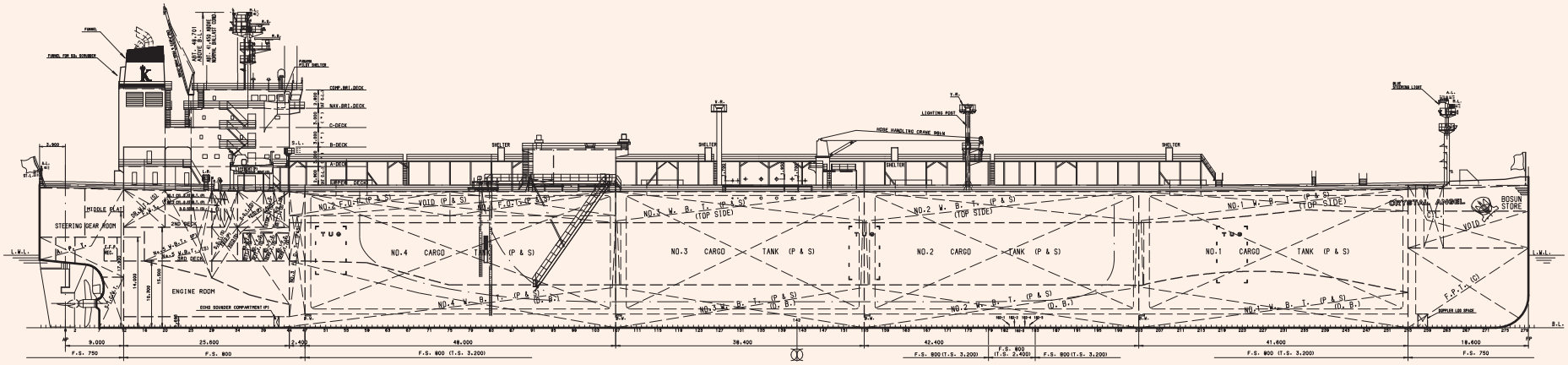
Kawasaki Heavy Industries, Ltd. delivered on February 9, 2020 the CRYSTAL ANGEL (HN: 1741), an 82,200 m³ capacity liquefied petroleum gas (LPG) carrier, for KUMIAI NAVIGATION (PTE) LTD. This is the 61st LPG carrier and the 12th vessel of the same type to be built by the company.

Features

1. This vessel adopts Kawasaki's uniquely developed bow shape called SEA-Arrow, which significantly improves propulsion performance by minimizing bow wave resistance.
2. The main engine powering the vessel is an energy-efficient, electronically-controlled, ultra-long-stroke, two-stroke low-speed diesel engine. In addition, the Kawasaki rudder bulb system with fins (RBS-F) and the semi-duct system with contra fins (SDS-F) contribute to reducing fuel consumption.
3. In order to satisfy new restrictions on SOx emissions which is implemented by the International Maritime Organization (IMO) in this year, the vessel includes a set of SOx scrubber at the exhaust gas outlets of the main engine and the power generation engine. With this system, general fuel oil can be used continuously after the regulations are tightened, without the need of switching to low sulfur fuel oil.
4. Four independent cargo tanks are installed in the cargo holds for carrying liquefied petroleum gas. The tanks are designed to provide optimal thermal insulation and absorb low-temperature contraction.
5. The cargo tanks are made with special cryogenic steel for loading LPG with a minimum temperature of –46° C. The tanks are wrapped in urethane foam for thermal insulation.
6. The vessel is designed to be able to navigate the newly expanded Panama Canal, which was completed in June 2016.

PRINCIPAL PARTICULARS

engtth (o.a.)	229.90 m
Length (b.p.)	226.00 m
Breadth (mld.)	37.20 m
Depth (mld.)	21.00 m
Draft (mld.)	11.20 m
Gross tonnage	47,236
Deadweight	53,995 t
Main engine	Kawasaki-MAN B&W 7S60ME-C8.2 diesel engine
Complement	29 people
Classification	ClassNK
Loading capacity (tank)	82,402 m³
Builder:	Kawasaki Heavy Industries Ltd.



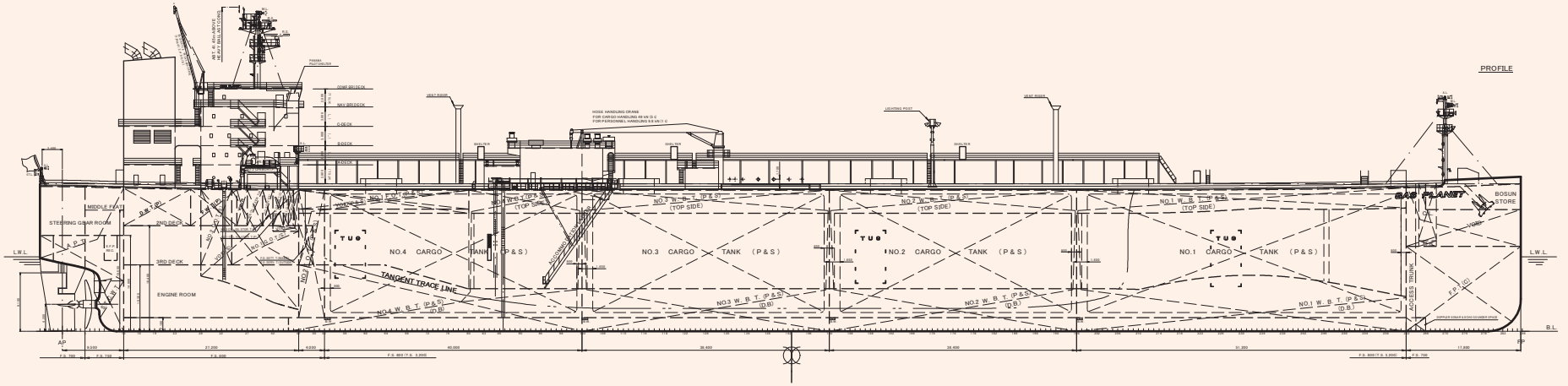
GAS PLANET 84,000 m³ LPG Carrier 20

GAS PLANET 84,000 m³ LPG Carrier 20

Kawasaki Heavy Industries, Ltd. delivered the 84,000m³ class LPG carrier, GAS PLANET (HN: 1743), to its owner, Lepta Shipping Co., Ltd. on October 16, 2020. The carrier has higher cargo-loading capacity without remodeling the hull form of the 82,200m³ type, which permits entry to LPG terminals as in the past. This ship is the first of the newly developed LPG carrier series compliant with the revised IGC code requiring more strict safety precautions for the ship. The GAS PLANET is compliant with the IMO NOx Tier III regulations. The main engine is an Exhaust Gas Recirculation (EGR) type and the electric generator engine adopts Selective Catalytic Reduction (SCR) as countermeasures for reduction of NOx emissions. Consequently, the carrier is permitted to navigate Emission Control Areas (ECAs).
This vessel adopts Kawasaki's uniquely developed bow shape called SEA-Arrow, which significantly improves propulsion performance by minimizing bow wave resistance. The main engine is an energy-efficient, electronically-controlled, ultra-long-stroke, two-stroke low-speed diesel engine. In addition, the Kawasaki Rudder Bulb System with Fins (RBS-F) and the Semi-Duct System with contra Fins (SDS-F) contribute to reducing fuel consumption. The main engine and electric generator engine are equipped with a SOx scrubber at the gas exhaust port, to satisfy the SOx emission restrictions started in January 2020. Accordingly, low SOx fuel oil can be used under the control of restrictions, and fuel oil costs can be reduced due to continuous use of conventional fuel.

PRINCIPAL PARTICULARS

Length (o.a.):	229.90 m	Main engine:	Kawasaki-MAN B&W 7S60ME-C10.5 diesel x 1 unit
Breadth (mld.):	37.20 m	Complement:	35 people
Depth (mld.):	21.90 m	Classification:	Class NK
Draft (mld.):	11.54 m	Loading capacity (tank)	84,178 m³
Gross tonnage:	49,231	Builder:	Kawasaki Heavy Industries Ltd.
Deadweight:	55,432 t		



DURHAM 84,000 m³ LPG Carrier 21

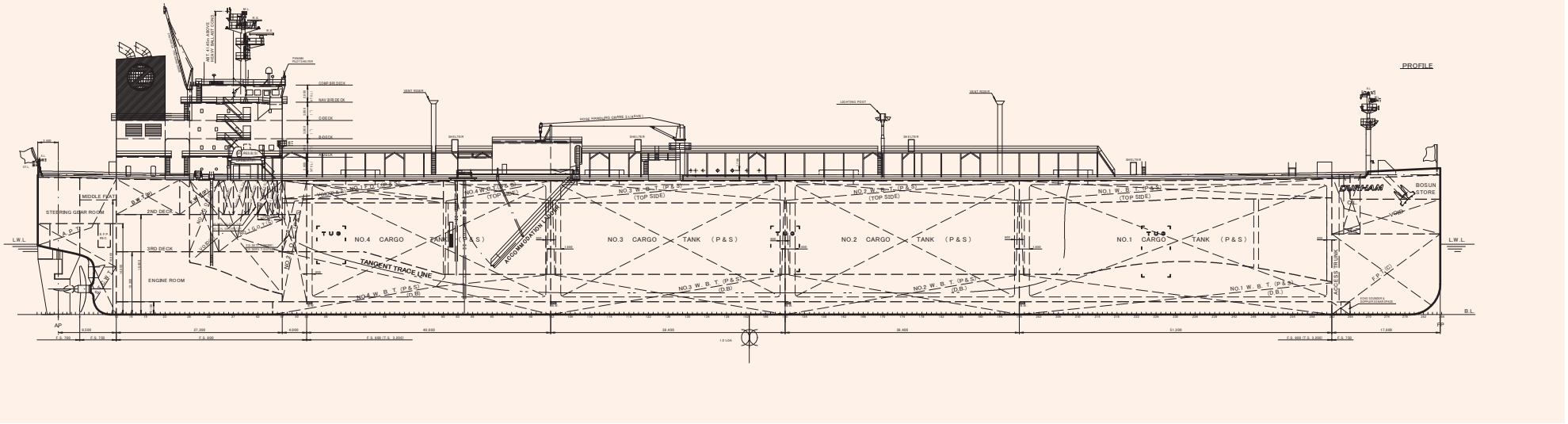
DURHAM 84,000 m³ LPG Carrier 21

Kawasaki Heavy Industries, Ltd. delivered the DURHAM, an 84,000m³ LPG carrier (HN: 1745), to Fair Wind Navigation, S.A. on January 29, 2021. This gas carrier is the second of the newly developed 84,000m³ type series compliant with the revised IGC code, with a larger cargo loading capacity based on the design of the previous Kawasaki 82,000m³ series. Kawasaki has now delivered a total of 63 LPG carriers. Despite larger cargo capacity of the new series, the principal particulars are almost the same, which permits entry to the same ports as the previous series.

The new gas carrier adopts the propulsion system compliant with the IMO NOx Tier III regulations as well as satisfying the revised IGC code. The main engine uses an Exhaust Gas Recirculation (EGR) type and the electric generator engine adopts Selective Catalytic Reduction (SCR) as countermeasures for reduction of NOx emissions. Consequently, the carrier can navigate Emission Control Areas (ECAs). The main engine is an energy-efficient, electronically-controlled, ultra-long-stroke, two-stroke low-speed diesel engine. The Kawasaki Rudder Bulb System with Fins (RBS-F) and the Semi-Duct System with contra Fins (SDS-F) also contribute to reducing fuel consumption. Kawasaki's unique bow shape called SEA-Arrow minimizes bow wave resistance and significantly improves propulsion performance. The main engine and electric generator engine are equipped with a SOx scrubber at the gas exhaust port to satisfy the SOx emission restrictions started in January 2020. Accordingly, low SOx fuel oil can be used under the control of restrictions, and fuel oil costs can be reduced due to continuous use of conventional fuel.

PRINCIPAL PARTICULARS

Length (o.a.):	229.90 m
Breadth (mld.):	37.20 m
Depth (mld.):	21.90 m
Draft (mld.):	11.54 m
Gross tonnage:	49,231
Deadweight:	55,408 t
Main engine:	Kawasaki MAN 7S60ME-C10.5 diesel x 1 unit
Complement:	35 people
Classification:	Class NK
Loading capacity (tank)	84,278 m³
Builder:	Kawasaki Heavy Industries Ltd.



CRYSTAL ASTERIA 84,000 m³ LPG Carrier 22

Kawasaki Heavy Industries, Ltd.

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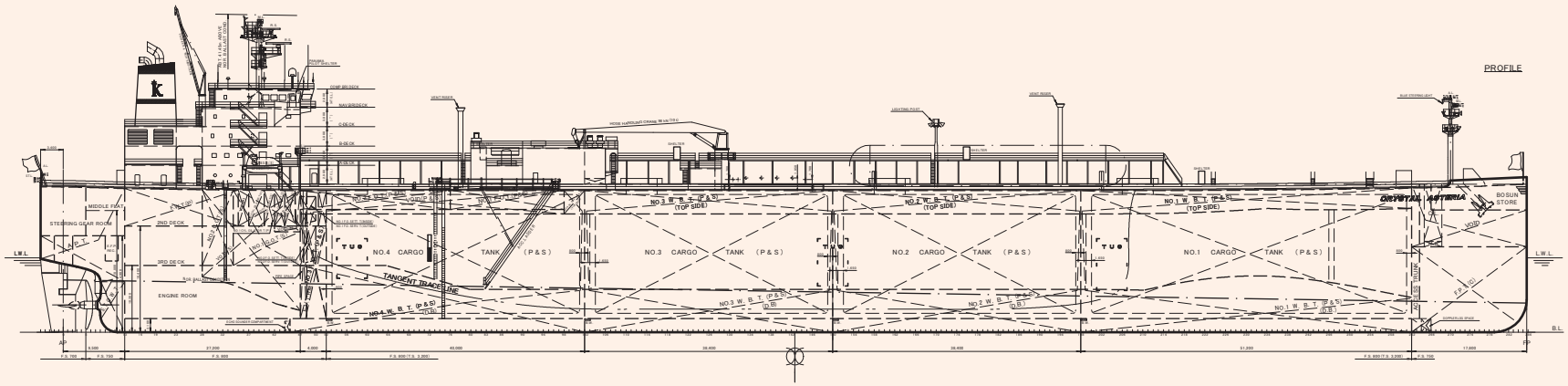
CRYSTAL ASTERIA 84,000 m³ LPG Carrier 22

Kawasaki Heavy Industries, Ltd. delivered Japan's first LPG powered LPG carrier, CRYSTAL ASTERIA (HN: 1748), to its owner, Kumiai Navigation (Pte) Ltd., on August 31, 2021.
The LPG carrier has a transport capacity of 84,000m³ LPG.
The LPG carrier has been designed with a dual-fueled main engine using LPG and low sulfur fuel oil as fuel. This is the first LPG dual-fueled LPG carrier based on the Kawasaki 84,000m³ series and the 64th delivery of Kawasaki LPG carriers.
Vessels operated by liquefied gas fuel instead of heavy fuel oil have been progressively introduced worldwide as an effective measure to cope with exhaust-gas emission regulations for vessels. The CRYSTAL ASTERIA using LPG as fuel can reduce emissions of greenhouse gas (GHG), so reducing the load on the environment as well. The Kawasaki group's expertise that has accumulated through building LPG and LNG carriers, or LNG fuel-operated vessels, have been applied to this new carrier.
The Kawasaki electronically controlled LPG-injection diesel engine for marine application (ME-LGIP engine) is used as the main engine. Compared with the use of conventional fuel oil, this engine can greatly reduce SOx and CO_2 emissions so can comply with SOx regulations and EEDI Phase 3 applying to ships with building contracts to be concluded in and after 2022.
The applied system is compliant with NOx Tier III regulations, and the main engine uses an exhaust gas recirculation (EGR) device. The diesel-electric generator combines a selective catalytic reduction (SCR) for denitration. These features allow the ship to navigate emission control areas (ECAs) when operating on conventional low sulfur-content fuel oil. Low fuel consumption can be achieved with the Kawasaki rudder bulb system with fins (RBS-F), and the semi-duct system with contra fins (SDS-F).
Kawasaki will continue to contribute to the realization of a low carbon and decarbonized society by developing and providing environment-friendly marine technologies including various commercial vessels that comply with environmental regulations such as LPG powered LPG carriers, as well as carriers for liquefied hydrogen, which represent a next-generation energy source.

PRINCIPAL PARTICULARS

Length (o.a.):	229.90 m
Breadth (mld.):	37.20 m
Depth (mld.):	21.90 m
Draft (mld.):	11.51 m
Gross tonnage:	49,145
Deadweight:	54,922 t
Main engine:	Kawassaki-MAN B&W 7S60ME-C10.5-LGIP diesel x 1 unit
Speed (service):	about 17.0kt
Complement:	29 people
Classification:	Class NK
Loading capacity (tank)	84,229 m³
Builder:	Kawasaki Heavy Industries Ltd.



AMIS UNICORN 61,000 DWT Bulk Carrier 61

Kawasaki Heavy Industries, Ltd.

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AMIS UNICORN 61,000 DWT Bulk Carrier 61

Kawasaki Heavy Industries, Ltd. delivered the bulk carrier AMIS UNICORN, with a capacity of 61,000 DWT (HN: 1746), for Mercy Marine Line S.A.

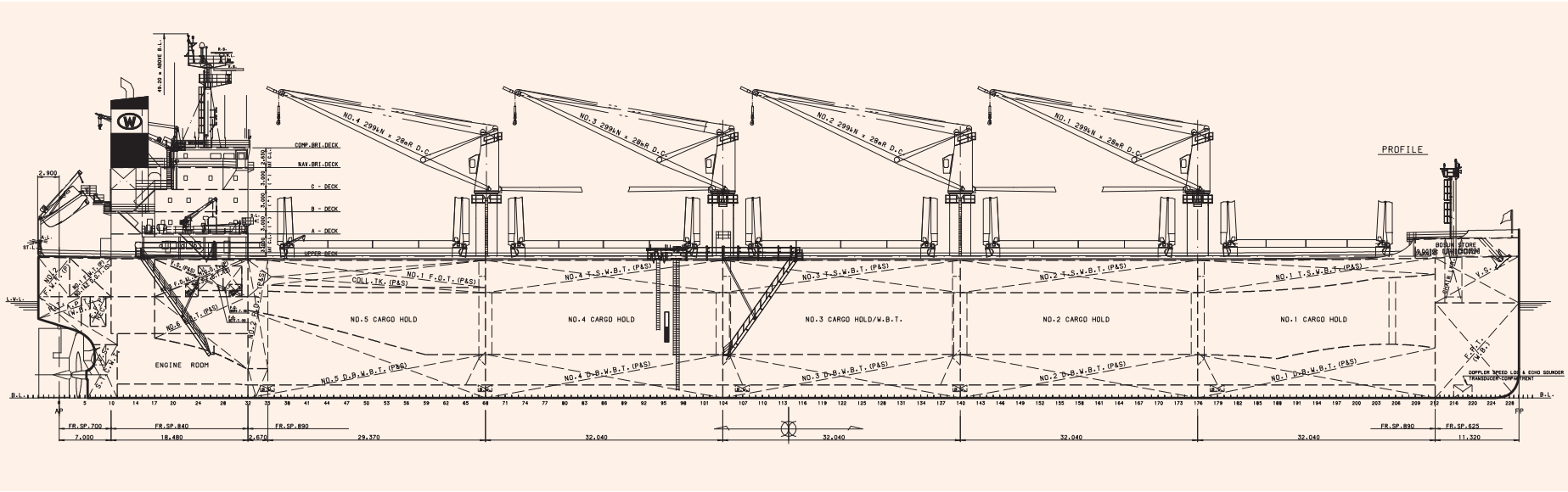
Features

1. The vessel has a flush deck with a forecastle and five holds that are designed for optimum transport of grains, coal, ores and steel products. Four 30-ton deck cranes are installed along the center in between the hatch covers to enable cargo loading and unloading in ports that lack cargo handling facilities.
2. The vessel employs various technologies to achieve maximum fuel economy, including an energy-saving, electronically-controlled main diesel engine, a bow designed to reduce wave resistance, high propulsive efficiency propellers, and the Kawasaki rudder bulb system with fins (RBS-F) and semi-duct system with contra fins (SDS-F), which all contribute to the vessel's enhanced propulsion performance.
3. The vessel incorporates various energy saving technologies, which reduce both fuel consumption and emission of carbon dioxide (CO_2), thereby complying with the EEDI* Phase 1 requirements.

*** EEDI:Energy Efficiency Design Index . Compulsory international regulations requiring energy-efficiency compliance in newly built ships based on EEDI values, which specify CO_2 emissions in grams for transporting one ton of cargo for one mile. EEDI regulation values apply in increasingly strict phases based on the construction-contract conclusion date and finished-ship delivery date. By Phase 1, bulk carriers are required to achieve a 10% reduction in CO_2 emissions**

PRINCIPAL PARTICULARS

Length (o.a.)	199.90 m	Main engine	MAN B&W 6S50ME-B9.5 diesel engine
Length (b.p.)	197.00 m	MCR (kw×rpm)	8,130 kW at 108 rpm
Breadth (mld.)	32.24 m	Speed (service)	Approx. 14.5 knots
Depth (mld.)	18.60 m	Complement	25 people
Draft (mld.)	13.00 m	Classification	American Bureau of Shipping (ABS)
Gross tonnage	34,657	Loading capacity (cargo hold volume)	77,539 m^3
Deadweight	61,175 t	Builder:	Kawasaki Heavy Industries Ltd.



ROYAL ORION 61,000 DWT Bulk Carrier 62

ROYAL ORION 61,000 DWT Bulk Carrier 62

Kawasaki Heavy Industries, Ltd. delivered the bulk carrier ROYAL ORION, with a capacity of 61,000 DWT (HN: 1747), for LEO OCEAN,S.A.

Features

1.ROYAL ORION is the first vessel (aside from LNG carriers) to be equipped with a ship operation management system called SOPass*1, which monitors and analyzes propulsion and fuel efficiencies, as well as main engine performance. While the vessel is sailing, SOPass remotely monitors and analyzes the data sent from the vessel at the onshore facility. This allows real-time checks of various performances, and thus contributes to reduction of life-cycle costs.

2.In order to satisfy new restrictions on SOx emissions*2 which is implemented by the International Maritime Organization (IMO) in this year **, the vessel includes a set of SOx scrubber*3 at the exhaust gas outlets of the main engine and the power generation engine. With this system, general fuel oil can be used continuously after the regulations are tightened, without the need of switching to low sulfur fuel oil.

3. The vessel incorporates various energy saving technologies, which reduce both fuel consumption and emission of carbon dioxide (CO_2), thereby complying with the EEDI*4 Phase 1 requirements.

4. The vessel has a flush deck with a forecastle and five holds that are designed for optimum transport of grains, coal, ores and steel products and so on. Four deck cranes with 30 ton lifting capacity are installed along the center in between the hatch covers to enable cargo loading and unloading in ports that lack cargo handling facilities.

5. The vessel employs various technologies to achieve maximum fuel economy, including an energy-saving, electronically-controlled main diesel engine, a bow designed to reduce wave resistance, high propulsive efficiency propellers, and the Kawasaki Rudder Bulb System with Fins (RBS-F) and Semi-Duct System with contra Fins (SDS-F), which all contribute to the vessel's enhanced propulsion performance.

***1 SOPass (Ship Operation and Performance analysis support system) is Kawasaki's proprietary system for real-time analysis of vessel performance, as well as for operational assistance.**

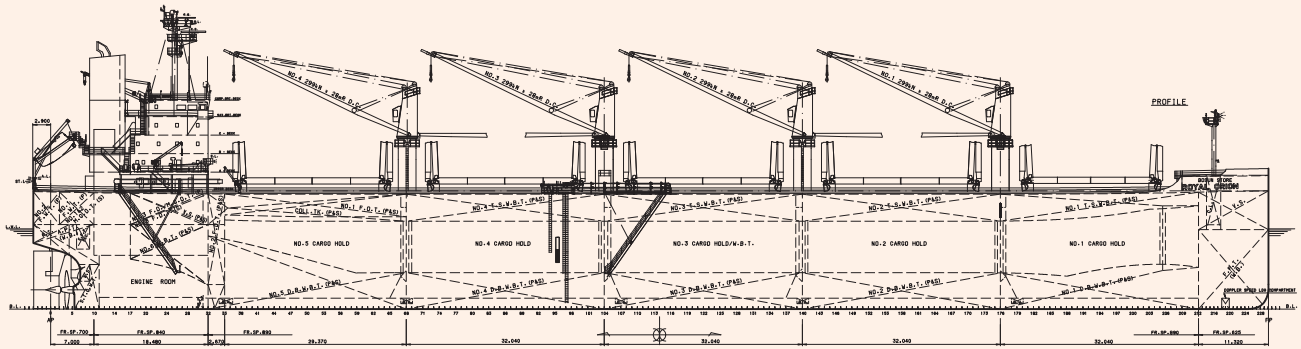
***2 SOx emission control: Currently, SOx emission restrictions in North American and European emission control areas (ECAs) limit sulfur content in fuels to 0.1% or less. Starting on January 1, 2020, new regulations will require that ships operating in all other parts of the world achieve fuel sulfur content levels of 0.5% or less, or alternatively, use equipment to reduce SOx in exhaust gases to an equivalent level.**

***3 SOx scrubber: an exhaust gas cleaning system, which removes SOx (sulfur oxide).**

***4 EEDI:Energy Efficiency Design Index . Compulsory international regulations requiring energy-efficiency compliance in newly built ships based on EEDI values, which specify CO_2 emissions in grams for transporting one ton of cargo for one mile. EEDI regulation values apply in increasingly strict phases based on the construction-contract conclusion date and finished-ship delivery date. By Phase 1, bulk carriers are required to achieve a 10% reduction in CO_2 emissions.**

PRINCIPAL PARTICULARS

Length (o.a.)	199.90 m	Main engine	MAN B&W 6S50ME-B9.5 diesel engine
Length (b.p.)	197.00 m	MCR (kw×rpm)	8,130 kW at 108 rpm
Breadth (mld.)	32.24 m	Speed (service)	Approx. 14.5 knots
Depth (mld.)	18.60 m	Complement	25 people
Draft (mld.)	13.00 m	Classification	Lloyd's Register of Shipping (LR)
Gross tonnage	34,793	Loading capacity (cargo hold volume)	77,539 m^3
Deadweight	61,170 t	Builder:	Kawasaki Heavy Industries Ltd.



Kawasaki-LNG floating power plant obtains AiP from DNV GL 112

Kawasaki Heavy Industries, Ltd.

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Kawasaki-LNG floating power plant obtains AiP from DNV GL 112

Kawasaki Heavy Industries, Ltd. has developed an LNG floating power plant equipped with its own high-efficiency power generation equipment and the gas engine model has obtained Approval in Principle (AiP)*1 from DNV GL based on its "Gas Power Plant" rules which were introduced in 2018.

An LNG floating power plant is an integrated system, in which LNG fuel tanks, LNG regasification unit, power generation equipment, and switchyard are all outfitted on the hull. The plant is towed on the sea or river, and then moored at the installation site, where power is generated and supplied to the onshore power grid.

Demand for this type of power plant is expected to be strong in countries where demand for electricity is rapidly increasing, such as in Southeast Asia, especially on islands or in locations where stable power sources are difficult to secure, and also in areas with geographical problems such as lack of land for constructing onshore power plants. LNG has a cost advantage over heavy oil for power generation as a fuel of the power plant, and emits less greenhouse gases than coal and heavy oil. As an environmentally friendly fuel, the scale of supply and demand as well as applications of LNG are expected to expand.

The main features of the Kawasaki - LNG Floating Power Plant are as follows:

(1) The plants are equipped with in-house developed gas engine or gas turbine with the world's highest level of power generation efficiency in this class. (Gas engine: 49.5%, Gas turbine combined cycle: 54.4%) These system have low nitrogen oxide (NOx) emissions and low environmental impact.

(2) The gas engine (of the gas engine model) can reach the rated load in 10 minutes from start, and can also achieve high partial load performance over a wide power range (30 - 100%).

(3) A durable, highly insulated aluminum tank is used with the same specifications as for small LNG carriers/bunkering vessels.

(4) High quality and reliable delivery are achieved through a seamless manufacturing value chain at Kawasaki's own factories for the main products such as power generation facility, tank, and barge.

Kawasaki has built over 40 LNG-related vessels since constructing Asia's first LNG carrier in 1981, including large LNG carriers and LNG fuel vessels, and has received an order for Japan's first LNG bunkering vessel. Kawasaki is a leader in LNG transportation technology with abundant expertise and rich experience. In addition, Kawasaki has extensive capabilities of developing, designing, and manufacturing the core equipment, gas engines, gas turbines, steam turbines, and heat recovery steam generators (HRSG) using its own expertise in the power plant field, and abundant experience of plant engineering in Japan and around the world. Therefore Kawasaki can provide integrated package solutions for the LNG bunkering vessel and tanks for the LNG secondary terminal.

Taking advantage of synergies between these LNG and energy related technologies, Kawasaki will actively market its energy related products and equipment including small and medium-size distributed power sources, which will contribute to development in areas where stable power sources are difficult to secure.

Outline of Specifications of Kawasaki-LNG Floating Power Plant

Model	Gas engine (*Obtained AiP from DNV GL)	CCPP (*Applying for AiP to DNV GL) (combined cycle power plant)
Conguration	Gas engines: 4 units	Gas turbine combined cycle (2 gas turbines, 2 heat recovery steam generators, 1 steam turbine)
Power output	30MW	80MW
Barge size	L120m x W36m x D6.5m	L110m x W48m x D20m
LNG tank	3,500m^3 x 2 units	5,500m^3 x 2 units

(Note)

*1 **Approval in Principle (AiP)**
To obtain confirmation by the classification society as a third party by a risk assessment and verification of compliance with classification rules for the conceptual design of new products and technologies.

Kawasaki has successfully verified the Close-range Subsea Pipeline Inspection by Autonomous Underwater Vehicle (AUV) 113

Kawasaki has successfully verified the Close-range Subsea Pipeline Inspection by Autonomous Underwater Vehicle (AUV) 113

Kawasaki Heavy Industries, Ltd. announced the successful completion of verification tests for the close-range inspections of a subsea pipeline by an autonomous underwater vehicle (AUV) off the coast of Awaji Island, Hyogo Prefecture on July 15, 2020.

With a focus on the growing demand for pipeline maintenance in offshore oil and gas fields, Kawasaki has been developing an AUV called SPICE*1 (Subsea Precise Inspector with Close Eyes) equipped with a robot arm for performing subsea pipeline inspections—the world's first—based on a fusion of submarine technologies and industrial robot technologies fostered in-house over many years. During verification testing, SPICE executed a close-range inspection process which involved deployment at sea to locate and perform tracking operations on a subsea pipeline, after which it returned to its docking station*2 for recovery. These tests were part of a series of tests required to verify autonomous operation capabilities, and were conducted from June 1st to 12th with the support of the Joint Technological Development Support Program for Offshore Oil and Natural Gas Fields,*3 which is supported by DeepStar*4 and The Nippon Foundation. SPICE's verification tests entailed inspections of a mock pipeline used to simulate a real subsea pipeline, located off the shore of Awaji Island in Hyogo Prefecture. The tests succeeded in verifying the performance of SPICE's autonomous robot arm control and sensor-equipped close-range inspection unit to track the pipeline while the AUV maintained stable travel, and represent a major step forward along the company's path to commercialization. Moreover, attendees at demonstrations carried out during the testing period expressed high praise and great expectations in response to the success of the tests.

Kawasaki will continue to carry out verification tests using equipment fitted with various inspection sensors in reflection of actual market needs, while simultaneously pursuing classification-society certification for its AUV. Furthermore, the company will keep on developing high-performance, high-quality products capable of uncrewed, automated operation for the AUV market, where demand is expected to grow for such underwater equipment, while proactively pursuing commercialization in FY 2021.

***1 "SPICE" is a trademark for AUV developed by Kawasaki Heavy Industries, Ltd.**

***2 A subsea docking station under development by Kawasaki. SPICE docks underwater with the station, which is attached via a cable to the mother ship (base ship for operations), enabling the AUV to charge and send collected inspection data to the mother ship. This arrangement enables SPICE to work for long periods undersea without frequent launch and recovery, thus reducing boat crew workload and improving safety.**

***3 A collaborative support program of The Nippon Foundation with the aim of participating in technological development in the ocean development field. Kawasaki was selected for participation in the program in FY 2019 in order to pursue applications for autonomous underwater robots in offshore oil fields, and the abovementioned verification tests were carried out as part of this program.**

***4 A marine technology development consortium comprising major oil companies, companies involved in ocean development, universities, research institutions and other such organizations with the aim of surveying, developing, and pursuing production in offshore oil and natural gas fields.**

Kawasaki Receives Order for SPICE, World's First AUV with Robot Arm for Subsea Pipeline Inspections 114

Kawasaki Receives Order for SPICE, World's First AUV with Robot Arm for Subsea Pipeline Inspections 114

Kawasaki Heavy Industries, Ltd. received of an order by Modus Subsea Services Limited (MODUS) in UK for an AUV*1 called SPICE.*2

Kawasaki has undertaken research and development for AUVs in response to growing demand for pipeline maintenance in offshore oil and gas fields. SPICE is the world's first AUV equipped with a robot arm for performing subsea pipeline inspections, developed based on a fusion of submarine-related technologies and industrial robot technologies fostered at Kawasaki over many years. SPICE will be used for operations in the North Sea and other sea areas around the world after delivery to MODUS in 2021. MODUS has committed to acquire two units of SPICE from Kawasaki, of which first one was placed an order this time.

By Kawasaki's technological synergies, a robot arm fitted with an inspection tool unit at the end enables SPICE to perform close-range inspections of subsea pipelines not possible with traditional AUVs. In addition, it is operated using a docking station also developed by Kawasaki, which increases inspection operation efficiency and reduces cost requirements, while also benefiting crews working on a support vessel by reducing their burden and improving safety.

SPICE's basic specifications and features are as follows.

Specifications	
Length overall	Approx. 5.6 m
Width	Approx. 1.4 m
Height	Approx. 1.1 m
Weight	Approx. 2,500 kg (in air)
Max. depth	3,000 m
Max. speed	4 knots
Propulsion equipment	Main propulsion propeller ×1, side thrusters ×2, vertical thrusters × 2
Navigation equipment	Inertial navigation system, sonar
Safety equipment	Ballast release equipment, iridium beacon

Features

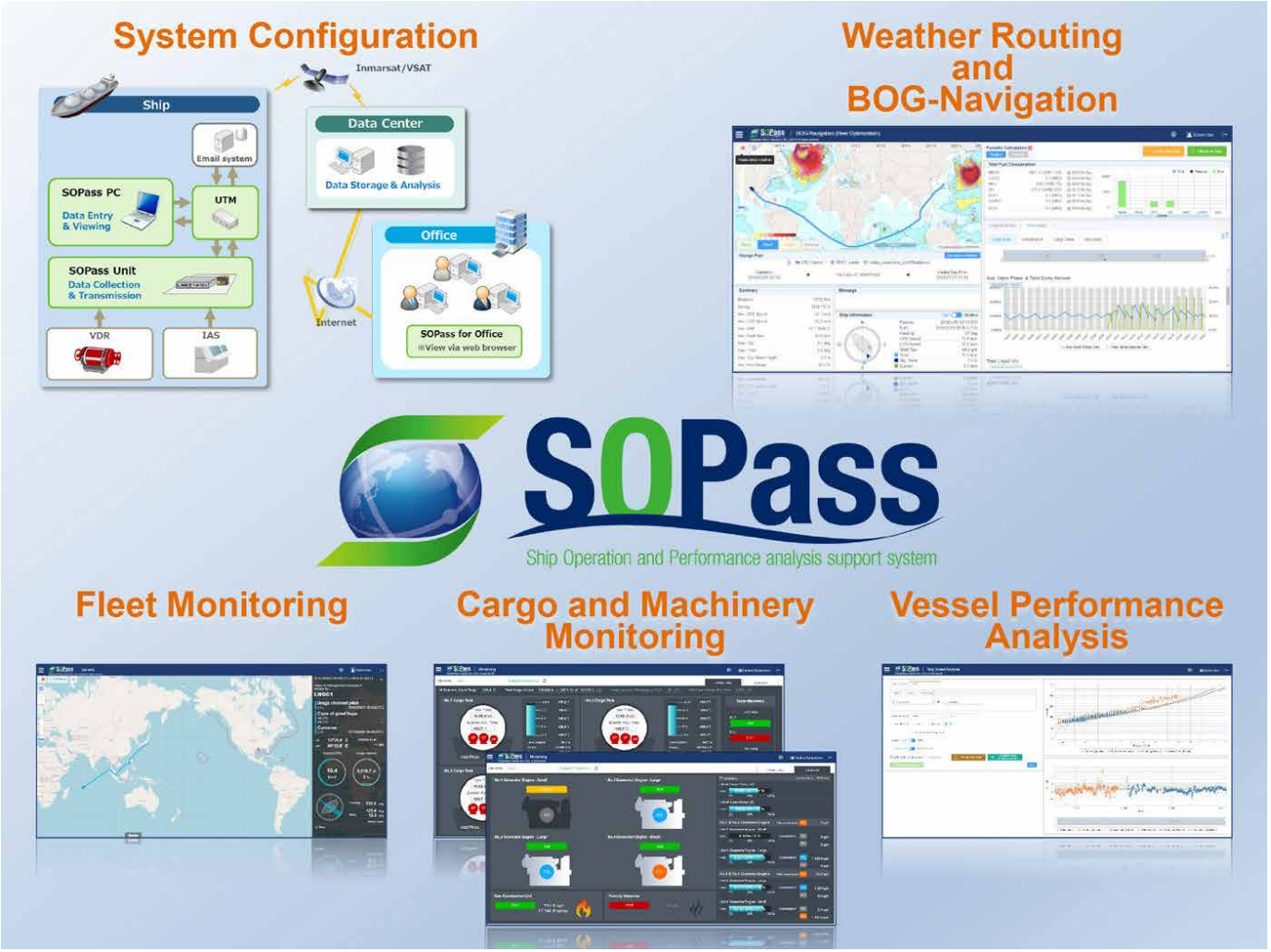
1. After being submerged into the sea along with the docking station, SPICE launches itself, searches for the pipeline to be inspected, performs inspections, and returns to the docking station once its mission completes. As this entire process is handled autonomously, SPICE does not require a dedicated ROV*3 operator or a highly sophisticated support vessel capable of dynamic positioning, unlike ROVs that used to be the standard pipeline inspection equipment.
2. SPICE comes equipped with an inspection tool unit fitted with close-range sensors at the end of the robot arm. When inspecting pipelines, SPICE controls robot arm autonomously to track the pipeline and performs efficient close-range inspection operations.
3. SPICE is capable of automated continuous detecting and tracking of subsea pipelines. It automatically avoids obstacles along the pipeline and continues inspections once the obstacle has been cleared. This enables uninterrupted continuous inspection operations.
4. After returning to the docking station under water, SPICE enables recharging the battery and sending collected data to the support vessel. SPICE can be launched and recovered under water for better operational efficiency than a conventional launch and recovery method.

Moving forward, Kawasaki will reflect user feedback and requests from MODUS in future development efforts and supply high-performance and high-quality products to meet the growing demand of AUV in the subsea inspection market. In this way and others, Kawasaki will play its part in creating a safe and secure remotely-connected society.

***1 Autonomous underwater vehicle.**
***2 Subsea Precise Inspector with Close Eyes. SPICE is a trademark of Kawasaki.**
***3 Remotely operated vehicle. While connected to the mother ship via a tether cable, the vehicle is operated by a dedicated operator.**

Kawasaki obtains ClassNK Innovation Endorsement Certificate for SOPass 115

Kawasaki Heavy Industries, Ltd. has obtained the Product & Solutions certificate for the SOPass from Nippon Kaiji Kyokai (ClassNK) based on evaluation of the innovative applicability of the system, which is included in the Innovation Endorsement newly provided for innovative development by ClassNK. The SOPass is the Kawasaki Ship Operation and Performance analysis support system.



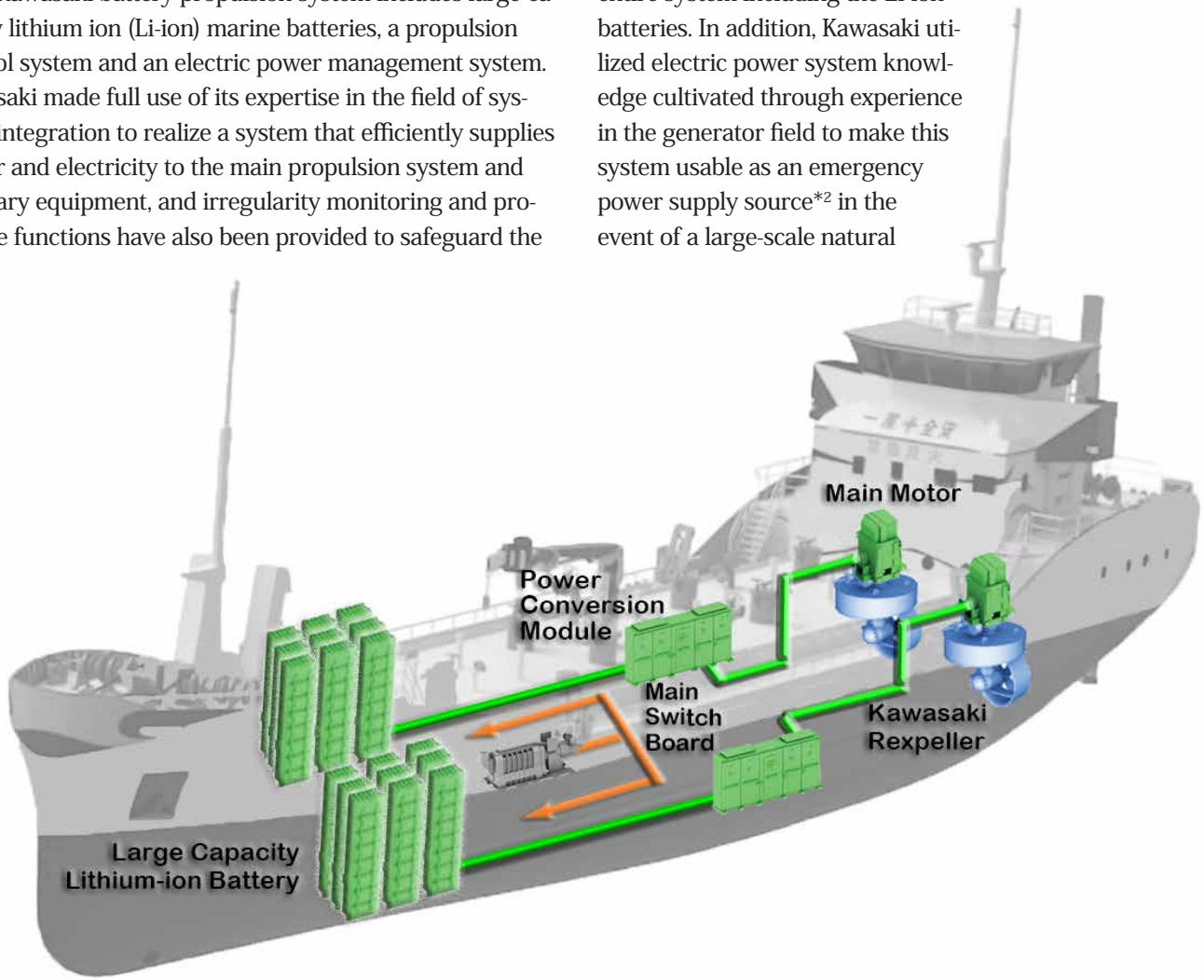
ClassNK Innovation Endorsement is intended to stimulate promotion and evolution of innovative technologies as well as support for environmental conservation, safety improvement, and sustainable development in the field of marine transport. ClassNK has now verified every function of SOPass which is an advanced solution using digital technologies.

Kawasaki SOPass can provide useful information for ship operational management. Information can be produced by integrating real data received from ships via satellite communication and Kawasaki's engineering expertise in shipbuilding, and integration is achieved by technologies such as ICT (Information and Communication Technology) and IoT (Internet of Things). This system can offer visualization of ship navigation, various performance analyses, and optimal route simulations that will contribute to energy saving. This system also provides the optimizing function of LNG cargo management for LNG carriers, which is the first in the industry of LNG transport. SOPass can be applied to various ship types and support economical and safe ship operation.

By January 2021, Kawasaki has received orders for SOPass for 17 ships mainly LNG carriers. The company expects that SOPass will be increasingly applied to various types of ship to alleviate the load on the environment and improve business efficiency in marine transport.

Kawasaki Receives First Order for Coastal Ship Large-capacity-battery Propulsion Systems 116

Each Kawasaki battery propulsion system includes large-capacity lithium ion (Li-ion) marine batteries, a propulsion control system and an electric power management system. Kawasaki made full use of its expertise in the field of systems integration to realize a system that efficiently supplies power and electricity to the main propulsion system and auxiliary equipment, and irregularity monitoring and protective functions have also been provided to safeguard the entire system including the Li-ion batteries. In addition, Kawasaki utilized electric power system knowledge cultivated through experience in the generator field to make this system usable as an emergency power supply source*2 in the event of a large-scale natural disaster, thus providing support for the business continuity plans and the life continuity plans in the region.



As the maritime shipping industry faces increasingly strict emission regulations from the International Maritime Organization (IMO) on carbon dioxide (CO_2), nitrogen compounds and other gases, many are looking to cleaner, alternative power sources to replace traditional heavy fuel oil. Fully battery-powered vessels achieve major reductions in emissions of CO_2, nitrogen oxides (NOx), sulfur oxides (SOx) and particulate matter (PM) during operation.

As a marine equipment manufacturer and systems integrator, Kawasaki plans to continue focusing its efforts on the provision of systems in a package optimized for user operations.

Basic Specifications for Kawasaki's Large-capacity-battery Propulsion System

Batteries: 1,740 kWh per set (total 3,480 kWh per ship)

Propulsion control system: Propulsive power control, energy and power flow control, maneuvering operation, system monitoring

Main propulsion system: Two 300 kW Kawasaki Rexpeller KST-115LF/AN-1.7 units (variable-speed, motor-driven control)

*1 **Zero-emission electrically propelled tankers planned and designed by e5 Lab Inc. for purposes of developing similar ships and promoting their widespread use. These two vessels in particular are slated for use in ship refueling operations within Tokyo Bay. The ships will be built by KOA SANGYO CO.,LTD. and IMURA SHIPYARD CO.,LTD.**

*2 **This idea was originally proposed by e5 Lab and Asahi Tanker.**

Kawasaki Develops New LNG Dual-fuel System for Medium-sized Tankers 119

Lloyd's Register (LR) has granted approval in principle (AiP) for a medium-sized oil tanker, developed by Sumitomo Heavy Industries Marine & Engineering Co., Ltd., that uses a liquefied natural gas (LNG) dual-fuel system developed by Kawasaki for medium-sized tankers. This was the first AiP received for a ship built outside of the Kawasaki Group and equipped with Kawasaki's LNG dual-fuel system.

As the industry faces increasingly strict gas emission regulations from the International Maritime Organization, LNG fuel and other clean fuels are gradually gaining popularity as alternatives fuels. Amid such changes, Kawasaki has obtained various AiPs for LNG dual-fuel systems designed for its own ships.

The Sumitomo Heavy Industries Marine & Engineering medium-sized oil tanker which received this recent AiP had its placement of the LNG fuel tank and other elements adjusted to enable the use of a dual-fuel (LNG and heavy fuel oil) supply and usage system without sacrificing cargo tank capacity. Based on the IGF Code* and ship classification rules that need to be observed for LNG fuel use, Kawasaki conducted technical reviews for the LNG fuel supply system, LNG fuel tank and safety measures required for using LNG fuel, leveraging its experience in the field to assist Sumitomo Heavy Industries Marine & Engineering in obtaining the AiP for their vessel.

Based on technological capabilities cultivated through the construction of LNG carriers over the years, Kawasaki has fostered a range of LNG-related applied technologies through the development of the world's first LNG-fueled pure car and truck carrier (PCTC) delivered in 2016, a newly developed LNG bunkering vessel, and various LNG-fueled ships. Utilizing this technological background, the company applies its LNG fuel supply systems and LNG fuel tanks for LNG-fueled vessels, as well as LNG-related technologies and knowledge to in-house shipbuilding and the provision of LNG dual-fuel systems for other companies' vessels, thus contributing to the reduction of emission gases in the marine shipping industry.

* **IGF Code: International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels. This code came into effect in January 2017.**

Kawasaki Completes first LPG-powered dual-fuel ME-LGIP engine 120

Kawasaki Heavy Industries, Ltd. completed of a Kawasaki-MAN B&W 7S60ME-C10.5-LGIP engine, an LPG-powered marine diesel engine to be used in a large LPG carrier being built at Sakaide Works for delivery to Kumiai Navigation (Pte) Ltd. This engine is the first MAN B&W S60 type LPG-powered engine to be produced in the world.

This dual-fuel engine design can use both LPG fuel and marine diesel oil, and includes the Kawasaki-ECO System (K-ECOS Lite), which simultaneously reduces fuel consumption and enables the engine to meet NOx Tier 3 regulations. The Kawasaki-ECO System (K-ECOS Lite) is an environmentally friendly low-emission system consisting of an exhaust gas recirculation (EGR) system, a turbocharger cut-out system, and a waste water treatment system, which complies with IMO NOx Tier 3 regulations and achieves low fuel consumption and low running costs. When using LPG fuel, the ME-LGIP engine cuts sulfur oxide (SOx) emissions by more than 90% compared with conventional two-stroke diesel engines that operate on heavy oil, and also greatly reducing carbon dioxide (CO_2) and nitrogen oxide (NOx) emissions.

The International Maritime Organization (IMO) has been establishing stricter emission regulations for SOx, NOx, CO_2 and other emissions in marine shipping throughout Europe, the United States and other parts of the world. LPG, which provides a clean-fuel alternative much like liquefied natural gas (LNG), has been the subject of increasing attention amid these changes. In response, Kawasaki is actively pursuing the sale and manufacture of Kawasaki-MAN B&W ME-LGIP engines as one of the next-generation of main engines intended to help operators meet updated emission regulations.

Kawasaki-MAN B&W 7S60ME-C10.5-LGIP engine

Rated output:	12,850kW
Rated speed:	84rpm
Cylinder bore:	60cm
No. of cylinders:	7

Kawasaki Heavy Industries, Ltd.

Kawasaki Receives AiP for LPG Fuel Supply System 121

Kawasaki Receives AiP for LPG Fuel Supply System 121

Kawasaki Heavy Industries, Ltd. has obtained approval in principle (AiP) from Nippon Kaiji Kyokai (ClassNK) and the American Bureau of Shipping (ABS) for a liquefied petroleum gas (LPG) fuel supply system that enables LPG to be used as ship fuel.

As the industry faces increasingly strict gas emission regulations from the International Maritime Organization, LPG fuel is receiving increased attention as a clean-fuel alternative to heavy fuel oil. Particularly in the LPG trade market, increasing emphasis is being placed on transitioning to LPG fuel sources. By using LPG fuel, Kawasaki's LPG carriers achieve emission reductions for CO_2, sulfur oxides (SOx) and other harmful substances in exhaust gases and comply with EEDI Phase 3 regulations.

Kawasaki's fuel supply system was developed using knowledge gained through LPG carrier, liquefied natural gas (LNG) carrier, and LNG-fueled vessel design and construction, as well as marine engine design and manufacturing operations. The LPG fuel supply system received AiP from more than one classification society, which proves its high reliability. Kawasaki has started building Japan's first LPG-fueled LPG carrier equipped with this system at its Sakaide Works, with the support of ClassNK and relevant supervisory agencies.

Kawasaki plans to continue developing and providing environmentally friendly ship technologies for LPG-fueled LPG carriers, LNG-fueled vessels, liquefied hydrogen carriers (liquefied hydrogen is gaining increasing attention as a next-generation energy source), and other vessels with the aim of achieving low carbon emissions throughout society.

The main features of Kawasaki's LPG fuel supply system are as follows:

1. Cyclical system design that is compatible with propane and butane and circulates LPG in a pressurized state capable of usage at normal ambient temperature
2. Features a control system with established high safety performance based on a risk assessment conducted in accordance with the IGC Code
3. Consists of equipment that can be used in LPG carriers and any other type of vessel