

LNG Bunkering Vessel "KEYS Azalea"



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As a bridge solution toward achieving a carbon-neutral society, the maritime industry is transitioning to LNG fuel. The importance of LNG bunkering vessels has been increasing globally in recent years because they are well-suited for supplying large quantities of LNG fuel to large ships.

KEYS Azalea, built by Mitsubishi Shipbuilding Co., Ltd. for KEYS Bunkering West Japan Ltd., is the first LNG bunkering vessel to operate in Western Japan. This vessel has been engaging in LNG bunkering operations for ocean-going LNG-fueled ships calling at various ports in the Kyushu and Setouchi regions, as well as in domestic LNG transport.

1. Vessel overview

Principal particulars of KEYS Azalea (hereinafter referred to as "this vessel") are shown in **Table 1**.

Table 1 Main specifications of KEYS Azalea

Length overall	82.4 m	Speed	Approx. 12.0 kn
Breadth	18.2 m	Main generator engines	Daihatsu 6DE23DF 1,170 kW x 3
Draft	4.8 m		
Gross tonnage	4,744	Propulsion motors	Nishishiba Electric NTIKE-RCK5 890 kW x 2
LNG tank capacity	3,533 m ³		

This vessel combines the functions of a conventional LNG carrier with those of a bunkering vessel that supplies LNG fuel via ship-to-ship transfer. Characteristics of this vessel are as follows:

- (1) One cylindrical independent Type C cargo tank with external insulation, having a capacity of approximately 3,500 m³ is installed. Type C tanks do not require a secondary barrier and are commonly adopted for small LNG carriers and LNG-fueled ships. This vessel is designed so that the longitudinal center of the tank volume is near the vessel's center of buoyancy; therefore, changes in ship trim before and after bunkering are minimal, allowing for operation with minimal ballast adjustment.
- (2) The dual-fuel electric propulsion system can run on both LNG and MDO (Marine Diesel Oil) and this system is the first time to be installed on an LNG bunkering vessel in Japan. This system significantly reduces CO₂, NO_x, SO_x, and PM (particulate matter) emissions from this vessel compared to conventional ships.
- (3) The cargo manifolds, each equipped with two hose handling cranes, are located on both the port and starboard sides near midship and at the bow. This configuration enables flexible selection of the manifold according to the size and hull form of the LNG-fueled vessel, and the layout of its bunker station.
- (4) Four sets of foam-type fenders and fender davits, which serve as ship-to-ship mooring equipment, are installed.
- (5) Side thrusters are installed at the bow and stern to facilitate berthing and unberthing in port and reduce cargo handling time.

Vessel unberthing, after bunkering has been completed for an LNG-fueled ship, is shown in **Figure 1**.

Characteristics of the LNG cargo handling equipment, and the integrated automation system that controls it, are described in the following chapters.



Figure 1 KEYS Azalea immediately after bunkering
(Source: KEYS Bunkering West Japan Ltd.)

2. Gas handling equipment

This vessel must perform various operations, including LNG bunkering for LNG-fueled ships, loading and unloading at land-based terminals, gas supply to the generator engines during voyages, as well as inerting, gassing up, and cool-down of cargo tanks and piping. Main equipment and gas handling functions installed on this vessel to enable these operations are described in this chapter.

(1) LNG pumps

Two LNG bunker pumps are installed inside the cargo tank. These are used to transfer LNG of the cargo tank during unloading and bunkering operations. In addition to the bunker pumps, a small pump is also installed for cargo tank cool-down and gas supply to the generator engines via the LNG vaporizer.

(2) Gas compressors

Two gas compressors are installed on this vessel. The role of the compressors is to supply boil-off gas (hereinafter referred to as BOG) from the cargo tanks to the generator engines and the Gas Combustion Unit (hereinafter referred to as GCU). Additionally, they are used to circulate cargo vapor during tank heating operations.

(3) LNG vaporizer and gas heater

This vessel is equipped with a shell-and-tube type LNG vaporizer and gas heater.

The LNG vaporizer is used to force vaporization of LNG and supply it to the power generator when BOG is insufficient, ensuring stability and redundancy of the LNG fuel supply.

The gas heater is used to raise the temperature of fuel gas supplied to the generator engines and the GCU to the appropriate level, ensuring system safety and combustion efficiency.

(4) GCU

The GCU is a device to safely dispose of surplus LNG gas generated during operations. LNG gas containing nitrogen (N_2) is generated during operations such as purging pipelines and inerting the tank. The GCU can safely combust such gas containing inert gas.

(5) Nitrogen generator

Membrane-type nitrogen generators are installed on this vessel. These are used to generate nitrogen gas needed for operations such as purging the pipelines and inerting the tank.

(6) Cargo piping

The cargo piping is thermal insulated. In piping design, a combination of bellows-type expansion joints and offset piping is used to avoid excessive stress caused by hull deformation

or thermal contraction due to low temperatures, thereby protecting the piping and connected equipment. Furthermore, safety valves are installed on the tank and cargo pipelines to protect the cargo system from excessive pressure increase.

(7) Metering and analysis system

This vessel is equipped with a cargo metering system and a gas composition analyzer to accurately measure the quantity and composition of fuel gas supplied to the LNG-fueled vessel for use in commercial transactions.

(8) Ship-to-ship LNG transfer system

This vessel is equipped with an LNG transfer system that uses cryogenic flexible hoses for flexible and safe bunkering operations for various LNG-fueled vessels. The hoses are connected to the bunker manifold of the LNG-fueled vessel using the aforementioned hose handling cranes. The connection ports to the bunker manifold are equipped with cryogenic-rated quick connections to expedite hose connection and disconnection. Furthermore, the system includes the emergency release couplings and a vessel separation detector, which allow rapid disconnection of the hoses in case of emergency, such as a fire or if the distance from the LNG-fueled vessel increases.

(9) Gas handling assistive function for LNG-fueled vessel

This vessel can assist with gas handling operations required by LNG-fueled vessels. Specifically, while connected to an LNG-fueled vessel, this vessel can perform inerting, gassing up, and heating operations on the LNG-fueled vessel's system using the aforementioned onboard equipment. This allows for the safe execution of ancillary gas handling tasks from this vessel, in addition to normal LNG bunkering operations.

3. Integrated Automation System

This vessel is equipped with the Integrated Automation System (hereinafter referred to as IAS) as its control system. The IAS enables centralized control and monitoring of the onboard plant from a remote control station, and is frequently installed on high-value- vessels such as large ocean-going LNG carriers. Since LNG is extremely difficult to handle, automation of the onboard plant was an important issue for this vessel as well. Incorporating automation technologies developed by Mitsubishi Shipbuilding Co., Ltd. (hereinafter referred to as MHIMSB) through years of building LNG carriers, the IAS on this vessel has the same advanced control functions as those on large ocean-going LNG carriers.

This vessel is equipped with Human Interface Stations (hereinafter referred to as HIS) in the wheelhouse and engine control room as IAS operating terminals. As shown in **Figure 2**, HIS monitors provide centralized display of onboard plant data, including cargo tank pressure, temperature, and liquid level, as well as pump operating status and various alarms. In addition to monitoring, crew members can remotely operate auxiliary machinery and valves from the HIS.

The IAS of this vessel is equipped with various automatic controls, and is designed to ensure the safe execution of complex LNG operations that require careful handling. For example, the IAS includes an automatic sequence for LNG bunkering, where a series of valve and bunker pump operations at the start and end of bunkering are automated. Additionally, the IAS controls the fuel gas supply system that delivers gas from the cargo tanks to the generator engines. The fuel gas supply system, which utilizes gas compressors, the LNG vaporizer and the gas heater, and its control, were designed by taking advantage of the expertise gained from the Fuel Gas Supply System (FGSS) for LNG-fueled ships, a product with an extensive track record for MHIMSB. As a result, this vessel achieves excellent automatic control with superior responsiveness to load fluctuations and high operability. In this way, many of the gas handling operations of this vessel which require high levels of expertise are automated by the IAS, contributing to a reduced crew workload and the prevention of operational errors.

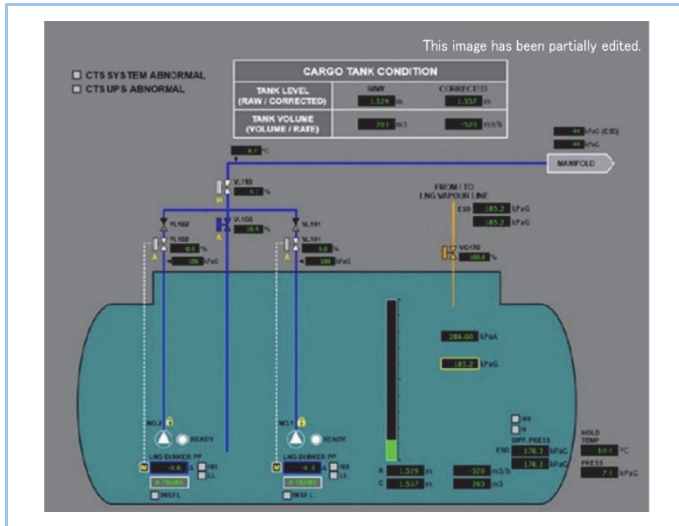


Figure 2 Example of the IAS operation screen

4. Future outlook

Following the adoption of the 2023 IMO GHG Strategy, which aims to achieve net-zero greenhouse gas (GHG) emissions from international shipping by 2050, the maritime industry is transitioning to gas fuels such as LNG and ammonia. Taking advantage of gas handling technologies developed through decades of designing and building LNG carriers, MHIMSB will continue to contribute to the realization of a decarbonized maritime society by providing vessels and fuel supply systems that support the transition to gas fuels.