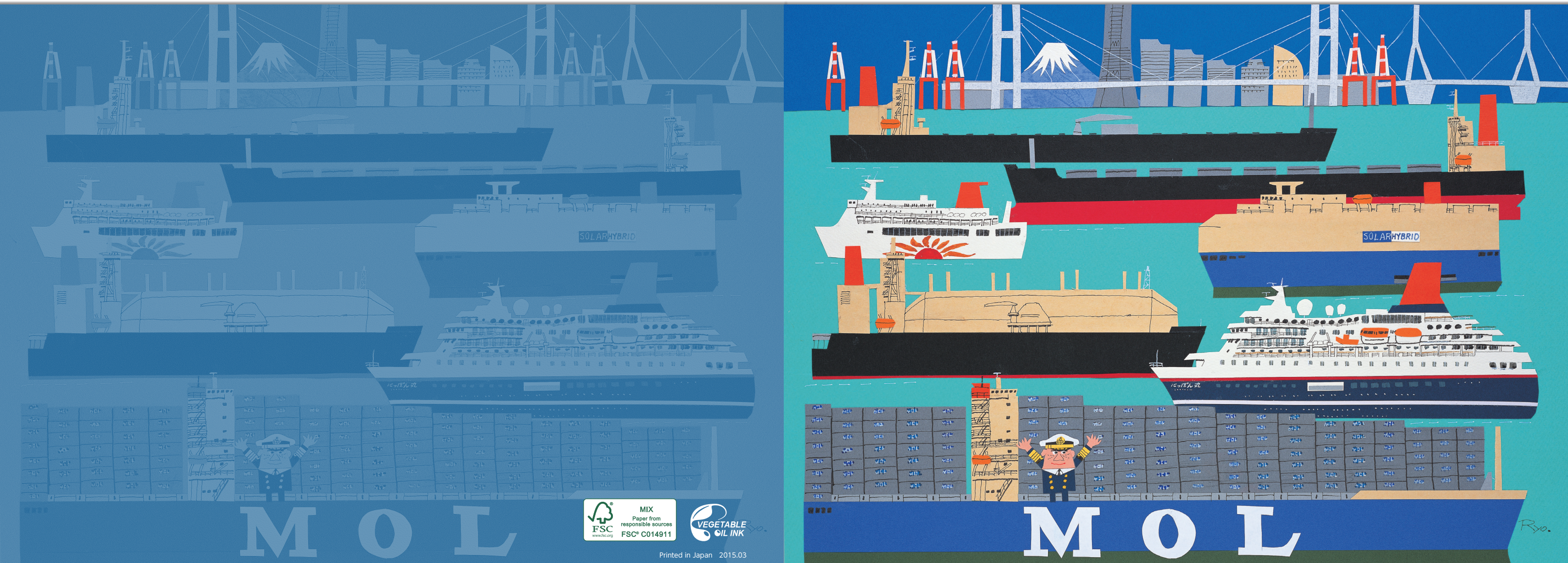


A Vessel for Every Need

Supporting **Everyday Life** and **Industries** Around the World



Merchant Vessels

Supporting Everyday Life and Industries Around the World

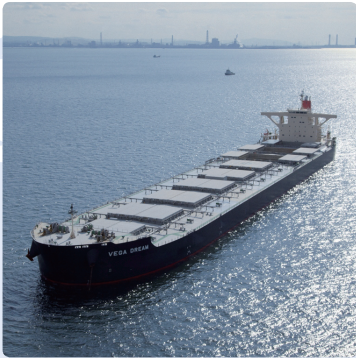
Ships bring efficiency and convenience to the movement of people and cargo. Of course, ships come in all types, from yachts to fishing boats and military vessels. But the ships that transport people and cargo are called “merchant vessels.” Just about everything we rely on in our everyday lives arrives by ship. 99% of commodities, energy resources, and materials imported to and exported from Japan – an island nation surrounded by the sea – travels by merchant vessels. It’s no exaggeration to say that merchant ships are indispensable to our lives.

Larger, Ever More Specialized Vessels

Merchant vessels have evolved to carry out their mission—transporting a diverse range of cargo safely, economically, and efficiently. Ships called “freighters” transport general cargo and finished products, tankers transport crude oil, bulk carriers move massive amounts of iron ore, and car carriers bring automobiles to markets across the sea. Over the years, “dedicated bulkships” have been introduced and refined to carry specific cargoes. At the same time, vessels have become larger and larger, to boost efficiency and realize economies of scale by maximizing the amount of cargo per voyage.

An ‘Ocean Shipping Super-market’

The Mitsui O.S.K. Lines, Ltd. (MOL) Group is a multimodal ocean shipping operator with a global fleet of merchant vessels and that support everyday life as well as industries all over the world. MOL Group vessels come in all shapes, types, and sizes, making the group an “ocean shipping supermarket.” This brochure introduces how these vessels transport the commodities needed for our lives and industries and offers an in-depth look at the structure and characteristics of different merchant vessels.



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Resource Transport

Bulkships transport huge volumes of cargoes such as iron ore, coal, grain, salt, aluminum, and copper ore without packing or packaging. These vessels are called “bulk,” “dry bulk,” or “bulk carriers,” and as the names imply, transport dry cargo in bulk. Bulkships vary widely in size and configuration, depending on the cargo they carry and the characteristics of the ports where they call.

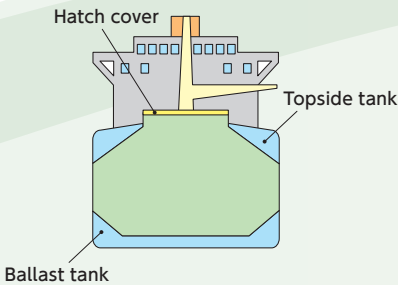
Bulkships by Size

VLOC stands for Very Large Ore Carrier. This class of ship is a recent development, reflecting the trend toward larger vessels in pursuit of economy. The “Capesize” is the largest class of bulkship that can carry any type of cargo, such as iron ore, coal, and grain. They are called “Capesize” ships because they cannot pass through the Panama Canal and have to sail around the Cape of Good Hope to sail between the Pacific and Atlantic oceans. The “Panamax” is the largest class of vessel that can pass through Panama Canal, measuring 900 feet (about 274m) long with a breadth of up to 106 feet (about 32m). The name Panamax can also apply to other types of vessels, such as containerhips, car carriers, and cruise ships. The word “handy” is included in the names of ship types smaller than Panamax. This reflects the convenience of being able to call at most ports around the world. Handy bulkers are equipped with their own cranes, allowing them to load and discharge cargo even at ports without loading/discharging facilities, and can transport a wide variety of commodities.

Bulkship Names by Size		
	Standard deadweight tonnage	Main cargoes
Very Large Ore Carrier (VLOC)	250,000	iron ore
Capesize	170,000	iron ore, coking coal
Panamax	72,000	Iron ore, coking coal, thermal coal, grain
Handymax	55,000	Thermal coal, grain, salt, cement, steel
Small Handy	28,000	Steel, cement, grain, ore

Structure/Characteristics

Bulkships have “topside tanks,” triangular ballast tanks (filled with water to stabilize the vessel) fitted at both shoulders/wings of the cargo holds. These help the ship maintain the proper trim no matter how much cargo is on board. The sides on the lower part of the hold are designed with a hopper configuration to maximize loading/discharging efficiency by preventing cargo from accumulating in the corners. Some bulkers have cranes for loading/discharging, while others rely on shoreside equipment. In general, the vessels larger than Panamax do not have cranes. There are hatch covers at the top of the hold, which are opened only during loading/discharging.



Capesize bulk carrier



Handymax bulk carrier



Loading operation on a coal carrier



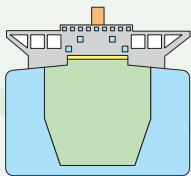
Discharging operation on a Capesize bulk carrier

Dedicated Bulkships by Cargo

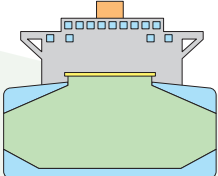
Generally, an optimal ship type of bulkship is chosen based on cargo volume and port scale, facilities, and equipment. But some dedicated bulkships are designed and constructed to transport a specific cargo in the safest, most economical, and most efficient manner.



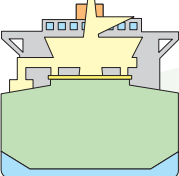
Iron ore has a high specific gravity, so the cargo hold is designed to be narrow, with the cargo heaping up in the center. Capesize-class vessels without cranes represent the mainstream in economical, efficient transport of iron ore.



These vessels transport coal for thermal power generation. They are designed to match the water depth and discharging equipment at a dedicated berth for a power station. The wide-breadth type (80,000-90,000DWT) is the mainstream, as this configuration allows the ship to load a large volume of coal and still navigate safely in shallow waters.



This type of vessel is specially designed to carry woodchips, the raw material for paper. The specific gravity of woodchips is low, so the hold is designed to maximize cargo capacity. In addition, wood chips do not shift very much in transit, eliminating the need for topside tanks.



Energy Transport

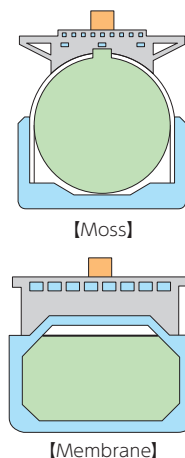
The world runs on crude oil and counts on tankers to keep the supply flowing. Tankers also transport a broad range of refined petroleum products including gasoline, as well as liquid chemical products. In recent years, natural gas has taken center stage as an environment-friendly energy resource. It travels to markets around the world in LNG carriers that are like floating vacuum flasks. Like other vessels, tankers vary in size and configuration depending on the cargo they carry. Their common characteristic is that they connect with some type of pipeline on shore to load and discharge their cargo.

Ocean-going Vacuum Flasks Transport LNG

Tankers carrying liquefied natural gas are called LNG carriers. In gaseous form, it would be impossible to transport methane-based natural gas, because of its immense volume. But when super-chilled to its liquid state, natural gas takes up only 1/600th of its gaseous volume, allowing efficient transport.

Structure/Characteristics

LNG's boiling point is extremely low minus 161.5°C, so transporting it by sea requires advanced technologies such as tanks made of materials especially engineered to withstand ultralow temperatures – ferronickel, stainless steel, and aluminum alloys. Emergency shut down devices are also critical to prevent incidents during loading or discharging. Because LNG is transported almost at its boiling point, many LNG carriers adopt steam turbine engines that can run on gas that boils off from the cargo tanks. Tank configurations include the Moss type (independent spherical cargo tanks) and the membrane type (composed of thin stainless steel).



Moss-type LNG carrier



Membrane-type LNG carrier

Vessels Play a Key Role in Offshore Energy Production

Some vessels have onboard plant facilities and equipment allowing them to serve as floating energy plants. These include Floating Storage and Regasification Units (FSRUs) and Floating Production, Storage, and Offloading (FPSO) systems.

- FSRUs receive cargo from LNG carriers at receiving terminals, store it in their tanks, and regasify it according to demand, and send the gas under high pressure to on-shore pipelines.
- FPSOs produce crude oil and gas from fluids extracted from subsea reservoirs using onboard plant facilities and equipment.



FPSO (source: MODEC)

Tankers Tailored to Fit Various Cargoes

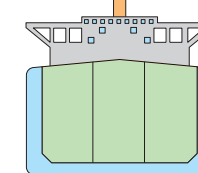
Whether they transport crude oil, petroleum, or chemical products, tankers share the following characteristics:

- A double-hull structure to prevent leakage of liquid cargo in case the outer hull is breached in an accident.
- Some of the cargo tanks are used as ballast tanks (filled with seawater to stabilize the vessel).

Crude Oil Tankers

Structure/Characteristics

The cargo tanks on these vessels are separated into two or three blocks crosswise and about five blocks lengthwise, allowing the ship to transport different types of cargoes. In general, cargo is discharged offshore at a sea berth, connected by a pipeline to the terminal on shore.



300,000 DWT-class VLCC

Product Tankers

Basically, the hull structure and loading/discharging methods are the same as crude oil tankers, but some chemical and product tankers have more tanks so they can transport a wider variety of cargoes. Usually, each tank has its own pipelines and cargo pumps to prevent cargo-contamination.

Product tankers carry petroleum products such as gasoline, naphtha, kerosene, and diesel oil. These ships are essential in transporting cargo to areas that do not have facilities to refine crude oil. There are generally three classes of product/chemical tankers. These days, larger vessels are becoming more common as demand increases.

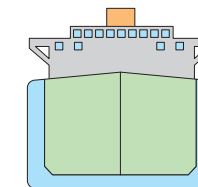
Product Tanker Names by Size

- MR type (medium range): 25,000 – 55,000 DWT
- LR I type (large range 1): 55,000 – 80,000 DWT
- LR II type (large range 2): 80,000 – 160,000 DWT

Chemical Tankers

Chemical tankers transport liquefied chemical products such as benzene, toluene, and alcohol products.

The cargoes transported by product/chemical tankers are more corrosive than crude oil, so tanks and pipelines are usually made of stainless steel, with special coatings inside.



LR1-type product tanker

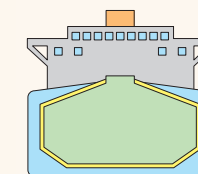


Chemical tanker

LPG Tankers

This type of tanker carries liquefied petroleum gas (LPG) such as propane and butane. Some LPG tankers are multipurpose vessels that can also transport liquefied chemical gases including liquefied ammonia, which is a raw material for textile and fertilizer production.

As the boiling points of liquefied propane and liquefied butane are higher than that of LNG (minus 42.4°C and minus 0.5°C respectively), the requirements for hull and tank structures and materials are not as strict as LNG carriers. Therefore, there are many smaller coastal LPG carriers as well. There are three basic types of LPG carriers: fully pressurized, fully refrigerated at atmospheric pressure, and semi-pressurized and refrigerated. Most large-scale ocean-going LPG carriers are the refrigerated type.



LPG tanker

Product Transport

Unlike bulkships that carry resources and tankers that carry energy, other types of vessels carry finished products. This section introduces car carriers that transport automobiles and containerships that carry a wide variety of cargoes such as apparel, appliances, and other items we use every day.

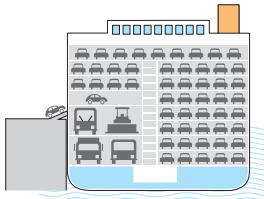
— ‘Floating Parking Garages’ Load/Unload Self-propelled Cargo, Boosting Transport Efficiency —



These vessels are called Pure Car Carriers (PCCs) or Pure Car and Truck Carriers (PCTCs), and they are designed specifically to transport cargoes such as automobiles and self-propelled construction machinery. In 1965, MOL launched Japan's first specialized car carrier equipped with loading/unloading equipment, the *Oppama Maru*.

Structure/Characteristics

Today's car carriers do not have loading and unloading facilities and equipment such as cranes. Instead, expert drivers drive the cars on and off through a hatch at the stern, which has a rampway that connects to the pier. This loading/unloading method is called Roll On/Roll Off (RO/RO).



Inside, the ship has multiple decks, like a huge multi-level parking garage. To maximize loading capacity, the drivers leave just 30cm between the front of one car and the rear of the next, and a mere 10cm from side to side. The height of some decks is adjustable to make more headroom for large buses, trucks, and construction machinery.

In the days of the *Oppama Maru*, car carriers could hold about 1,200 vehicles, but today's largest PCCs and PCTCs have capacities of 8,400 units. Typical MOL-operated standard car carriers are about the same height as a 15-floor parking garage and have a capacity of 6,400 vehicles. Car carrier loading capacity is calculated for standard passenger cars measuring 4.125m long and 1.55mm wide.



A car carrier with a capacity of 6,400 units



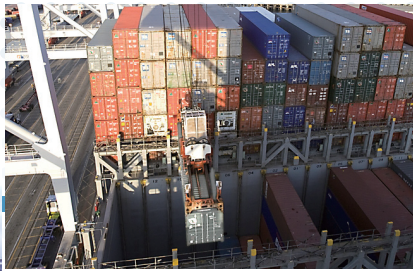
A specialized vehicle being unloaded from the rampway

World's First Newbuilding Hybrid Car Carrier

Since today's cars are designed to be earth-friendly, it only makes sense that the ships bringing them to market should offer the same level of environmental protection. That's why MOL takes a proactive approach to implementing green technologies. MOL-operated car carriers adopt an aerodynamic bow as the standard design to reduce wind pressure. The hybrid car carrier *Emerald Ace*, which was delivered in 2012, has solar panels on the deck to power vessel systems while the ship is in berth, achieving zero CO₂ emissions.



Loading cars on a car carrier



40-foot containers being loaded on a containership



Once off the ship, the container is placed on a trailer for delivery to the customer

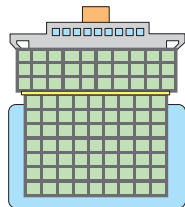
— Door-to-door Transport with International Standard Containers —



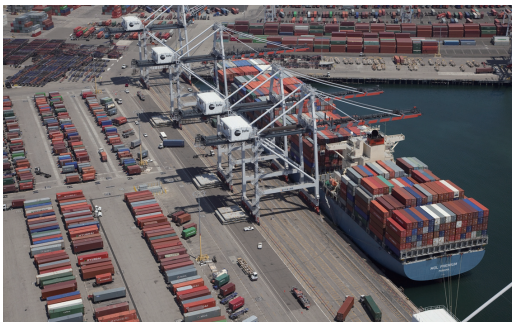
These vessels carry cargoes that are loaded into international standard ocean containers. Shipping routes and schedules are set in advance like bus or train services, and vessels periodically call at predetermined ports. In addition, containerized cargoes can be swiftly and easily reloaded to trucks and rail cars, making it possible to provide integrated door-to-door transport service.

Structure/Characteristics

Containerships call at container terminals that have loading and unloading facilities and equipment. So generally, these vessels are not equipped with onboard cranes. The vessels can sail at higher speeds than other ship types to maintain stable calling schedules.



10,000 TEU-class containership

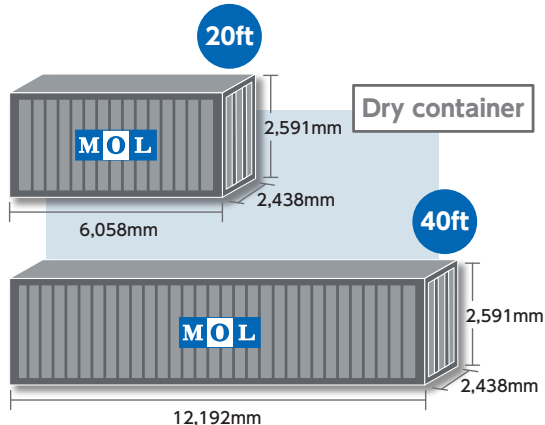


A containership berthed at a container terminal

Ocean Containers: Size, Numbering, and TEUs

Sizes, strength, external dimensions, and the numbering system for ocean containers are standardized by the International Standardization Organization (ISO).

- There are basically two lengths for containers: 20 feet and 40 feet.
- Types of containers include "dry containers," "refrigerated (reefer) containers," "open top containers," and "tank containers," and are selected according to their intended use.
- Numbers on the container designate its owners, type, and size.
- Loading capacity and transport records of containerships are expressed in "TEUs," a term that stands for "Twenty-foot Equivalent Units." A 20-foot container is 1 (one) TEU. A 40-foot container is counted as 2 TEUs.



Passenger Transport

When it comes to long-distance travel, people have always counted on ships. Today, cruise ships ply routes around Japan and all over the world, providing a leisurely escape that allows people to “enjoy time and space,” as well as a means of travel.

In addition, ferries have grown with the spread of car and truck transportation, and also play a key role in domestic logistics services. But like cruise ships, ferry travel also opens up new horizons in leisure.



Premium Dining in the *Nippon Maru*

— Ferries Efficiently Transport People and Cargo in Coastal Japan —

Ferries are liners that carry passengers, cars, trucks, and semitrailers all together. Long-distance ferries have the following advantages, since they are operated mainly at night.

- Ferry travel integrates both transportation and accommodation, making trips more affordable. Plus if travelers bring their cars on board, they will have greater mobility when they reach their destination.
- When it comes to cargo transport, ferries give drivers a chance to rest while their cargo continues to move. In addition, ferries allow for “unmanned sailing” – transporting only trailers without drivers aboard. What’s more, transporting cargo and people by ferry reduces CO₂ emissions, which is a key cause of global warming, compared to other modes of transport, so they are expected to be an essential part of the “modal shift” promoted by Ministry of Land, Infrastructure, Transport and Tourism in Japan. Ferries also help address the shortage of long-haul truck drivers and reducing labor burdens.

Ferries

Structure/Characteristics

In general, the lower part of the hull has space to accommodate vehicles and trailers, which are loaded and unloaded via a rampway set at the stern, bow, or side of the vessel using the RO/RO method. Passenger cabins, restaurants, and other amenities are located on the upper decks. Some long-distance ferries are huge, with luxurious appointments almost on a par with cruise ships.



This ferry can accommodate 632 passengers, 77 passenger cars, and 154 trucks

— Pleasure Travel with Hospitality That Knows No Limits —

Cruise ships take passengers from one place to another, but the real joy is in the journey. Once you come aboard, the time is all yours to spend as you please – enjoying fine dining, watching a live musical performance, or just taking in the sights at sea.

Structure/Characteristics

Cruise ships have multiple decks packed with a full range of facilities for passengers to enjoy during their voyage – all types of staterooms and suites, restaurants, lounges, cinemas, bars, theaters, and even spa and salon services.

The *Nippon Maru* is equipped with the “Fin Stabilizer” rolling prevention system to maximize passenger comfort. It also features variable pitch propellers – the angle of the screws can be adjusted for smooth berthing or departure in any size port.



The *Nippon Maru* offers an impressive level of daintiness and relaxation

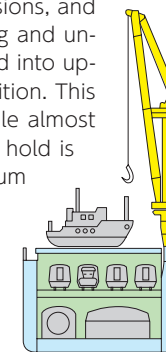
Vessels Serving Specialized Fields

This section introduces some of the MOL Group’s most highly specialized vessels.

— Setting the Standard in the Transport of Heavyweight, Long, and Other Oversize Cargoes —

Heavy lifters are vessels designed especially to carry heavyweight cargoes weighing more than 30 tons each, such as plant components, large construction machinery, and even *shinkansen* bullet train cars. The cargo hold is box-shaped with few protrusions, and has a wide hatch on deck for ease of cargo loading and unloading. What’s more, the cargo hold can be divided into upper and lower sections with a strong, movable partition. This configuration gives the vessel the flexibility to handle almost any cargo. A large item that cannot fit in the cargo hold is carried on the deck, which is reinforced for optimum strength. Heavy lifters are also equipped with powerful cranes, so they can load and unload heavyweight cargoes on their own. To ensure the vessel’s stability during loading and unloading operations, these vessels are designed with high-volume ballast tanks on both sides.

Heavy Lifters



A heavy lifter loading a *shinkansen* bullet train car

— These Hard-working Boats Keep Marine Traffic Moving —

Tugboats are used to push or pull vessels or structures on the water. Their sizes vary depending on the task. The most common type of tugboat, called a harbor tug, assists large vessels berthing and unberthing. Harbor tugs are generally in the 200-ton to 300-ton class. Oceangoing tugs, which tow huge cargoes such as plant equipment in the open sea, range up to several thousand tons.

Tugs are equipped with immensely powerful engines because they have to move vessels and equipment much larger than themselves. Harbor tugs also have azimuth thruster propellers that can rotate 360° and allow the boat to maneuver in tight quarters. Used tires and rubber fenders are placed around the tug to prevent damage to the ship which the vessels come into direct contact during operation.

Tugboats



A tugboat guides an LNG carrier into port

— Laying and Maintaining Undersea Cables in the Internet Age —

Cable ships lay, repair, and pick up undersea cables. These ships have to maintain a fixed position during operation, regardless of wind and wave motion, so they are equipped with a Dynamic Position System (DPS) to keep them in the correct spot.

Onboard features of cable ships include a cable tank where the cable is kept, a linear cable engine and a drum cable engine, which roll the cable up and down, an undersea robot used to inspect and repair undersea cables, and so on. The deck is used as an operation space. The ship also has a cable control room, allowing safe, continuous on-screen monitoring of cable operations.

Cable Ships



Cable ship (source: Kokusai Cable Ship Co., Ltd.)