CONCEPT 02

ALICE SYSTEM

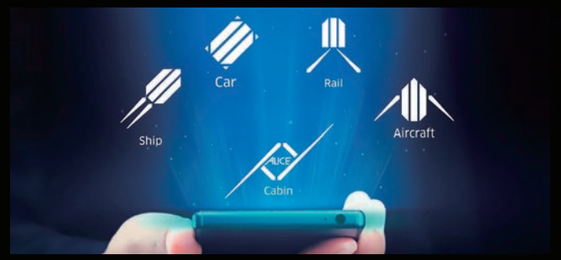
Public transportation system for more convenient and comfortable transport enabled by Kawasaki's comprehensive strengths in land, sea and air transport technologies

ALICE SYSTEM is our answer to the theme of fulfilling the "Impulse to Move" for the purpose of mass mobility. The goal is to provide a convenient and comfortable public transportation system, and the plan aims to implement the relevant technology in 2050.

The system is built centered around ALICE Cabin (the "Cabin"). The concept is that independent passenger cabins are able to autonomously connect with different modes of transportation, including cars, trains, airplanes, and ships, and to be carried by them. This interconnected mobility system aims to eliminate the need for passengers to transfer and provide a solution to issues posed by existing public transportation services, such as chronically overcrowded trains and inadequate barrier-free environments.

In the present situation, while universal design is being adopted by various facilities, many passengers, especially those with disabilities or traveling with small children, still have concerns about inconvenient facilities and feeling uncomfortable in public places. Existing public transportation services provide some options to meet the need for privacy, however, these are generally targeted only at high-end users.

Wishing to solve these issues, the design concept of ALICE SYSTEM contains our commitment to delivering an easy-to-access solution to those in need of privacy in public.



To go on a trip, make your plans by selecting options related to mobility mode — land, sea, or air — as well as destinations, food, and other details. When you are ready, send a request for an ALICE Car to pick you up at home or any other place.

ALICE Car

Road vehicle to carry the Cabin. Supports transshipment of passengers. Adopts the hydrogen power generator O'CUVOID (details are provided later in this document)

ALICE Ship

High-speed passenger vessel modeled after a fully submerged hydrofoil (Jetfoil). Provides safe, comfortable and free movement throughout the ship during navigation P.26

ALICE Cabin P.22

ALICE Aircraft

Aircraft pursuing passenger comfort, notably with lounge areas with a view created by taking advantage of the latest airframe geometry P.24

ALICE Rail

Complete with the Cabin, dining car and lounge areas, the train delivers good privacy and comfort. Adopts the hydrogen power generator O'CUVOID (details are provided later in this document) P.23

Cross-sector cooperation for joint development

The development of ALICE SYSTEM involves Kawasaki's largest-ever inter-company collaboration, specifically to carry out the following procedures: for car, train, airplane, and ship to connect with the standardized cabin, first determine the dimensions of the cabin, which should be based on that of the train, the mode with space requirements tighter than others; and the airplane and ship are designed in alignment with the dimensions determined.

FUEL

Hydrogen fuel is adopted for use in each mode of mobility. For fueling, a range of options were considered to make the best possible choice for each. Looking at the possibility of hydrogen being adopted in various forms in society, such as high-pressure or liquid hydrogen, filling or cartridge type, the plan is laid out to use this opportunity to promote Kawasaki's related technical capabilities.

POSSIBILITY

One of the objectives of developing ALICE SYSTEM is to present a proposal that will trigger public discussions on "What constitutes better public transportation systems?" The proposal will be made by introducing a range of possible ways of deploying cross-sectoral services using this mobility model, such as: ALICE Car serving as a taxi for passengers to transfer between transport modes; the Cabin equipped with medical service functions to provide ambulance service; and the Cabin as a travelling shopping center.

Cabin

Dimensions: 2200mm (H) × 3050mm (W) × 2175mm (D)
Weight: 1000kg
Capacity: 4 seats

Concept

ALICE SYSTEM's interconnecting module. Designed with an emphasis on passenger comfort and convenience while adopting the barrier-free concept, specifically by securing a more-than-sufficient space for a maximum capacity of four seats, which can be removed to create a space for wheelchairs. The Cabin's power supply capabilities are reduced to the minimum required, by omitting a power generator and with electricity supply received from the facilities housing the module. This enables a significant reduction in purchasing and maintenance costs, compared with private jets and cruisers, enabling privacy of comparable quality to be offered at an affordable price.

Remote communication system

A semi-transparent glass display is installed on one of the interior walls of the Cabin. This is a remote communication support tool, primarily to enable passengers to consult a doctor remotely or attend an online business conference while traveling. In addition, the system includes a real-time video streaming function for different cabins to share images of their inner situation with each other, allowing users of more than one cabin to feel like being together in one place. Also, a directional speaker is installed to give public announcements in an appropriate manner. For giving information to passengers with visual or hearing impairments, voice or text format can be chosen by each cabin, improving the accuracy of delivering information to the target, compared to the existing information communication capabilities.

Operation using the display within the cabin

Concierge function

The Cabin comes with a concierge function aided by a robotic arm mounted on the side of the seat. Robotics technology is applied to provide semi-automated processes for tasks performed previously by human attendants, such as serving drinks, helping passengers put on and take off coats, and holding a book, smartphone, or the like in the right position.

Support provided by the robotic arm mounted on the side of the seat

Rail

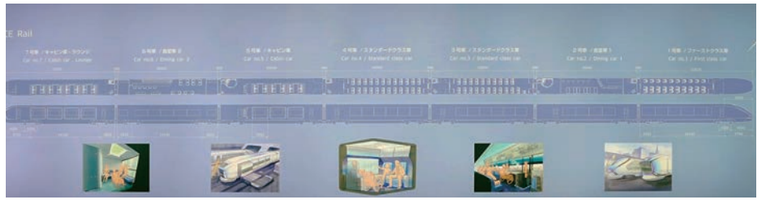
Concept

ALICE Rail is the railway system to carry the Cabin with the objective of offering a high-quality passenger experience in terms of privacy and comfort. The plan aims to deliver quality on par with that of private jets and cruisers, facilities equipped to provide high-level confidentiality protection for attending important business meetings and flexibility in customization of the interior space that cannot be matched by private compartments offered by some existing limited expresses, including premium options for adequate comfort and relatively high privacy.

In ALICE SYSTEM, the Cabin comes in several different types to be chosen by users according to their specific needs, and with an interior layout and facilities prepared to accommodate customization needs. This is for offering quality comfort particularly targeting businesspersons, group travelers, and wheelchair and stroller users.

Train formation

The train is composed of a total of seven cars, which are divided into a cabin section for Cabin users and a general section for general passengers to use as usual. The general section is subdivided into standard and first class blocks. In order to ensure privacy, passage between the two sections is restricted, and each section is staffed independently. Also, each has a dining car offering different service options and food menus attached. The cabin section includes exclusive lounge areas.



Train formation

Space design

Dimensional designs are based on full-size Shinkansen specifications. First, the aisle width was set to 900 mm to ensure that wheelchair users could pass through without difficulty. Then, the depth of the Cabin (2,175 mm) was determined to allow passengers to move comfortably between the aisle and the Cabin. As a result, the overall height of ALICE Rail exceeds that of the Shinkansen train car by 300 mm.

In consideration of wheelchair users, barrier-free designs are included in the floor plan. In addition to step-free floors, particular considerations are given to reduce their stress when moving between cars to access the dining car. Also, special measures are taken to create a sunken kitchen in the dining car to allow those in wheelchairs to interact with the staff and chefs comfortably at the same eye level when ordering and eating a meal.

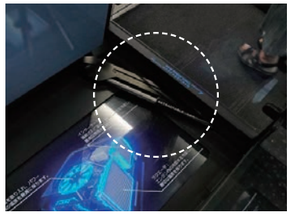
Docking

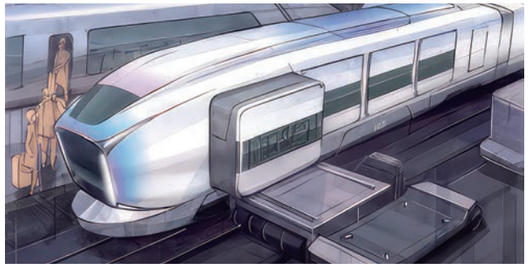
The plan for docking the Cabin onto ALICE Rail is by moving the Cabin to position itself in parallel with ALICE Car and inserting it from the side. The insertion process is started by deploying the conveyer equipped with ALICE Car and completed by using pull-in arms mounted on ALICE Rail to lock the Cabin inserted.

As ALICE Rail is operated by shar-

ing platforms with general trains, the docking process is to be performed only from the side opposite to the platform. This is to avoid interfering with conventional platform operation procedures, including first-class and standard-class passengers using the platform for embarkation and disembarkation.

In the case of docking on a double track platform, the insertion process will be performed over the track. To do this, a self-propelled bogie-mounted conveyor is to be placed over the track to allow the Cabin to slide on it into the train.


Pull-in arm


Docking using a self-propelled platform

Fuel

For fuel, a high-pressure hydrogen cartridge system is employed. Refueling will be completed by exchanging cartridges during standby for shuttle train operation, thus achieving high work efficiency to overcome time restrictions. The plan has employed the hydrogen fuel engine O'CUVOID.

Exchanging hydrogen cartridges

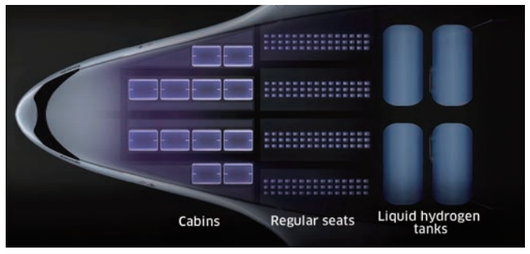
Specifications table (estimates)	
No. of cars per train:	7
Track width:	1,435 mm
Total train length:	148,650 mm
Total width:	3,225mm
Total height:	3,950mm
Floor level:	1,300mm
Total seating capacity:	152 (7 ALICE Cabins + 124 general passengers)
Maximum speed for commercial use:	260 km/h (fully electrified section); 130 km/h (non-electrified section)
Fuel:	High-pressure hydrogen (875 L/car)
No. of O'CUVOID units installed:	9 (35 kW)/car
Interior facilities:	Passenger car (cabin, first-class, standard class); dining car; lounge: restroom, etc.

CONCEPT 02 ALICE SYSTEM

Aircraft

Concept

ALICE Aircraft is distinguished by its structure design to deftly connect the private Cabin space and public areas offering good in-flight freedom of movement. Our vision is to establish technologies to eliminate the discomfort experienced by many passengers from being confined to their seats for many hours, a major issue posed by the existing flight service, and allow all passengers, including individuals with special needs and those traveling with small children, to enjoy the freedom of moving with comfort, comparable to that found on large cruise ships, which itself is often the purpose of traveling.



Interior floor plan

Design

Major design requirements are to be able to: 1. carry ALICE Cabin with its design standards established; 2. fly about 10,000 km from Japan to Paris; and 3. have sufficient hydrogen fuel loading capacity. For fuel to meet these requirements, the plan has chosen liquid hydrogen, which is smaller than high-pressure hydrogen in volume. With liquid hydrogen, compared to traditional kerosene-based jet fuels, while the fuel volume will be about four times as large, the weight can be reduced to one third. To secure the required loading capacity, a blended wing body has been employed to achieve high volumetric efficiency.

Docking

The cabin docking process uses the boarding entrance for cabin passengers to be built on the both lateral sides of the fuselage. Like existing aircraft, only the portside entrance is to be used in normal times, and the starboard side entrance will be used only for emergency escape. The Cabin is robotically led to the entrance, loaded by the conveyor or other devices onto the aircraft, and locked in its specified location on board. Before the decision was made to choose this method, a number of other options were discussed and excluded for various reasons. Among such candidates were a plan to locate the cabin loading bay at the aft and another to lift up the cabin to load from above, which posed concerns, such as the discomfort of passengers about being handled like cargo, the hazard posed by lifting up the Cabin, and the risk of rainwater entering from the opening in the ceiling. The entrance for general passengers will be created in parallel and used in the current manner.

Facilities

The plan includes the creation of lounge areas containing restaurants and observation facilities. The space can be designed to feature skylight windows to offer a good view of the star-filled sky. To ensure stress-free movement of passengers on board, the aisle width is set to 1,500 mm, particularly to enable two wheelchairs to pass each other comfortably, and restrooms will have a sufficiently large space to accommodate needs for nursing care. Also, robotic processes will be introduced to play some of the roles that are traditionally performed by human cabin attendants, aiming to increase efficiency in providing in-flight services.

Issues

In the context of air transport operations, the highest priority issue is to ensure safety, which should come before realizing the above-described design concepts. Future discussions are needed to establish specific technology solutions to ensure the safety of Cabin users. Among the ideas on the table are: an earthquake-proof structure could be adopted to enable the Cabin to control shaking in the interior, even in a shaking aircraft; and the Cabin could have a feature to receive oxygen supply and eject itself out of the aircraft on an individual basis in the event of an emergency.

Development of capabilities to use hydrogen fuel is based on the hydrogen aircraft core technology currently under development at Aerospace Systems Company. Major challenges to be addressed are: to meet the fuel requirement for large volumes of liquid hydrogen, specifically by securing sufficient hydrogen fueling volumes at airports and establishing a high-speed refueling process between flights; and reduce the weight of the overall aircraft including hydrogen related equipment and the overall airframe structure.

In order to implement this project, further studies are needed to work out solutions from the perspective of technology and regulations (safety requirements).

Specifications table (estimates)	
Total length/width:	60 m long; 60 m wide (equivalent to Boeing 787-9)
Main wing area:	360 m² (including fuselage section)
Engine/output:	Hydrogen combustion engine (400 kN unit x 2)
Fuel:	Liquid hydrogen (40 t)
Cruising speed:	900 km/h (Mach 0.84)
Cruising range:	10,000 km (Japan-Paris)
Total seating capacity:	228 (12 ALICE Cabins + 180 general passengers)
Takeoff weight:	250 t
Liquid hydrogen tank:	150 m³ tank x 4

Ship

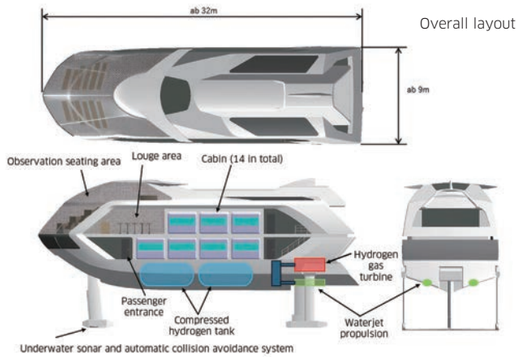
Concept

ALICE Ship is a high-speed vessel modeled after Jetfoil — the passenger-carrying fully submerged foil type-hydrofoil produced by Kawasaki — and a carrier of the Cabin. The goal of this project is to offer a distinctively comfortable passenger experience on board by incorporating the Cabin's functions effectively. Looking to differentiate itself from ALICE Aircraft, which offers a long-distance transportation capability, ALICE Ship is designed to have a capacity for an around 150 km cruising range. By combining the Cabin's features with the Jetfoil's strong anti-rolling features and high-speed capabilities, the highlight of this technology, this maritime mobility model aims to allow all types of passengers to have a transfer-free, comfortable and convenient trip by sea.

Design

This ship will be able to navigate with its hull lifted above the water, like the Jetfoil. To establish this ability, the design plan gives particular consideration to weight and space.

By adopting hydrogen fuel, this project faces lower fuel efficiency than conventional light fuel oil, due to difference in energy density, meaning a requirement for a larger fuel storage space. To address this requirement, the cruising range is reduced from around 500 km at present to 150 km to secure sufficient space.



Overall layout

For hydrogen fuel to be loaded on board, compressed hydrogen has been chosen for the purpose of weight reduction and space saving. By choosing compressed hydrogen, the fuel system can omit a tank structure with ultra-low temperature resistance (-253℃) and a carburetor, essential functions to run a liquid hydrogen-fueled system. Please note that this design plan assumes that the development of hydrogen turbines will advance so that their performance will achieve a level comparable to conventional gas turbines in terms of power-to-weight ratio by 2050.

Docking

Cabin docking takes place from the both sides of the hull, and the maximum loading capacity is set to 14 cabins in combined total. One major problem with this process is that it is susceptible to the effect of waves in the quay rocking the ship, and it is essential to keep the ship stable during docking operations in order to ensure the safety of the Cabin. One solution proposal is using a lifting device to raise the vessel above the water surface so that the ship is not impacted from wave motion and tidal differences and retains a stable state suited to receiving the Cabin from its sides safely. With currently available lifting devices, it will take from several tens of minutes to one hour to raise the vessel to an appropriate level, posing a challenge to overcome by taking measures to shorten the overall cabin docking time to ensure a comfortable travel experience. Another important issue is related to the ship's structure of accommodating Cabins on two different levels. Future discussions will be needed to determine which of the two methods to apply — adjust the level of the vessel using the lifting device or the level of the Cabin on land.

Facilities

One of the key features of ALICE Ship is automatic anti-collision systems equipped with underwater sonars, a measure to free people from using a seat belt, a standard requirement for Jetfoil passengers and a factor restricting their freedom of movement during the voyage, and allow them to walk around on board as they wish and in safety. This reflects the project's commitment to delivering a distinctive passenger experience specific to this ship. Also, the ship features a fully autonomous navigation system, which can eliminate the need to install a cockpit and assign relevant crew, resulting in space on the second floor with a good view freed for creating an observation seating and lounge area. In addition, barrier-free designs are adopted for onboard facilities in reference to the barrier-free law, such as an aisle width set to accommodate the passage of wheelchairs and barrier-free toilet systems.

Issues

In general, ships are equipped with various functions to be able to endure severe marine environments, typically to prevent salt corrosion and submergence. For this ship, especially, strong watertightness at the connection section between the vessel and the Cabin is imperative to prevent the entry of seawater. As the Cabin composes a part of the exterior of the vessel, it is essential to implement measures in the Cabin to protect it from salt corrosion, and appropriate measures are needed to enable navigation even when the cabin loading capacity is not filled up.

For emergency escape, considerations are necessary to determine whether to adopt only conventional methods or to add a lifeboat function to the Cabin.

Given the ship's design range of 150 km, hydrogen refueling will be needed not only on the mainland but also on islands, meaning that development of hydrogen fueling infrastructure on an island is a precondition for making the ship's service available, which poses a major hurdle to many remote islands at present.

Discussions will be held continuously to address these issues specifically, aiming to implement the project.

Specifications table (estimates)	
Vessel type:	Passenger-carrying fully submerged foil type-hydrofoil
Propulsion:	Waterjet propulsion
Total length/width:	32 m long; 9 m wide
Deadweight capacity:	26 t
Engine/output:	Hydrogen gas turbine (2,000 kW unit x 2)
Fuel:	Compressed hydrogen (11 m³ tank x 2)
Maximum velocity:	40 knots (approx. 74 km/h)
Cruising range:	80 kairi (approx.150 km)
Total Seating capacity:	120 (14 ALICE Cabins + 64 general passengers)
Special notes:	Fully autonomous navigation system; underwater sonar and automatic collision avoidance system

Conclusion

ALICE SYSTEM represents the possibility of future public transportation systems envisioned by Kawasaki. We have showcased the relevant technology concept to the world through Expo 2025, anticipating that it will trigger public discussions to identify additional issues and suggest improvements. Making effective use of such feedback from society, and bringing together the expertise of each company, we will continue with this endeavor toward achieving the goals.

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