



NYK SPARK BOOK

Providing Competitive Services Favored by Customers

Nippon Yusen Kabushiki Kaisha

Supplementary Volume of *NYK Report 2016*
Handbook for 'Creative Solutions'

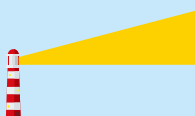


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Supplementary Volume
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Handbook for
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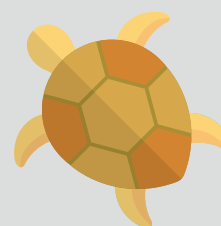
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Cautionary Statement with Regard to Forward-Looking Statements

Some statements made in the *NYK SPARK BOOK* are forward-looking statements, which involve certain risks and uncertainties that could cause actual results to differ materially from those projected. Please be advised against undue reliance on such forward-looking statements, which are based on information currently available. NYK undertakes no obligation to publish revised forward-looking statements to reflect events, circumstances, or unanticipated events after the present juncture.

The Meaning of 'Leveraged by Creative Solutions'



**We will pass on traditions
inherited from our predecessors
to create new advantages.**

Tadaaki Naito

President, President Corporate Officer

The NYK Group has a long history of challenge and innovation. On many occasions, we have faced a rough sea, such as during times of war or economic crisis. Each time, despite only having modest numbers of employees, we have overcome difficulties to remain a leader in the world's shipping industry. Moreover, we have often pioneered businesses that are the first of their kind in Japan or in the world.

An issue we currently face is commodification of vessels. One driver of this trend is speculative investment in the shipping industry, which has emerged because ordering vessels no longer requires related expertise. Another contributing factor is the development of shipyards in emerging countries. The advantages our predecessors established through strenuous effort are not working any more.

We cannot survive in today's rapidly changing business environment by only repeating past actions. If we do not reform ourselves, emerging trends will leave us behind. However, if our predecessors' hard work established past advantages, then our generation too should be able to create new advantages for the future.

The spread of the Internet enables rapid imitation of innovative services. Therefore, we must continue creating new value and seeking differentiation. As well as offering customers new, impressive solutions, we have to continue advancing a range of in-house efforts, such as eliminating the 3M (*Muda*, *Mura*, and *Muri*) in day-to-day duties and vessel operations, establishing a flexible organisation by introducing diverse work styles, and invigorating businesses through the reform of employees' mindsets.

Aiming to encourage innovation, we set out 'Leveraged by Creative Solutions' as a slogan in 2014. At the same time, we established the Creative Solutions Group. The various initiatives we have launched since then have focused on building an organisation in which ideas for differentiation arise one after another from operating sites. These ideas do not have to be major inventions or technological developments that revolutionise the shipping industry; they do not need to advance us a full step ahead of competitors, they just need to be sufficient enough to advance us, even if only half a step ahead, towards differentiation.

In addition, I want to foster as many employees as possible who act on their own initiative, use the capabilities of others by overcoming organisational boundaries, and establish new advantages decisively. Of course, I realise that this kind of transformation will not happen overnight. However, the initiatives we have introduced in relation to Creative Solutions will steadily improve our overall capabilities. In spite of our long history of more than 130 years, it is important to keep abreast of changing conditions and advance concerted efforts to achieve new competitive advantages, working together as the NYK Group throughout the world.

The *NYK SPARK BOOK* focuses on Creative Solutions, which are establishing new technologies and strategies, as well as on the organisational capabilities supporting these innovations. In closing, I sincerely hope this report furthers understanding of the NYK Group's activities.

3M

Muda: Non-value-adding activities

Mura: Unevenness in production or work activities

Muri: Excessive burdens

01

Creative Solutions That Heighten Competitiveness



Exploiting Big Data to Boost Competitiveness—Increasing Use of IoT in Vessel Operations

The energy efficiency of vessels transporting cargo improves as they become larger. Beyond a certain point, however, the benefits of enlarging vessels become marginal. As a result, efforts to reduce CO₂ emissions by improving vessels' energy efficiency through enlargement have almost reached their limit. In response, the NYK Group will realise energy-saving vessel operations that reduce CO₂ emissions by focusing on systemic innovations.

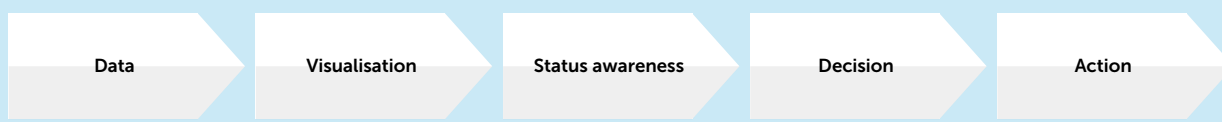
Sharing Data in a Timely Manner between Vessels and Onshore Operations

Our platform for using big data comprises the Ship Information Management System (SIMS). NYK and its Group company Monohakobi Technology Institute (MTI) jointly developed and began to use SIMS in 2008. The implementation of this system to vessels enables crew members to provide onshore personnel with detailed hourly updates on the status of vessel operations and fuel consumption. By evaluating vessels' speed and fuel consumption as well as weather conditions, crew members and onshore personnel can improve the efficiency of

vessel operations and vessel allocation.

Having installed SIMS on more than 150 of our operating vessels, including containerships, dry bulk carriers, car carriers, crude oil carriers, and LNG carriers, we are beginning initiatives to use the big data obtained from SIMS for other applications. By upgrading SIMS technology as vessel operations infrastructure so that it caters to the needs of each vessel type and enhancing SIMS technology for the analysis of big data, we will be able to prevent engine breakdowns, thereby reducing maintenance costs and time loss due to engine problems and realise safe, reliable cargo transport.

Big Data Analysis and Utilisation Process



Sharing information in a timely manner between vessels and onshore operations



Shipside viewers



Onshore viewers



Examples of using big data and IoT

Party	Function	Usage example
Vessel operator	Vessel operations	Energy-saving vessel operations
		Safe vessel operations
		Schedule management
	Fleet development	Fleet plans
Shipowner Vessel manager	Technology management	Service plans
		Charter vessels
		Safe vessel operations
		Cleaning of hulls and propellers
	Shipbuilding	Status monitoring and maintenance
		Measures for environmental regulations
		Modification to save energy
		Design optimisation

Using IoT and Big Data in the NYK Group

During vessel operations, voyage, engine, and other data is updated in real time, leading to the accumulation of huge amounts of basic data; model tests in water tanks cannot produce the type of big data that actual voyages generate worldwide. We will use this big data to

reduce the environmental burden of transport and realise energy-saving vessel operations, thereby differentiating our services. Through the Ship Performance Analyzing System (SPAS) or SIMS, crew members will share data gathered from various onboard equipment with onshore personnel in a timely manner to provide high-value-added services.

SPAS

(Ship Performance Analyzing System)

Began operating in 2007

This digital abstract log data system enables crew members to input abstract log data, send it from vessels to a dedicated server, and share it with onshore personnel. The system also enables storage of up to 10 years' worth of data.

Abstract log:

This is a summarised version of a vessel's log and includes data on course, voyage distance, weather conditions, sea conditions, fuel consumption, and other navigation and engine related data.



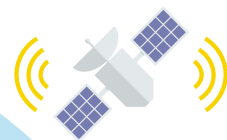
Onboard

SIMS

(Ship Information Management System)

**First-generation SIMS: Began operating in 2008;
Second-generation SIMS: Began operating in 2014**

This system enables the sharing of detailed information about the status of vessel operations and fuel consumption between vessels and onshore operations automatically. The introduction of SIMS has enabled onshore personnel to analyse the status of vessel operations in greater detail based on vessel speed, fuel efficiency, and weather conditions.

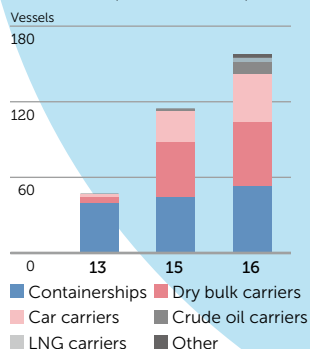


Once a day

Once an hour

Number of vessels

with SIMS (As of March 2016)



Voyage data

- Vessel speed, wind direction, wind speed, course, rudder angle, time and others

Engine-related data (added in second-generation SIMS)

- Fuel consumption, revolutions, horsepower, temperature of exhaust gas, scavenging air pressure and others

Vessel motion sensors

Data Visualisation

Usage
example
3

Realising optimal vessel operations
and predicting engine breakdowns
→ Please see page 07.

LiVE (Latest Information for Vessel Efficiency) portal site

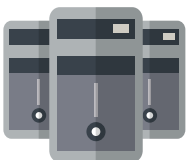


The portal site displays data collected through SIMS (see screenshot on left). By monitoring these data, vessel managers and operators can optimise vessel operations and predict engine breakdowns, due to support vessel safety from onshore.

LiVE

Onshore

Data centre



IoT for Vessels

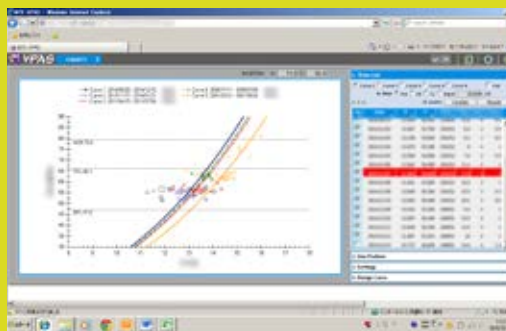
IoT refers to the incorporation of tele-communication capabilities into a wide variety of devices or sensors to enable status monitoring or remote control. In IoT for vessels, data is collected from onboard devices and sent to onshore operations via satellite communication automatically. The main advantage of IoT for vessels is that sharing and using data helps crew members and onshore personnel take optimal operational measures.

Data Analysis

Usage
examples
1, 2

Realising optimal route plans and
energy efficient hull modifications
→ Please see page 06.

VPAS (Vessel Performance Analysis System)



VPAS analyses vessels' operational performance based on data gathered through SPAS and SIMS. We introduced VPAS more than 20 years ago, and in 2015 we upgraded the system for a third time to enhance its operability. The new version can be used by more people, thereby contributing further to energy saving and safety in vessel operations.

The result of an analysis of the relationship between vessel speed and fuel consumption

Capabilities of VPAS

Users can check the performance of the vessel in terms of the relationship between vessel speed and fuel consumption as well as performance degradation according to the vessel's aging. For example, the system helps users to plan optimal scheduling of hull and propeller cleaning.

Content of the updated version

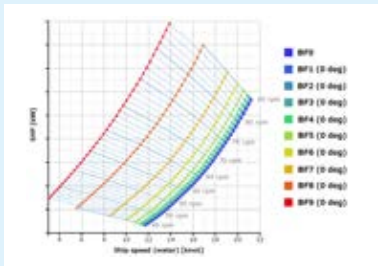
- **Enhanced precision:** We have enhanced precision significantly by taking advantage of the latest analysis methods as well as our track record and expertise.
- **SIMS compatibility:** As well as traditional abstract log data (SPAS), VPAS can analyse performance based on data from SIMS, which is becoming increasingly widespread.
- **Internet compatibility:** Users can access the new system via the Internet. Consequently, more people can check the status of operating vessels.



Realising optimal route plans

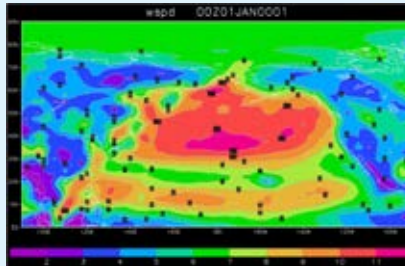
The system creates simulations based on vessel performance models and meteorological statistics and enables the preparation of optimal route plans.

Vessel performance models



Based on collected data, the system creates graphs showing the relationships between wind speed, main engine revolutions, speed, and fuel consumption.

Past meteorological statistics

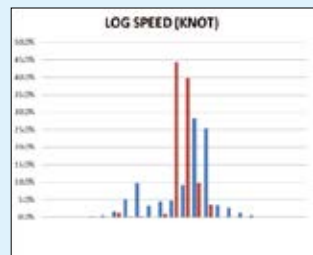
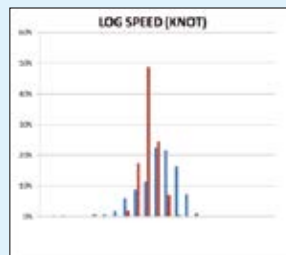
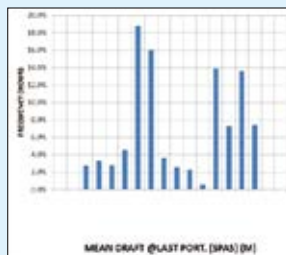
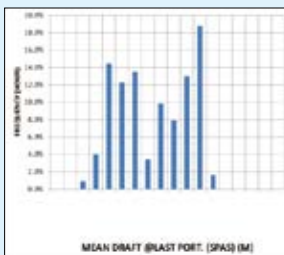


Based on past meteorological statistics for routes entered into the system, the system predicts and evaluates arrival times, vessel speeds, and fuel consumption by creating simulations of vessel operations.

Calculates estimated arrival times, vessel speeds, and fuel consumption for each season and month

Realising energy efficient hull modifications

This system enables users to decide on the optimal vessel types for present operations based on various kinds of data obtained from vessels, including vessel speed, revolutions, horsepower, draft, and displacement.



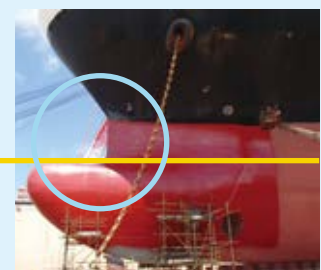
We collected and stored actual voyage data from a vessel for half a year after modification of its bulbous bow and installation of energy-saving equipment on board. The analysis of this data revealed a 23% reduction in CO₂ emissions—higher than estimated. Moreover, the monitoring of engines' operating status and the vessel's condition during the same period verified that hull modification did not adversely affect the safety of vessel operations.

Bulbous bow:

This is a protruding bulb at the front of a vessel below the waterline that modifies the way the water flows around the hull, reducing drag and thus increasing speed, range, and fuel efficiency.



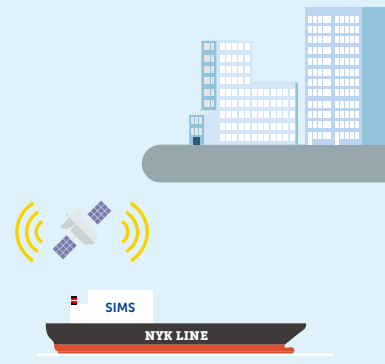
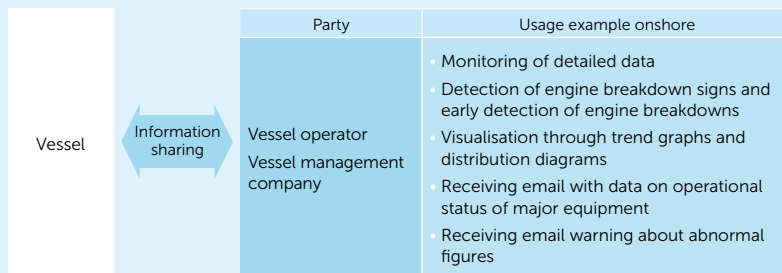
Before modification



After modification

Realising optimal vessel operations and predicting engine breakdowns

Intensive sharing of data between crew members and onshore personnel through timely visualisation of information



Outside Evaluation

In fiscal 2015, testifying to high evaluation of our efforts to advance the use of big data and increase the safety and energy-savings of vessels, we received a series of awards, including a special award from the Japan Institute of Navigation, the 2015 Minister of the Environment Award in the Technical Development and Commercialization category for the promotion of measures to address climate change, and a Ministry of Land, Infrastructure, Transport and Tourism Award at the 12th Eco Products Awards.



2015 Minister of the Environment Award for the promotion of measures to address climate change



Special award from the Japan Institute of Navigation, received in fiscal 2015

In conjunction with efforts to collect and store various types of data relating to vessel operations and analyse big data, we intend to heighten the quality of our research by increasing the number of partners with which we conduct research and development focused on the use of big data. As part of this initiative, in February 2016 we concluded a joint research agreement with Japan Marine United Corporation in relation to the 14,000 TEU containership *NYK Blue Jay* and a series of containerships of the same vessel type that we will take delivery of over the next few years. After these containerships enter into service, we will work with Japan Marine United to repeatedly verify a range of data collected from the containerships and improve

vessel operations. Our goal is to use this research to develop vessels that are even more competitive.

Further, we plan to store big data collected from SIMS through this joint research effort at the Ship Data Center, which the ship classification society ClassNK established in December 2015. By sharing these data with outside partners, such as classification societies, shipyards, and manufacturers, we intend to pursue higher levels of efficiency and safety in vessel operations.

In these ways, the NYK Group is steadily creating high-value-added services that keep it half a step ahead of competitors.

01

Creative Solutions That Heighten Competitiveness

Exporting Japan's Fruit and Vegetables to the World— Exploiting the Growing Potential of CA Containers

Currently, the NYK Group manages approximately 1,700 controlled atmosphere (CA) containers. CA containers are special reefer containers that curb respiration, which reduces the freshness of fruit and vegetables. NYK and Monohakobi Technology Institute (MTI) have created an original container that is able to have its internal humidity level controlled. For long periods, the container can preserve the freshness of fruit and vegetables that are particularly sensitive to moisture, such as leafy vegetables.



Innovating Existing Technology to Preserve Freshness and Lower Costs

Since 2013, NYK and its Group company Monohakobi Technology Institute (MTI) have been conducting transport tests on the use of CA containers for the ocean transport of fruit and vegetables grown in Japan. Transport test runs from Hakata port to Hong Kong and to Singapore were successful, enabling us to realise Japan's first use of CA containers to export fruit and vegetables. Thanks to one of the NYK Group's Creative Solutions, the internal humidity of the CA containers is kept above 90% at all times, maintaining the freshness of fruit and vegetables, including leafy vegetables, that are sensitive to humidity. MTI has a patent pending for this humidification method. Although it takes longer than air transport, ocean transport is roughly 90% less cost. Our series of transport tests showed that despite longer transport times than air transportation, the use of CA containers for ocean transport keeps fruit and vegetables fresh.

By 2020, Japan's government aims to increase exports of agricultural, forest, and fishery products to ¥1 trillion, twice the level of 2012. Furthermore, a rise in the number of countries participating in the Trans-Pacific Partnership (TPP) will help to ensure that the overseas transport of fruit

and vegetables becomes an area of dynamic growth. Until now, the NYK Group has been managing approximately 1,000 CA containers. However, the whole Group will step up efforts to develop CA container services. With our sights set on business arising from the TPP, we procured an additional 700 CA containers in November 2015. Also, Yusen Logistics Co. Ltd. began marketing CA container services in September 2015.

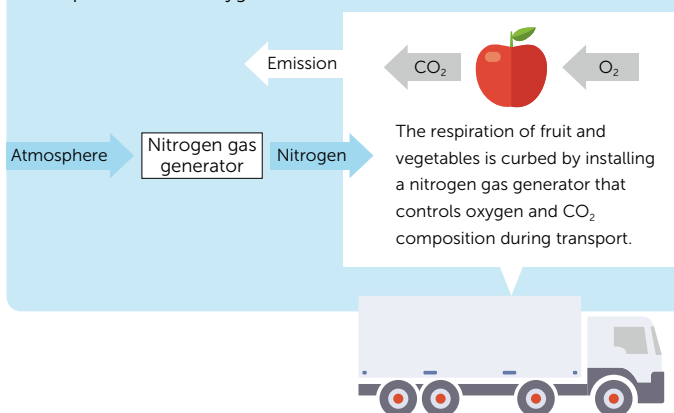
Weekly, a containership transports CA containers to Hong Kong while another transports them to Thailand. However, an issue that we face is the difficulty of loading different cargoes together because the optimal oxygen density and temperature for each type of product is different. We will continue innovative efforts so that we can load products with different optimal temperatures together.



Loading a CA container

CA Containers

These containers can control not only the temperature but also the concentration of oxygen and CO₂. The continued respiration of fruit and vegetables after harvesting consumes sugars, lowering quality. An effective countermeasure is to curb respiration by keeping fruit and vegetables in 'hibernation' through storage at low temperatures and oxygen concentration levels.



Melons before test storage in CA containers



After 2 weeks



Garland chrysanthemums before test storage in CA containers



After 2 weeks



02

Creative Solutions That Open Up New Possibilities

Capturing Opportunities Related to New Vessel Fuel—Growing the Potential of LNG Fuel

In the shipping industry, LNG is attracting increasing interest as an environment-friendly fuel as regulations for vessels' gas emissions become stricter. In addition to environmental friendliness, LNG promises economic benefits. While there are such issues as the development of supply infrastructure, there is a possibility that demand for LNG fuel could grow dramatically.

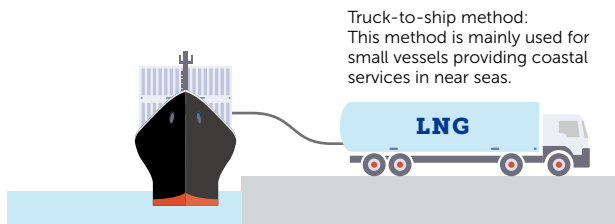


Taking on New Technological Fields and Realising Japan's First Commercial LNG-Fuelled Vessel

Responding to strengthening environmental regulations worldwide, the NYK Group has been focusing on LNG as a next-generation fuel that can replace heavy oil and taking measures to realise the commercial use of LNG fuel. The first achievement of these efforts was the LNG-fuelled tugboat *Sakigake*, launched in August 2015. Japan's first LNG-fuelled vessel, *Sakigake*, does not differ greatly from traditional tugboats in size, appearance, and operability. However, the vessel incorporates technology that will usher in the era of LNG fuel. With this in mind, we named the tugboat *Sakigake*, which means 'vanguard' in Japanese.

The tugboat is equipped with a medium-speed dual fuel engine developed by Niigata Power Systems Co. Ltd. This engine enables the vessel to switch fuel freely between heavy oil and LNG while operating. When the tugboat is using LNG, it is heated and converted into a gas in the fuel tank and sent to a buffer tank, which stabilises the pressure of the gas and then supplies it to the engine. These newly invented LNG receiving and carburation systems installed in *Sakigake*, for which patents are pending, include such features as the use of pressure differential to deliver liquid and gas.

The vessel receives LNG fuel supplies through a truck-to-ship method whereby a flexible hose connects the vessel to a tank truck onshore. As with the onboard systems of *Sakigake*, this supply method is the first of its kind in Japan. Working in partnership with the supplier, Tokyo Gas Co. Ltd., we developed a safe, efficient method that is compliant with the relevant laws and regulations. We realised the new supply method thanks to the cooperation of many parties, including the Ministry of Land, Infrastructure, Transport and Tourism, Japan Coast Guard, Kanagawa prefecture, and the city of Yokohama.



Converting Issues into Business Opportunities and Exploiting the Potential of LNG Fuel Related Businesses

LNG-fuelled vessels are becoming more common as companies respond to more stringent environmental regulations. This trend is particularly pronounced among vessels operating in the North Sea and the Baltic Sea. Given that



Shore-to-ship method:
This method is mainly used for small and medium-sized vessels operating on routes between fixed points.

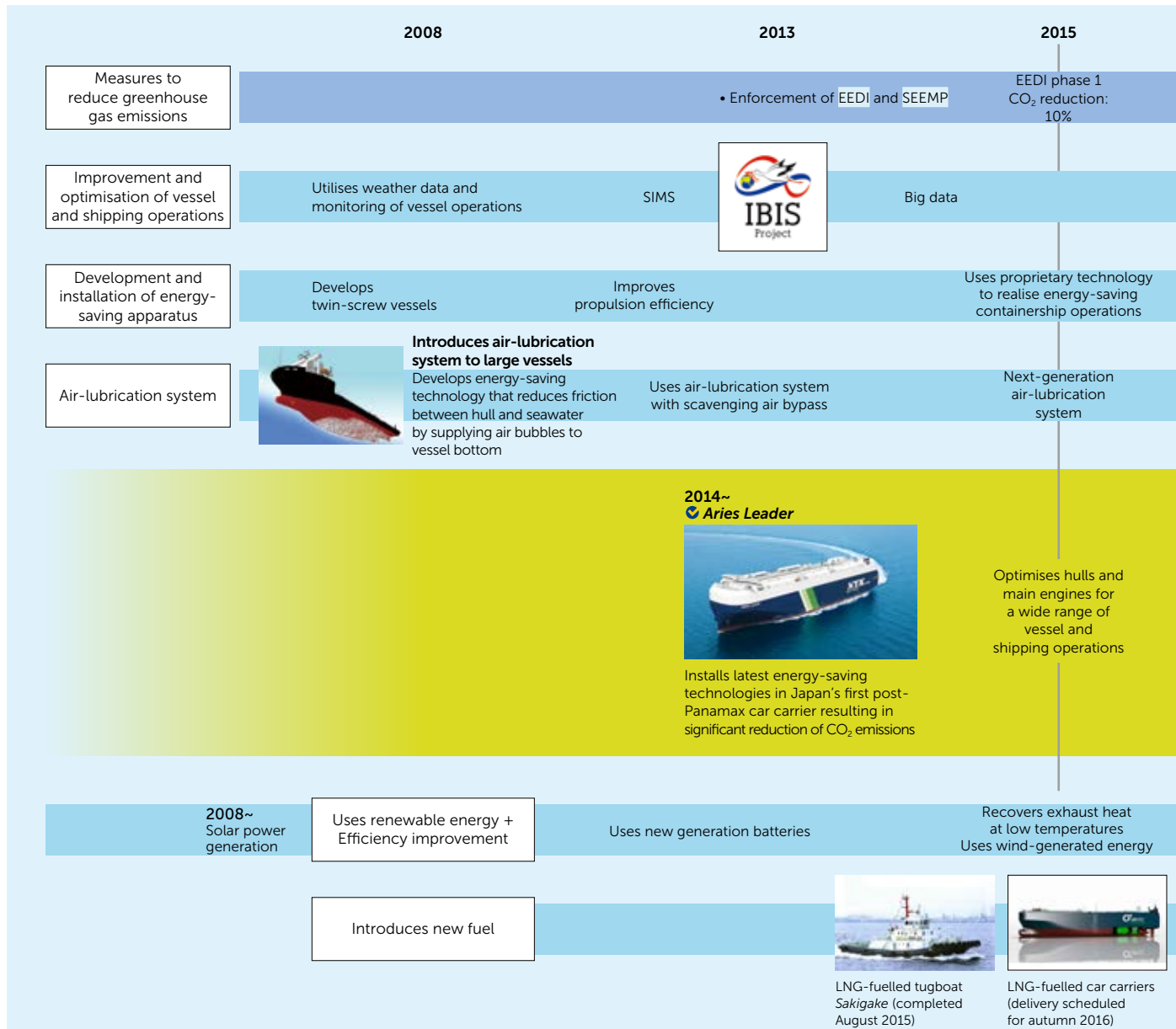
vessels' annual fuel consumption is equivalent to 250 million tons of heavy oil, the potential for growth in demand as a result of conversion to LNG is significant. However, one major issue is that widespread use of LNG will require the development of supply infrastructure.

With this issue in mind, the NYK Group, ENGIE, of France, and Mitsubishi Corporation studied the possibility of engaging in LNG fuel supply operations. As a result, in June 2014 we reached an agreement to build the world's first LNG bunkering vessel and participate in an LNG fuel sales business in Europe. We will take delivery of this LNG bunkering vessel at the end of 2016, and we plan to sell and supply LNG mainly to LNG-fuelled vessels operating in the North Sea and the Baltic Sea. The first of such client vessels shall be the LNG-fuelled car carriers of United European Car Carriers B.V., of Norway. Through this business, we will reduce the environmental burden of vessels further while providing supply infrastructure to help spread the use of LNG fuel.

Environmental Technology Roadmap

Bearing in mind the international agreement among G7 countries to target a 50% reduction in worldwide greenhouse gas emissions by 2050, the NYK Group is developing technology for environment-friendly vessels. Following on from the completion of the LNG-fuelled

tugboat *Sakigake* in August 2015, we plan to take delivery of two LNG-fuelled car carriers and an LNG bunkering vessel in 2016. Further, we will continue providing society and customers with new value by introducing leading-edge containerships with outstanding fuel efficiency and using big data to realise more efficient vessel operations.

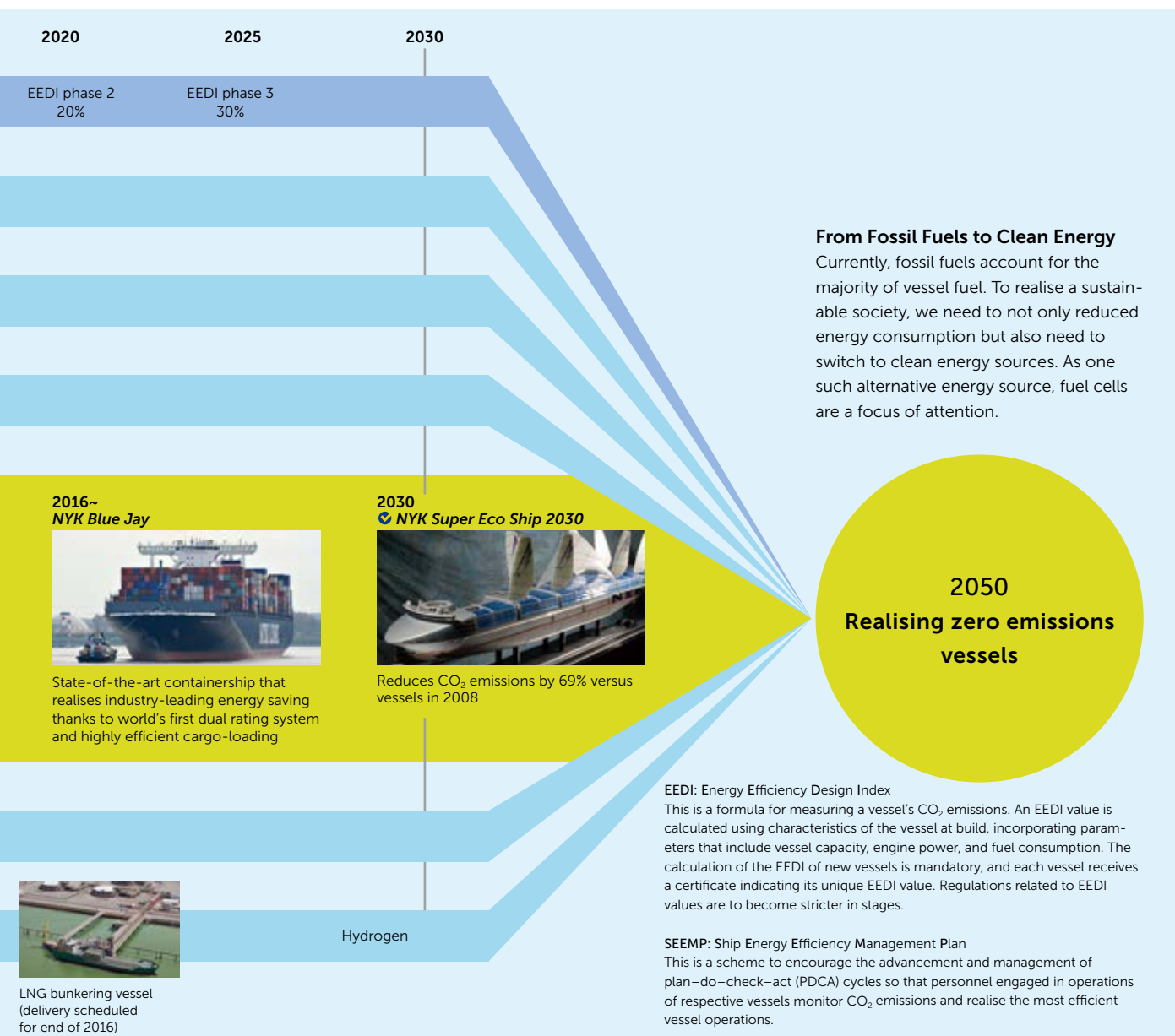


Aries Leader: Next-Generation Car Carrier That Reduces CO₂ Emissions by 30%

In May 2014, the NYK Group took delivery of its environmental flagship and Japan's first post-Panamax car carrier, *Aries Leader*. In anticipation of the widening of the Panama Canal, the new vessel has a maximum capacity of 7,000 vehicles. This enlarged capacity combined with the car carrier's incorporation of a range of energy-saving equipment promises to reduce CO₂ emissions by 30% compared with the previous vessel type. The vessel's equipment includes an air-lubrication system, hybrid turbochargers, and the use of water-emulsified fuel in the boiler.

Advancing towards NYK Super Eco Ship 2030

By 2050, we aim to develop zero emissions vessels. As a midpoint on the road to achieving this goal, we have created a concept ship, *NYK Super Eco Ship 2030*. This futuristic containership will reduce CO₂ emissions by 69% versus vessels in 2008 by combining fuel cells and renewable energy, such as solar and wind power, with a lighter hull. Already, we have successfully realised practical applications for several technologies envisioned for *NYK Super Eco Ship 2030* by incorporating them on board our ships.



Creative Solutions That Advance Safety



Safety Is Our Most Important Mission—Ongoing Safety Initiatives

Our mission is to transport customers' cargo on time reliably. Reflecting its belief that safety underpins trust and that trust underpins business, the NYK Group devotes time and effort unstintingly to ensuring the safety of its vessel operations.

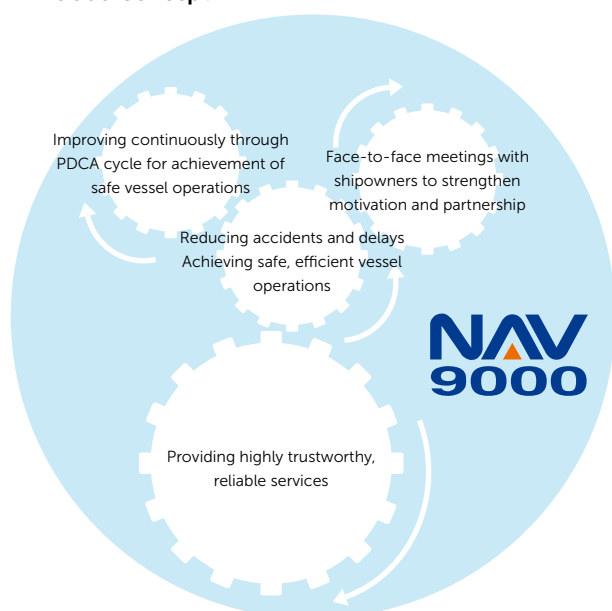
Ensuring All of Our Operating Vessels Transport Customers' Cargo Reliably

Viewing safety as our most important mission, personnel onshore and on board vessels make continuous, concerted efforts to advance initiatives.

If a marine accident occurred that led to delays in customers' supply chains, the effect on the economic activities of customers and supply chains' stakeholders could be immeasurable. Moreover, the time and effort to rectify the impact could be immense and require much more time than thorough safety management.

Aiming to support the economic activities of customers by rigorously removing the 'seeds' of potential problems that could impede safe, efficient vessel operations, the NYK Group began operating its original safety promotion activity, NAV9000, in 1998. The NYK Group requires all vessels that transport its customers' cargo, regardless of whether they are owned or chartered vessels, as well as shipowners and ship-management companies to comply with the Group's unified safety standards for safe vessel operations. These painstaking activities ensure that we work in unison with ship-management companies, shipowners, and crew members to achieve safe vessel operations.

NAV9000 Concept



Asking the General Manager of the Marine Group about Safe Vessel Operations

Q&A

Q. What is required to realise safe, reliable transport?

The NYK Group operates more than 800 vessels. While vessel types and engines of vessels and the cargoes they transport diversify, safety requirements and environmental regulations for vessel operations are becoming more stringent. In these conditions, systems that enable coordination among sales departments, the Marine Group, and crew members on board vessels are indispensable for providing customers with safe, efficient transport. Onshore personnel, navigation officers, and engineers share detailed data about vessels in a timely manner. This showing allows onshore personnel to mitigate crew members' workload by giving support and advice on route selection or the speed at which to proceed to the next port—decisions that crew members previously had to take alone. Everyone involved in these operations wants to be of service to customers by providing them with safe, reliable transport. Also, personnel in sales departments, navigation officers, and engineers are eager to use their respective fields of expertise in cooperative initiatives aimed at creating new business opportunities.

Q. How is the NYK Group using its technological capabilities to enhance safety?

We are advancing the development of systems and hardware. For example, we are developing systems that collect and visualise data from vessel operations as well as devices that provide detailed photographs of the insides of engine combustion chambers. Because we are able to store and analyse detailed data from vessels, it is becoming possible to check when and why breakdowns occur. The next time collected data shows similar precursors, we can flag the abnormality, respond appropriately, and prevent problems in advance. We are confident that we can optimally combine expertise accumulated over many years with this newly available data to advance our analytical capabilities even further.

Creative Solutions That Advance Safety



Fostering High-Quality Crew Members—Ensuring Safe Vessel Operations through Personnel Development

In recent years, our responsibilities with respect to safety and the environment have risen significantly as has our need for competent crew members. In response, the NYK Group is concentrating efforts on fostering crew members. We are involved in the development of crew members from the training stage, providing trainees with thorough onshore and onboard training and a comprehensive set of self-study tools.

Using Training Methods Based on Experience and Innovation

Our primary reason for establishing NYK-TDG Maritime Academy (NTMA) in the Philippines was to establish a stable supply of highly capable crew members and contribute to the safety of vessel operations. In ensuring safe vessel operations and protecting the environment, the training of crew members, who actually operate vessels, is paramount. NTMA is at the core of our training efforts.

The NYK Group has been employing and training Filipino crew members for roughly 30 years. Aiming to draw on this experience and become involved in the basic training of crew members, we established NTMA. Since we established it nine years ago, the academy has produced more than 560 graduates. In addition, NTMA is currently training more than 500 undergraduates. We have deployed some NTMA graduates to high-risk vessels, while others are on track for promotion to chief officer or first engineer in 2017.

It takes at least 10 years after acquiring a seafarer's licence to become a captain or a chief engineer. Maintaining a long-term perspective, we will continue to engage in high-quality training.

Messages from Graduates

Jose Tosoc Jr.

Second Engineer
One of the First NTMA Graduates



As a member of NTMA's first batch of graduates, I am currently serving as a second assistant engineer on board a chemical tanker. During training, we were told repeatedly that 'NTMA is for training, vessels are the real field utilising the expertise, and attitude is what defines you'. Also, the NYK Group's Filipino crew members have a family-like unity. I think this is a strength that other shipping companies lack. All of us love our jobs and work with pride. To be among the first batch of graduates is both an honour and a responsibility. I want to adhere to NTMA's mission and vision and support all of the activities of NTMA and the NYK Group. I will happily tackle any initiatives that contribute to the Group's growth.

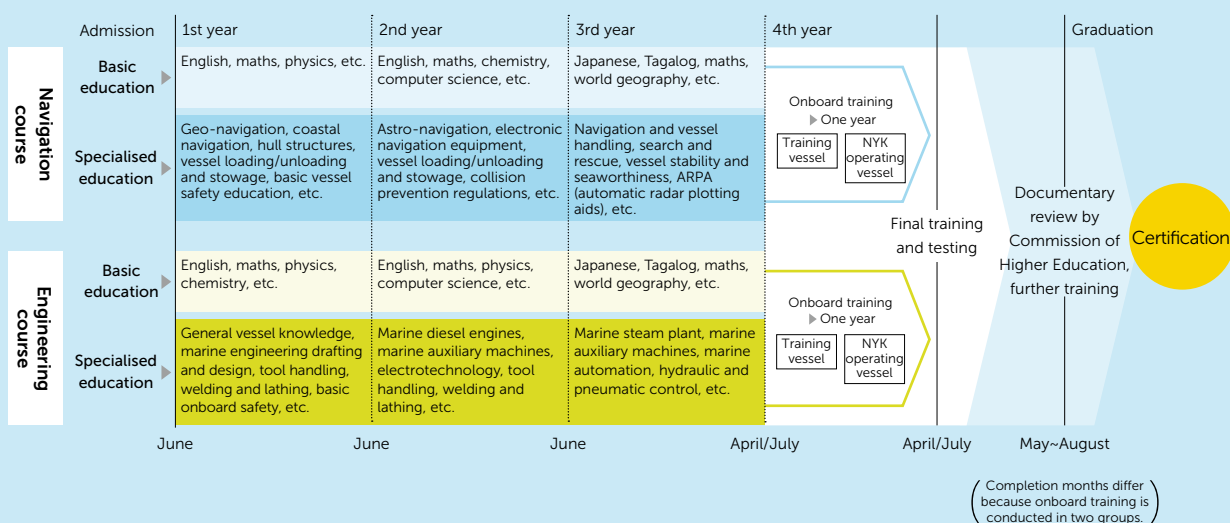
Anthony Aguilar

Third Officer
One of the First NTMA Graduates



NTMA not only provided us with a curriculum that included navigation, vessel handling, and arts and science subjects but also gave us guidance on becoming personnel who are suitable for the positions of officer and engineer in the NYK Group. On board vessels, we are treated like family. After graduating from NTMA, without having first served as a junior officer, I was appointed third officer. My duties are very challenging, but I have been able to overcome the pressure and difficulties thanks to the patient help of senior colleagues, who are like older brothers. Although I still have a lot to learn, I will do my best to be a responsible officer and contribute to the Group's further growth.

Outline of NTMA's curriculum



03

Eliminating Human Error—Using Creative Solutions to Reduce Crew Members' Workload

We aim to create a safe working environment by cultivating a safety-focused mindset among crew members so that they continue to perform day-to-day duties with an awareness of the need to prevent collisions, equipment breakdowns, and work accidents.



Aiming to Reduce Accidents through POWER+

As an addition to its wide variety of quality assurance activities, the NYK Group began POWER+ next-generation safety activities to reduce vessel operating accidents and casualties caused by human error. We conduct these activities based on two basic tenets. First, rather than safety being merely adherence, individuals should take the initiative and choose to implement and establish safety. Second, individuals should show consideration for and help each other to cultivate a safety culture in which individuals act for the benefit of the group.

In 2015, NYK Shipmanagement Pte. Ltd. (NYK SM), which is the ship-management company at the core of the Group, began these activities. To inculcate the new basic tenets of the activities in all personnel, from management through to frontline personnel, NYK SM is conducting a range of different workshops, briefings, and educational ship visits. NYK SM's task is to develop the Group's safety culture not only by enhancing skills—which has been the main focus of previous initiatives—but by fostering a willingness among personnel to show consideration for and help each other.

Reflecting the high evaluation of these activities, we received the 2015 Seafarers Safety Initiative Grand Prize from the Ministry of Land, Infrastructure, Transport and Tourism in September 2015. We plan to implement the activities in all of our operating vessels with a view to bolstering safety even further.



Slogan: We are one team and one family.



Example of Activities

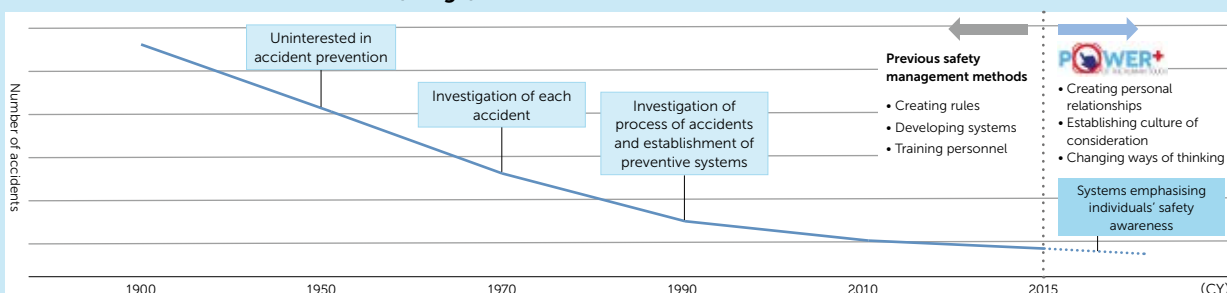
While on board, each crew member carries a Safety Passport, which includes family photographs and a declaration of commitment to conducting operations safely. Each crew member introduces themselves and their family members to encourage a family-like environment at sea.



A Chief Officer's Opinion

When crew members on board show family photographs to each other, it helps us to relax, and conversations become lively. I think these opportunities to get to know one another better have made us more considerate towards each other and heightened safety awareness; a crew member is more likely than before to alert another if spotted not wearing safety equipment. Also, discussions at morning meetings before beginning work have become wide-ranging and lively. To make sure we return happily to our families after working on board, we cannot compromise the safety of vessel operations. POWER+ reminds us of the important things we tend to forget.

Transition of number of accidents (image)

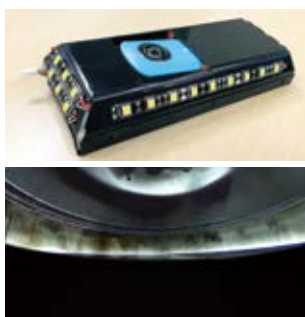


Reducing Crew Members' Workload: *Kirari NINJA*

NYK, its Group company Monohakobi Technology Institute (MTI), and Daito Electron Co. Ltd. have jointly developed *Kirari NINJA* (patent pending), a device that can automatically photograph the inside of a vessel engine's combustion chamber.

Until now, a crew member has had to stop the engine and go inside to inspect the combustion chamber. However, darkness made seeing the inside of the chamber in detail difficult. Also, working for long periods in high temperatures exhausted crew members.

Kirari NINJA comprises a panoramic camera and a light. By installing it on the upper part of the piston in the combustion chamber, 360-degree photographs of the interior can be taken during one round of vertical piston movement, which takes approximately 10 minutes. This capability dramatically reduces the workload of crew members. Moreover, the photographs taken enable them to see the condition of the inside of the combustion chamber in great detail, which promises to help prevent engine accidents and reduce maintenance costs.



Photograph of the inside of a combustion chamber taken by *Kirari NINJA*, which is shown in the upper photograph

A Chief Engineer's Opinion

Until now, inspecting inside an engine involved working in very hot, confined spaces. However, *Kirari NINJA* has enabled inspectors to minimise the time spent working inside engines. Also, detailed inspections inside engines by an engineer used to require opening the engine, but *Kirari NINJA* enables inspections without opening. As a result, we are able to conduct inspections more often, and in doing so contribute to safe vessel operations. In retrospect, it surprises me that this type of inspection tool did not exist. I think it took the particular viewpoint of a shipping company to identify the need and develop such a tool.

Supporting Safe Vessel Handling: *i.Master*

Docking and undocking is one of the most tense times in vessel operations. To provide assistance in reducing the risk of colliding with the quay, the NYK Group has introduced *i.Master* software for handheld digital charts. The software gives crew members a bird's eye view of the vessel's movement and the surrounding situation. Via a tablet computer, the software shows crew members the course of a vessel and its docking or undocking speed and automatically identifies other vessels. Furthermore, the system allows crew members to monitor docking and undocking constantly without being on the bridge. Collisions with the quay could force vessels to lay up for long periods. As well as inconveniencing customers, such delays would lead to a loss of trust. By using *i.Master* effectively, we will reduce the risk inherent in docking and undocking.



i.Master is just one example of our innovative efforts to develop useful technologies for a range of operational situations and thereby build systems that ensure stable, safe, and efficient vessel operations.

A Captain's Opinion

For vessels such as car carriers, which have many blind spots from the captain's position when docking and undocking, *i.Master* is a really valuable support tool for the captain because it gives an overview of the vessel's movement. Also, we take advantage of a tablet computer's portability to ensure smooth communication. For example, while handling the vessel, the pilot can use the system to discuss docking and undocking plans with crew members, and they can check with each other as needed.

Enabling Accurate, Easy Measurement of Tank Liquids: *Honesty*

NYK, its Group company MTI, and Semco Ltd. have jointly developed *Honesty*, an efficient tank sounding device (patent pending) that improves efficiency when measuring liquid stored in the vessel's tanks. Tank sounding entails measuring the depth of liquid



stored in the tank or the distance from the top of a tank to the liquid surface. *Honesty* significantly streamlines the process of sounding the surface of liquids in tanks.

Moreover, the device accurately measures cappuccino bunker, which causes the quantity of delivered bunker oil to appear greater than it actually is due to small air bubbles being in the bunker oil when bunkering. *Honesty* is able to measure accurately the quantity of bunkered oil, even cappuccino bunker, because its sensor does not react to bubbles on the surface of the liquid.

In addition to bunker oil, the device can measure colourless and transparent liquid, such as lubricating oil, ballast water, and bilge. While incorporating a range of progressive features, the device has outstanding usability. It is lightweight and easily portable and does not require an external power source because it operates on standard batteries. Also, *Honesty* has received approval from the ship classification society ClassNK.

A Chief Engineer's Opinion

Tank sounding is always a race against time when we have to sail as soon as possible after bunkering. The introduction of *Honesty* has enabled us to measure tank levels quickly and accurately. Also, we measure the levels of all ballast tanks daily. However, measuring the surface level of colourless and transparent seawater is difficult and time consuming. *Honesty* has significantly reduced the time we spend making these measurements.

Promising a Wide Range of Uses: *UMS Check System*

NYK and its Group company MTI developed the *UMS Check System*, the first time a Japanese ship-ping company has developed such a



system. Before engines and equipment are operated unattended, for example at night, measurements need to be taken, and the taking of such measurements is called an 'unmanned machinery space (UMS) check'. In a conventional UMS check, crew members take measurements from all equipment installed in a vessel's engine based on an extensive checklist and manually record the collected measurement values on paper. The introduction of the *UMS Check System* removes the need to record data on paper. The system not only greatly reduces data-entry time compared to entry with a conventional keypad but also notifies the crew if abnormal figures are entered, allowing the crew to respond quickly.

Furthermore, because the system instantly shows data trends for the past week, it quickly alerts crew members of abnormalities and promises to become a useful training tool. In addition, the system displays data trends as graphs so that crews can check changes over time and allows crew to store photographs or videos of equipment-related abnormalities. Also, the system can send data directly from handheld terminals to onshore servers, allowing onshore personnel to view data in a timely manner. We intend to use the resulting big data to create new value.

A Chief Engineer's Opinion

The checking of whether each of the more than 1,000 items on the UMS checklist is at a safe value calls for competence and concentration. Digitisation allows the setting of benchmarks for inspection items so that inspectors can readily tell if the measurements they have taken are correct. I feel that, besides enabling us to send inspection data to onshore operations for use, the system has made this inspection data more immediately useful for onboard operations.

04

Emphasising What Must and Must Not Change—Sustaining Our DNA while Advancing Personnel Strategies

For more than 130 years, the NYK Group has taken on ambitious initiatives to create new businesses. We are committed to continuing this tradition and achieving further growth through evolution as a comprehensive global-logistics enterprise. Personnel strategies based on society's current needs and our competition strategies will help these efforts, thereby ensuring that our services satisfy even more customers.



What Must Not Change

Exploiting DNA Developed over 130 Years

The NYK Group has pursued new advantages by taking on ambitious initiatives and realising Creative Solutions throughout its history of more than 130 years. Our corporate culture—the product of this dynamic legacy—helps to pass on our positive corporate DNA to the next generation of employees. Another important way in which we pass on corporate DNA is through job rotation, which enables employees to experience a variety of workplaces and broadens their network of colleagues. We establish advantages by approaching issues from the viewpoints of society or customers, formulating ideas ahead of competitors, and following through on initiatives with unflagging determination. Today, the corporate DNA we have inherited is driving an array of initiatives themed on leveraging Creative Solutions. In carrying out their day-to-day duties, all Group employees share and put into practice our corporate DNA, which we clarified by establishing Integrity, Innovation, and Intensity (3I's) as the NYK Group Values in 2007.

Onshore and on board operating vessels, more than 55,000 NYK Group personnel work as a team to operate businesses on a global scale. By extending employees' expertise through involvement in a wide range of duties and heightening capabilities through a broad variety of stimulating training, we aim to produce personnel with the initiative to create advantages in any era.

What Must Change

Reforming Mindsets, Increasing Opportunities, and Developing Employee Capabilities

In April 2014, NYK launched an initiative for the advancement of women's careers, Project W. Through this project, we aim to create an employee-friendly and flexible organisation that can adapt to challenging situations in which all employees with their own capabilities work as an effective team, regardless of gender. In fiscal 2015, the project's second year, we focused on the influential role that managers play in personnel development and established opportunities to review how managers' think, communicate, and behave.

For example, managers tend to suggest reducing the workloads of employees who are combining child rearing with work, which can lower an employee's motivation unintentionally. Through seminars, we heighten awareness of managers in relation to such issues and show how they can address them through changes in ways of thinking and acting.

Also, as part of initiatives to enable diverse personnel to play important roles, we aim to achieve greater female participation by the end of fiscal 2020, with an aggregate of 80 female employees having significant work experience at NYK offices overseas. To develop personnel who are able to work globally, we will continue expanding and improving initiatives that help personnel to work overseas with peace of mind regardless of gender.

What Must Change

Promoting Health and Preventing Disease to Increase Corporate Value

We believe that promoting employee health and preventing disease enhances productivity and profitability and, as a result, heightens corporate value. Therefore, in April 2015, the Human Resources Group and the NYK Health Insurance Society collaboratively launched a project that contributes to business management through health promotion. Under this project, we are compiling health checkup results in a database, which we will use to facilitate disease prevention. Also, we plan to hold events to heighten employees' awareness of disease prevention and health.

We will support the promotion of health because it underpins the ability of all employees to perform their roles vigorously.

Main measures

- Providing guidance from in-house doctors to those that have high risk of developing lifestyle-related diseases
 - Inviting trainers of leading athletes to conduct coaching events
 - Ensuring 100% of employees have regular health checkups
 - Providing cancer-related health checkups
-

What Must Change Reforming Work Styles to Raise Labour Productivity

As part of efforts to reduce overtime work, we are implementing an arrive-early-leave-early scheme after completing a six-month trial period for the scheme, which began in July 2015. The primary aims of this initiative are to ensure employees work healthily, establish workplaces with flexible working hours, increase productivity and competitiveness by raising operational efficiency, and end the custom of long working hours. We want to create a corporate culture that can produce results within limited time frames and develop workplaces in which any employee can actively play a role.

Further, agreeing with and contributing to the initiative, labour unions have collaborated with the Human Resources Group to establish a website on our intranet. At any time, employees can access this website, which features work practices themed content. For example, it offers ideas on working efficiently and includes our *Work-Life Balance Newsletter*, which features interviews with senior management about using time efficiently.

With a view to enabling employees to realise Creative Solutions that reform their work style, we will raise the awareness of all managements and employees about work practices and consider how to advance the initiative even further.

Main measures

- Providing free breakfasts
- Prohibiting managers from speaking to subordinates before 8:45am
- Opening buildings and turning on air conditioning earlier
- Collecting quantitative data about and analysing hours of overtime and workplace arrival and departure times
- Holding seminars



Discussing Personnel Strategy with a Representative of the Human Resources Group

We ask a representative of the Human Resources Group about the type of personnel we need to foster and the issues and direction of the group's personnel strategy.

Q&A

Q. What type of personnel do we need for the coming era?

Of course, we need personnel who are able to work effectively anywhere in the world. Looking ahead, however, we also need people who are able to think for themselves and take proactive, far-sighted measures in volatile business conditions. On occasion, our strength as an organisation has been seen as weakening our capabilities on an individual level. In conditions that are difficult to predict, personnel will need to take the initiative to identify issues and progress through a process of trial and error. Our employees must be sensitive to changes in conditions and be prepared to advance initiatives through to completion with strong determination.

Figuratively speaking, the NYK Group is sometimes described as having 'many people who are good at cooking fish, but few who catch fish'. Our logistics businesses only function effectively when our solutions cater to customer needs. It is extremely important the NYK Group identifies issues in customers' operations and devises solutions, in other words 'catches fish'. We want employees to accumulate a wealth of experience and develop their capabilities as individuals to tackle new situations and effect change.



Q. How will the NYK Group enable employees' individuality to shine?

Each individual should acquire the habit of forming and then considering to develop a hypothesis. It is important that they then refine these ideas by discussing them robustly with other personnel without being concerned about rank. The NYK Group has an uninhibited corporate culture, and employees are tightly knit. However, I do not think there are as many chances as there were previously for each person to discuss their ideas candidly.

Given this issue, from fiscal 2015 NYK sets aside time for free discussions on certain topics during rank-based group training for employees in their second, fifth, seventh, 10th, and 14th year with the company. Also, four times a year we have an outside lecturer conduct NYK FUTURE seminars, targeting employees in their seventh, eighth, or ninth year with us. In addition, aiming to foster global perspectives and networks of personal connections, we began sending employees to Switzerland and France for short-term training in fiscal 2015. Meanwhile, the Creative Solutions Group holds *Kirari Dojo* (Creative Solutions Workshops) for mid-career employees who have been with us between 13 and 20 years. In these ways, we have begun operating a personnel development 'pipeline' that stretches from employees in their first years with NYK through to mid-career employees.

Q. What personnel strategies will the NYK Group pursue to win out in the international arena?

First, we must ensure personnel in Japan (hereinafter called home staff) develop truly global capabilities. The broad-mindedness and flexibility to accept different cultures and ways of thinking is required to work effectively in an international environment. Also, leadership skills to set clear goals and motivate others to work towards them are important. We will foster personnel who are tuned into the latest developments wherever they are in the world and who are able to take decisions and draw on local resources.

Second, we need to develop local personnel overseas. At local overseas Group companies, we are promoting growing numbers of local personnel to high-ranking managerial positions. In some cases, these managers have Japanese personnel working under them. National staff are playing an increasingly important role in boosting our competitiveness.

We intend to foster home staff and national staff tirelessly in the international arena. In these efforts, we will emphasise the NYK Group Values of Integrity, Innovation, and Intensity (3I's) as a common premise while respecting diversity and individuals with the ambition to take on challenges.

Q. What are the tasks the NYK Group faces in HR development efforts going forward?

In recent years, the Group has been focusing efforts on participating in the offshore business and other business areas that lie beyond the boundaries of traditional shipping. As a result, situations arise in which our existing expertise is inadequate. Although we are gradually accumulating new expertise, I feel we need to recruit technology specialists and legal experts. To this end, the Human Resources Group, which is part of the NYK Headquarters organisation, will have to search for and scrutinise personnel not only in Japan but worldwide.

Creative Solutions That Broaden Our Horizons

04

Transforming Our Corporate Culture— Supporting and Advancing Awareness

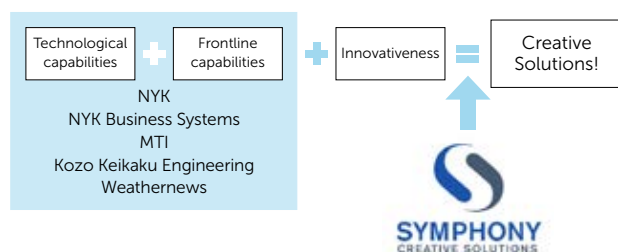
The medium-term management plan 'More Than Shipping 2018' formally set out the NYK Group's commitment to pursuing Creative Solutions. To promote Creative Solutions Groupwide, we launched the Creative Solutions Development Fund in 2014 and began *Kirari Dojo* (Creative Solutions Workshops) in 2015.



Encouraging Innovation through the Creative Solutions Development Fund

Aiming to discover and foster Creative Solutions among Group companies and build an environment conducive to creating new businesses, we set up the Creative Solutions Development Fund in 2014. Two drives for applications have resulted in 67 submissions, approximately 10% of which the fund is supporting.

As the inaugural project aimed at establishing a business based on the fund's support, NYK, its Group company Monohakobi Technology Institute (MTI), NYK Business Systems Co. Ltd., Weathernews Inc., and Kozo Keikaku Engineering Inc. jointly established Symphony Creative Solutions Pte. Ltd. (SCS) in Singapore in March 2016. The new company is tasked with developing and providing next-generation solutions in the shipping and logistics fields. Accordingly, SCS will take advantage of the frontline capabilities, technological expertise, and networks of the shareholder companies to rapidly advance the development of innovative solutions that cater to increasingly sophisticated needs in logistics frontline operations. Given the growing difficulty of establishing differentiation as the Internet of Things (IoT) becomes more common, the fund will add impetus to projects and initiatives that create high-value-added services based on insights into customers' precise needs.



Holding Creative Solutions Workshops

In April 2015, we began *Kirari Dojo* (Creative Solutions Workshops), a programme that seeks to develop employees into leaders who will drive innovation. Targeting mid-career employees that we hope will establish and advance projects focused on differentiation, the programme includes seminars conducted by outside lecturers and 'training camps'. Using projects that are actually under way as case studies, the programme teaches participants how to advance projects practically and systematically. Further, to disseminate the ethos of the Creative Solutions Workshops programme, we have designated members of the Committee of Corporate Officers and general managers of groups as programme supporters and formed a next-generation group comprising junior employees. Also, we have begun a programme that provides junior employees with opportunities to work with the junior employees of our partner companies to prepare and implement projects. As a result of participating in such programmes and seeing their Creative Solutions become a reality and operational improvements actually being implemented, more personnel will view their work proactively. We are confident that such personnel will transform our corporate culture and create a constant stream of differentiated services that keep us half a step ahead of other companies.



Programme that emphasises discussion

An Example of the Creative Solutions Development Fund's Support

Capitalising on expertise cultivated over many years, Yusen Navtec Co. Ltd. upgrades devices and collaborates with the Dry Bulk Marine Quality Control Group to ensure that the cleaning of vessel bottoms in Japan and overseas complies with the NYK Group's standards. These activities could contribute to the Group's competitiveness because they have the potential to be used for vessel types other than dry bulk carriers and to accelerate fuel-saving efforts. With this in mind, the Creative Solutions Development Fund is supporting efforts to establish upgraded devices as intellectual properties and select and conduct negotiations with local providers of services for the cleaning of vessel bottoms overseas.



Diver cleaning a vessel bottom under water

Social Contributions That Deepen Ties with Society



Strengthening Our Connection to Society—Advancing Proactive CSR Initiatives

As a responsible corporate citizen coexisting with international society, NYK Group will actively address social issues. Through these activities, we aim to enhance our corporate value for all stakeholders. Also, our social contribution activities are rooted in a commitment to pursuing high-value-added services that bring happiness to stakeholders.

Showcasing the Shipping Industry's Appeal: Yusen Mirai Project

Aiming to provide education on maritime topics and communicate the appeal of working on oceangoing vessels, we launched the Yusen Mirai Project at the end of 2014. This project began in response to requests to have opportunities for instructors to experience vessel operations and for students to visit vessels when our senior management team, including former president Kudo (currently chairman), were touring maritime academies all over Japan.

Specific activities

- Support for primary and junior high school pupils and the general public to experience vessel operations
- Lectures conducted by NYK Group navigation officers and engineers for primary and junior high school pupils
- Presentations about the shipping industry for junior high school pupils at school orientation events
- Vessel construction site study tours for maritime academy students
- Vessel study tours for maritime academy students
- Opportunities for maritime academy instructors to experience on-board training of NYK Group vessels
- Short-term student exchanges between NTMA in the Philippines and maritime academies in Japan

Because we conduct an interesting range of activities, we have been receiving more requests to hold seminars from a wide variety of schools. Also, students exchanges between maritime academies in Japan and NTMA in the Philippines have met with favourable receptions, with Japanese instructors and students commenting that they found Filipino students' high levels of motivation inspiring.

By continuing these activities, we not only hope to discover highly motivated students who want to become crew members but also expect to increase the number of young people who aspire to enter maritime academies or work in the shipping industry.

This project is not the type of initiative that produces results quickly. Therefore, we are prepared to make patient, long-term efforts to expand and improve the project with a view to increasing the number of people who are interested in the shipping industry and vessels and their close relationship with society.



Study tour of a vessel under construction in a dock

Launching a Sea Turtle Survey Project

As part of our environmental preservation activities, we plan to establish the Kishu Minabe Loggerhead Turtle Survey Project in partnership with the nonprofit organisation Earthwatch Institute in July 2016. By conducting this ecological survey of loggerhead turtles, which are an endangered species, we aim to encourage study and increase awareness of the ocean environment, which we have naturally developed an affinity with in the course of our business activities.

Incorporating More Fair Trade Products

As part of efforts to make social contributions through small things in our immediate surroundings, we are promoting the popularisation of products that have international fair trade certification. In October 2015, we changed the coffee that we offer to guests in meeting rooms at NYK Headquarters to a fair trade product. Following that, we replaced all coffee and tea served at the café at the headquarters with fair trade products in April 2016. We hope such efforts will help set the tone for heightened concern with global social issues among employees.



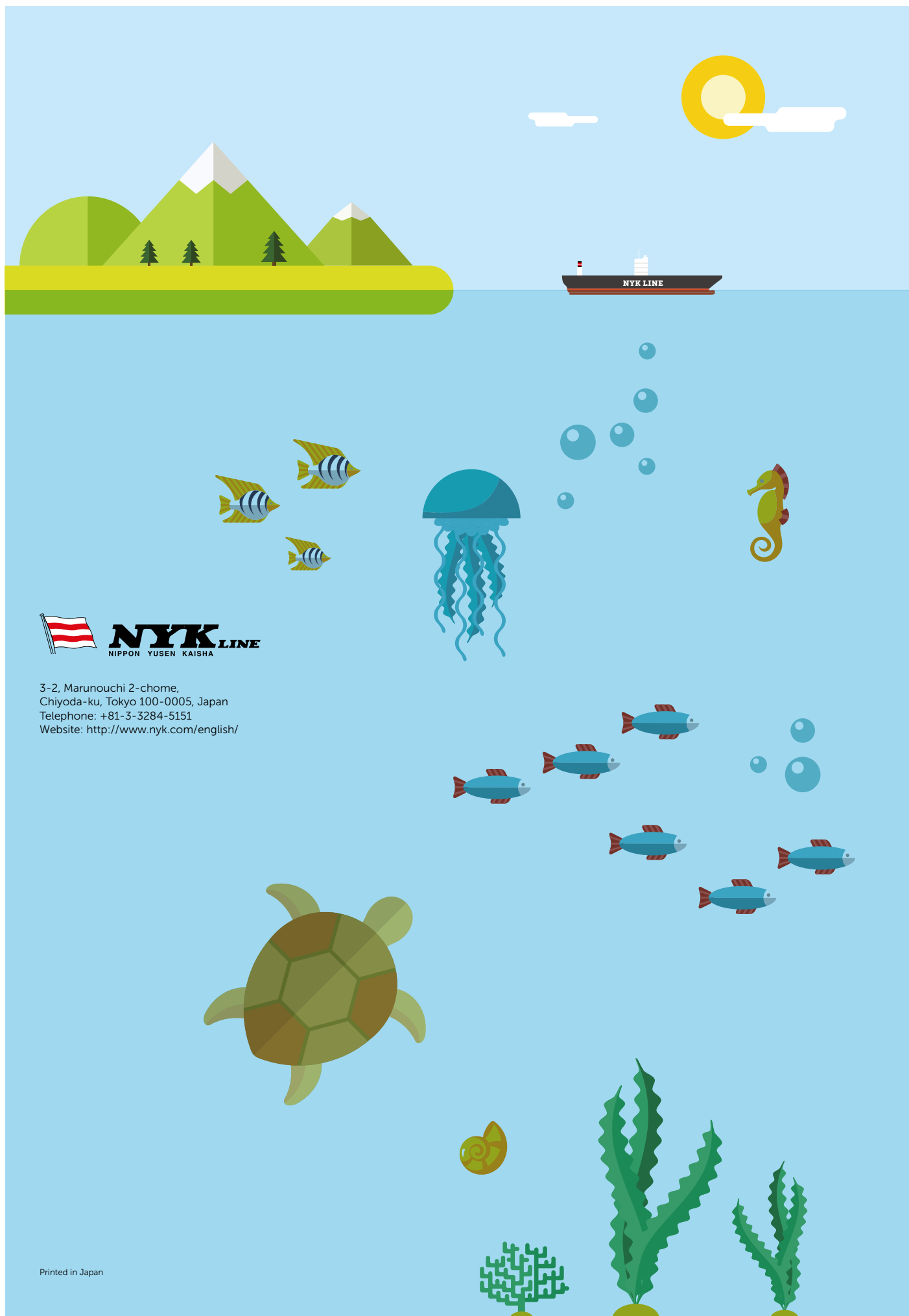
We expect visitors to NYK Headquarters and customers of the café at the headquarters to consume approximately 120,000 cups of coffee and tea a year.



International Fair Trade Certification Label

Products for which all processes, from raw material production and import through to manufacture and completion, adhere to international fair trade standards can be labelled as fair trade products. The purchase these products promotes improvement in the labour standards for producers in developing countries and environmental preservation.





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