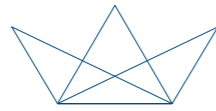


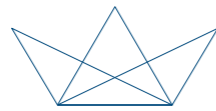
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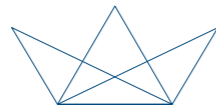
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THE WORLD'S HIGHEST LEVEL OF TECHNOLOGIES



SHIPBUILDING IN JAPAN
SOLUTION
BOOK
2019

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WHO CAN MEET THE NEEDS?

JAPAN WILL OFFER THE SOLUTION!

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Supported by To help makers develop and realise new products, Japan Ship Machinery and Equipment Association has received support from the Nippon Foundation and is now providing business assistance to them.



ISSUE 1

Fuel prices are increasing and the cost burden is high.



SOLUTION

Japanese Eco ships cover all ship types and have already realised the highest levels of fuel efficiency in the world.

Fuel efficiency is not a new topic for Japanese shipyards. For the last 40 years a lot of technology resources have been placed into fuel efficiency research and development. The Eco ships now on offer from Japanese shipyards have advanced hull forms that contribute to propulsion performance. These hull forms have been matched with fuel efficient main engines and other machinery as well as independently developed additional fuel efficient equipment which is all supported by technology.

Sayaringo STaGE LNG carrier

Mitsubishi Shipbuilding's next generation LNG carrier (Sayaringo STaGE) is a vessel highly acclaimed for its improved Moss-type spherical cargo tanks and outstanding reliability. The adoption of the apple-shaped tanks in addition to a continuous cover

has enabled an increase in LNG carrying capacity, and hybrid propulsion system combining a steam turbine and engines that can be fired by gas has enhanced overall fuel efficiency significantly.



Photo: Mitsubishi Shipbuilding Co., Ltd.

20,000TEU Type Container Carrier "MOL Truth"

It is high fuel efficiency that is a marketing weapon of Japanese shipyards, as a size of container carriers grows larger.

The "MOL Truth" 20,000TEU Container Carrier built by Imabari shipbuilding has adopted the cutting-edge technology such as low friction coatings, a highly efficient propeller and engine plant, a highly optimised hull form, which has achieved a 20% CO₂ emission reduction per container transported, much less than that of former design of 14,000TEU.



Photo: Mitsui O.S.K. Lines, Ltd.

Sunflower Kirishima

The Japan Marine United built ferry combines fuel efficiency technologies such as a newly developed highly optimised hull form and contra-rotating propellers to achieve an advanced fuel efficiency

performance. It is driven by a hybrid propulsion system using the main engine or electric motors. It has achieved a high performance both in fuel efficiency during operation and manoeuvring in harbours.



Photo: JAPAN MARINE UNITED CORPORATION



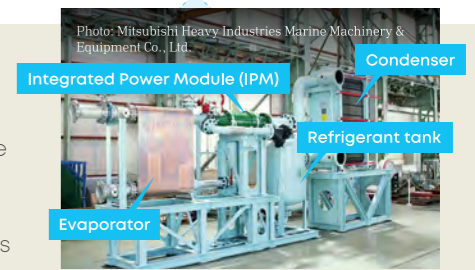
Photo: Naikai Zosen Corporation

TRANS HARMONY 1

The Naikai Zosen built new type car carrier has through the use of all types of low-energy measures such as low wind resistance hull form and low energy additional equipment (STEP) and other equipment reduced fuel consumption by around 17%. For each car transported CO₂ emissions have been reduced by 52% compared to existing ships. In addition, a lift-able deck on two floors of the vessel has increased the ships capability to carry high and heavy vehicles. As safety measures for crew, a crew member identification system that can show whereabouts of crew in the ship and an infrared video camera system that can monitor in the dark have been installed.

Waste heat recovery system

In Japan there is technology that recovers and reuses the waste heat from the engine room to improve fuel efficiency. For example, three companies—Kobe Steel, Miura and Asahi Shipping—have jointly developed a binary power cycle generation system for ships that uses the waste heat emitted from the engine's turbocharger to generate electric power for use as the ship's auxiliary power. Mitsubishi Heavy Industries Marine Machinery & Equipment (MHI-MME) has also organic rankine cycle power generation system (ORC) in his variety of energy saving product portfolio. Beside of ORC, MHI-MME keep on improving a technology of Waste Heat Recovery System (WHRS) and well proven technology using twin turbines combination system comprising of exhaust gas turbine and steam turbine is available in the market and it has obtained very good reputation by its high performance.



ORC



Photo: Kobe Steel, Ltd.
Binary cycle power generation system for ships



ISSUE 2

Building a new replacement vessel is difficult so there is a need to increase the fuel efficiency of existing ships.



SOLUTION

In Japan there is a wide variety of technology to improve the efficiency of ships in operation. No matter what the size or type of vessel there is an answer.

The development of low energy technology is a speciality of Japan. Japan's ship machinery manufacturers are providing fuel consumption improvement technology to all vessels whatever the size or type. In particular low energy propulsion efficiency machinery and low friction anti-fouling coatings can be simply applied after a ship has entered into service contributing to an improvement in the operating efficiency of the existing fleet.

CFRP Propeller



Nakashima Propeller was the first company in the world to develop a CFRP propellers for standard merchant vessels.

It uses stronger materials in the blade than has been used conventional before resulting in high efficiency and low vibration.

CFRP propellers bring high efficiency and low vibration. It has also achieved an advanced propeller in terms of quietness.

They are also advanced in terms of quietness.

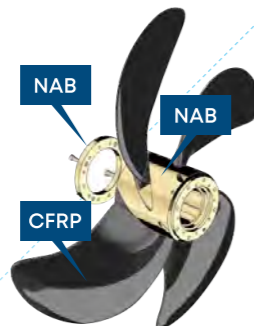


Photo: Nakashima Propeller Co., Ltd.

Controllable Pitch Propeller

Kamome Propeller has achieved world leading sales of controllable pitch propellers. By adjusting the blade angle the ship speed can be simply controlled across in the full range of speed from top to dead slow including stopping and reversing.

In combination with the original control device that took the propeller off-design performance into consideration, it is possible to restrain variation of the main engine power due to external changes or change of load condition to improve the manoeuvrability, safety and economy of ship operation.



Photo: Kamome Propeller Co., Ltd.

Propeller Boss Cap Fins

MOL Techno-Trade is engaged in R&D and sales of Propeller Boss Cap Fins (PBCF) which eliminates the hub vortex generated behind the rotating propeller and improves the propulsion performance up to 5%.

With optimisation and refinement to the shape of the fins, the advanced type of PBCF was successfully launched in 2017 which brings additional savings in fuel consumption compared to the conventional type.



Photo: MOL Techno-Trade, Ltd.

Super(Ultra)-low-friction antifouling paint

Japanese marine paint manufacturers are aiming at improving ship propulsion by developing paints that reduce frictional resistance and also protect ship's bottom from biofouling by marine creatures. They are also considering the marine environment by lining up products which meet environmental performance standards.

Recently Chugoku Marine Paints has started to introduce SEAFLO NEO CF PREMIUM, cuprous-oxide free and fuel saving antifouling. Nippon Marine Paint Coatings is adding to the product lines, i.e. a biocide free SPC antifouling – Aquaterras and super-low friction antifouling paints – A-LF-Sea & the new LF Series.



Photo: NIPPON PAINT MARINE COATINGS CO., LTD.

Application of A-LF-Sea to "QUEEN ELIZABETH"



ISSUE 3

Ships which show good fuel efficiency during sea trials can see speed significantly reduced during actual operations.



SOLUTION

Performance in actual trading conditions is a ship's real power. For many years Japanese shipbuilders have been placing importance on operating performance in actual sea conditions.

Competition in designing Eco-ships has been intensifying and there are some shipyards which are developing ships based on optimizing performance in calm seas. Japanese shipbuilders have been paying attention to the problem of Eco-ships that see a decrease in speed in actual trading conditions which are influenced by wave and wind and are working toward improving performance in real sea conditions

"OCTARVIA"

A joint industry project called OCTARVIA has been established for developing a method of accurately evaluating the performance of ships in actual sea conditions.

It involves 25 Japanese shipping, shipbuilding, maritime equipment companies and the related organisations. By establishing an objective index for ship performance, it hopes to realise more efficient seaborne transportation and lead to reduction of load on the global environment.

BOW

Japanese shipbuilders are taking into consideration actual sea conditions to develop their own original bow shapes on newbuilding ships. Japan Marine United's LEADGE-Bow® has sharp shape at the water line section of the bow end which reduces resistance from waves and also reduces fuel consumption when encountering heavy wave conditions.



Photo: JAPAN MARINE UNITED CORPORATION

WIND

Japan has been looking at the problem of wind resistance from an early stage. BELUGA ACE, the first vessel in Mitsui O.S.K. Lines' Flexie series of next generation car carriers, has a spherical shape bow that reduces wind resistance. Compared to existing car carriers it is expected to reduce CO₂ emissions by around 2%.



Photo: Mitsui O.S.K. Lines, Ltd.

EEDI Weather

The Energy Efficiency Design Index (EEDI) is an index based on flat calm sea conditions. On the other hand, EEDI Weather is an index which assesses the influence of wave and wind in actual sea conditions on the fuel consumption of ships.

In May 2017, the preliminary verification certificate of EEDI Weather was issued to Namura Shipbuilding in collaboration with National Maritime Research Institute, for the VLCC by ClassNK as world's first VLCC.



Photo: Namura Shipbuilding Co., Ltd.



ISSUE 4

The IMO has agreed a strategy to reduce greenhouse gases (GHG). What measures are available to reach the GHG reduction targets?

In Japan there are many projects progressing to find new methods to power ships such as wind power, hydrogen, bio technology and other solutions.

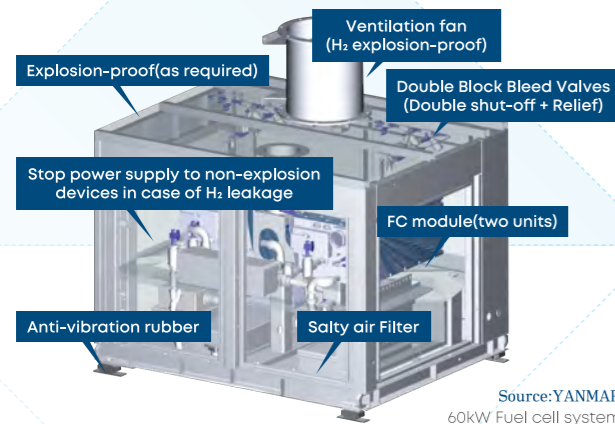
Hydrogen fuel

In fiscal 2017, as part of a project received from the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to draw up the draft guidelines for safety of hydrogen fuel cell-powered boats, Yanmar, the National Maritime Research Institute (NMRI) and the Japan Ship Technology Research Association (JSTRA) conducted tests on an actual hydrogen fuel cell ship. These tests were carried out on the NMRI managed test ship which was fitted with a Yanmar built fuel cell system and a lithium-ion battery system made by BEMAC Corporation.

Yanmar is continuing the research and development aimed at realising the hydrogen fuel cell powered ship of the future.



Photo:YANMAR
Test boat



Source:YANMAR
60kW Fuel cell system



SOLUTION

Japan is taking a lead in the research and development of alternative next generation technologies to reduce GHG.

Battery Ship

Battery power is known as most promising solution for GHG reduction on short distance voyages. Oshima Shipbuilding is currently building a small passenger ship for 50 person powered by lithium-ion batteries. The project also includes the plan to fit the ship with an automated navigation system and, in the future, to establish the technology for autonomous navigation.



Photo:Oshima Shipbuilding Co., Ltd.

Bio Fuel

As bio fuel is mainly made up from plants it is effective as a carbon neutral alternative fuel which not only reduces carbon dioxide (CO₂) emissions, but also sulphur oxide emissions and it is emerging as a promising candidate to become a marine fuel. Yanmar adapted a marine engine for the use of bio fuel and, as part of research into a hydrogen fuel cell, confirmed that refined palm oil can be used as a marine fuel.

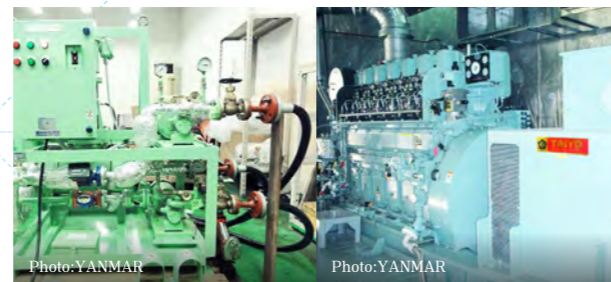


Photo:YANMAR
HFO-Biofuel blender unit

Photo:YANMAR
Diesel generator system



ISSUE 5

The IMO's global regulation of sulphur oxide (SOx) emissions begins in January 2020. Which compliance method should be taken?

Japanese ship machinery manufacturers have from an early stage been developing technology to meet every type of environmental regulation and proposing solutions that meet the different needs of each customer. By constantly upgrading existing products and developing new technology each year new technology and products are being launched.

Japan's SOx scrubber systems

Japan has SOx scrubber technology that is recognised around the world. For example Fuji Electric's SOx scrubber has for the first time introduced cyclone technology into the internal construction of a scrubber. It is the world's smallest scrubber* and, with no moveable parts, pressure loss is very low. Also Mitsubishi Kakoki Kaisha's first SOx scrubber system is the first to receive recognition as a domestic product from the Republic of Panama, a major ship registry.



Rectangular Scrubber

Mitsubishi Shipbuilding and Mitsubishi Hitachi Power Systems (MHPS) have jointly developed DIA-SOx R-type (Rectangular shape)SOx scrubber intended for large size vessels. The product is developed by combining MHPS' comprehensive exhaust gas treatment technologies, cultivated through its exhaust gas desulphurisation systems for thermal power plants, with Mitsubishi Shipbuilding's marine engineering expertise. The application of a rectangular shape realises superior space saving essential for onboard installations. The two companies have also developed the world first funnel which integrates SOx scrubber, ACTIVE FUNNEL, to enable best space efficiency and shortest installation work period.

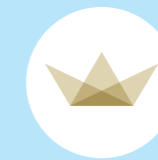


Photo:Mitsubishi Shipbuilding Co., Ltd.

MGO mono-fuel engine



Japan Engine Corporation (J-ENG) is developing a new marine engine "UEC-LSJ" which burns only marine gas oil



SOLUTION

There are many options to controlling SOx emissions, and Japan has a full line up of the alternatives.

(MGO). This next-generation engine is fully compliant with SOx emission regulation 2020 and IMO's NOx Tier III regulation, and furthermore, realising remarkable low fuel oil consumption which could contribute to the upcoming strengthened newbuilding efficiency standards of the Energy Efficiency Design Index (EEDI). And owing to the stable quality of MGO, the engine maintenance cost can be saved.

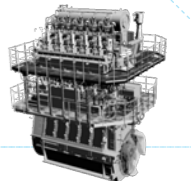


Photo:Japan Engine Corporation

Onboard sulfur-in-oil analyzer

Nippon Yusen Kabushiki Kaisha (NYK) and Nippon Yuka Kogyo, a NYK Group company, have teamed with HORIBA, to develop a new portable sulfur-in-oil analyzer that can detect the presence of sulfur in fuel oil onboard a vessel. The new device will be utilised to check the compliance with the IMO fuel sulfur regulation, as well as to determine the best timing to change fuel and adhere to regulations which contributes toward the reduction of fuel consumption, through the analysis of data from various vessels.



Photo:Nippon Yuka Kogyo Co., Ltd.

Retrofitting

Demand is increasing for the retrofitting of ships with SOx Scrubbers and Ballast Water Treatment Systems. Sanwa Dock is one of the first shipyards in the world to create and successfully employ a process for retrofitting using 3D Laser scanners so that the engineering and construction work can be performed quickly.



Photo:SANWA DOCK CO LTD
Scrubber Chemical Tanker Retrofitting



ISSUE 6

There is increasing momentum towards the use of LNG as marine fuel. What is the current state of research and development for LNG fuelled ships?



SOLUTION

Japan has a full line-up of technologies for use of LNG as a marine fuel.

Japan has committed resources to the development of ships, engines and equipment to utilise LNG as fuel.

There are many examples of LNG powered dual fuel (DF) engines in operation with high level of reliability and maturity. As part of the drive toward the development of ships that are environmentally friendly a variety of research and development is taking place to encourage the wider use of LNG as marine fuel.

Gas-fuelled low-speed four stroke engine

In 2018 Hanshin Diesel completed the world's first gas-fuelled low speed four stroke engine (G30). While maintaining the same basic construction of the current diesel engines the combustion chamber has been

modified for gas. G30 meets the requirements of the IMO's NOx Tier III regulations and has achieved higher fuel efficiency than current diesel engines.

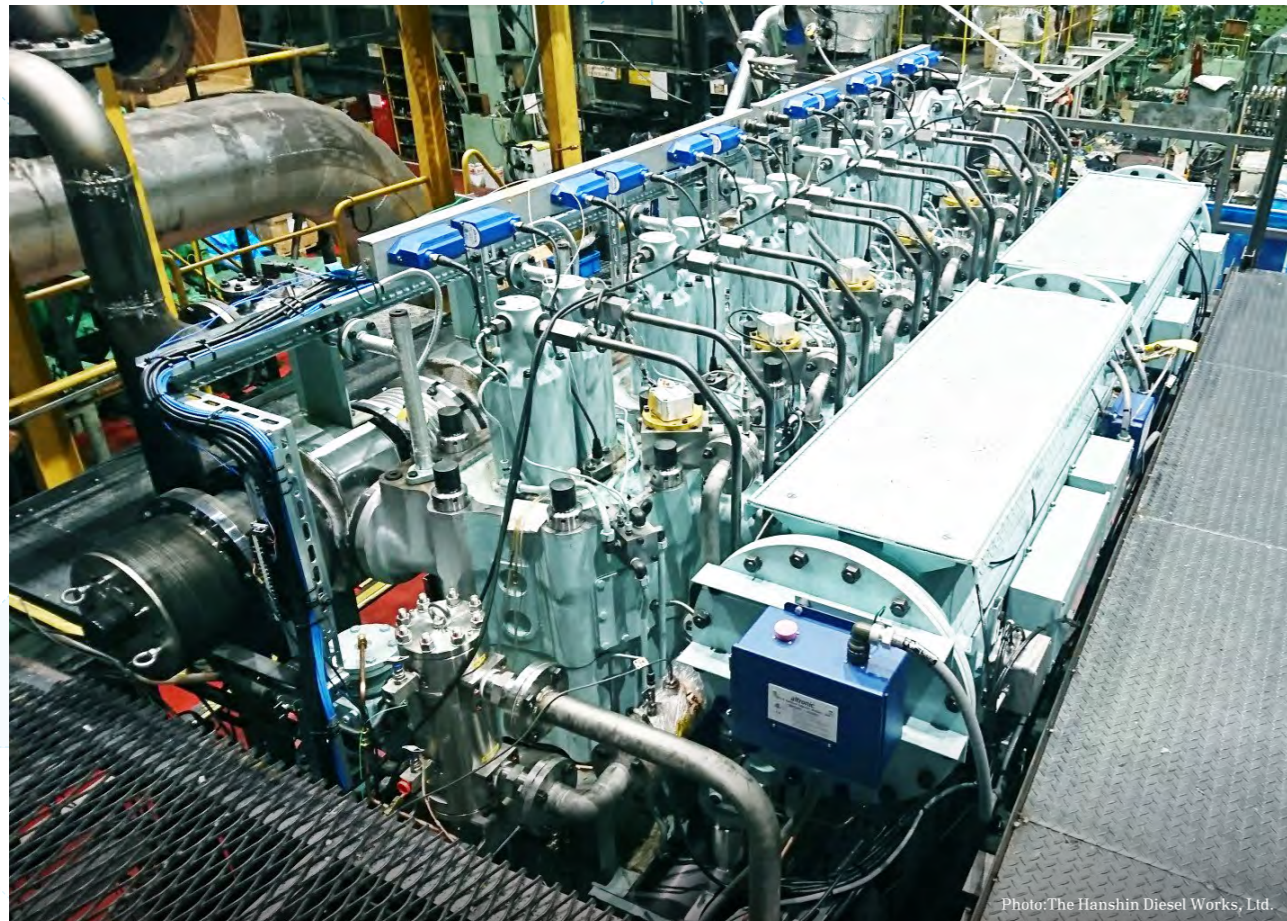


Photo: The Hanshin Diesel Works, Ltd.



Photo: DAIHATSU DIESEL MFG. CO., LTD.

4stroke DF engine

Dual Fuel Engine

All the marine engine makers in Japan have LNG powered dual fuel engines in their product line. Diesel United played a central role in the development of the world's first low pressure (lean premixed combustion type) 2-stroke engine (X-DF). Among the medium-speed engine manufacturers Niigata Power Systems created the world's first dual fuel engine that can be directly connected to a fixed pitch propeller (FPP). Yanmar* and Daihatsu Diesel have also independently created their own dual fuel engines and have a full line up of products which are environmentally friendly. From now on each manufacturer will continue their strategy of developing highly reliable and environmentally friendly products.



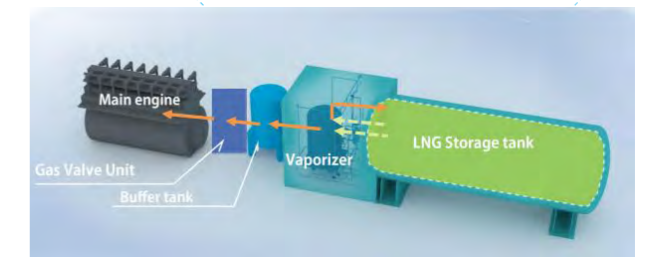
Photo: Mitsui E&S Machinery Co., Ltd.

The first ME-GI engine in Japan

FGSS

Sanoyas Shipbuilding and Sumitomo Seika have jointly developed the LNG fuel supply system (Fuel Gas Supply System FGSS) and they have already received orders

for low pressure type FGSS used with 4 cycle dual fuel engines. The system is comprised of vaporizer, buffer tank, and a double skin vacuum insulation type LNG containment system which has superior insulation performance. Simple construction is one of the specialties of this design. No pump is used but by simple adjustment of the pressure LNG is supplied to the vaporizer.



Source: Sanoyas Shipbuilding Corporation

LNG Fuelled Bulker

Nippon Yusen Kabushiki Kaisha (NYK) and Oshima Shipbuilding are jointly developing designs for a post panamax LNG fuelled bulker. A new feature of the design is that the LNG tank is positioned behind the accommodation area so that the impact on the cargo space is minimized. The LNG tank and associated equipment are built as a unit on land for quick installation when the vessel is in dock, cutting the usually long LNG conversion time by around 20%.



LNG Tank placement

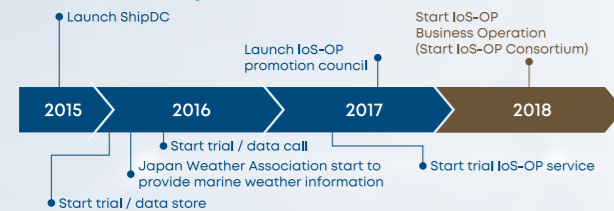
Source: Oshima Shipbuilding Co., Ltd.

Internet of Ships Open Platform

In Japan there are various trials underway with the aim of utilising ship Internet of Technology (IoT) data. ClassNK's wholly owned subsidiary Ship Data Center (ShipDC) started working toward the establishment of an industry open platform of data collected from ships - known as the Internet of Ships Open Platform (IoS-OP) - by setting up a consortium of IoS-OP users in May 2018. Through the management of IoS-OP, ShipDC is aiming to realise the flow of data throughout the maritime industry. The creation of a ship data open platform with practical rules that are developed with specific details is the world's first. The initiative that the Japanese maritime cluster put together in developing a method of sharing the industrial data is drawing a lot of attention from other industries.

Ship data starts to be used

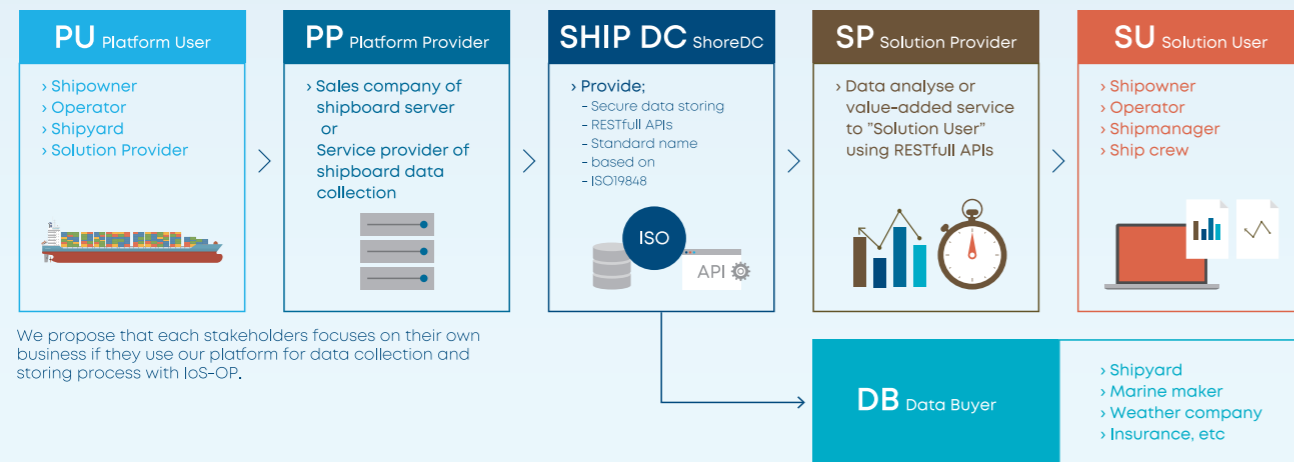
ClassNK and ShipDC has worked on Data



ShipDC is dividing up the work at both the upstream and downstream levels including areas such as the creation of data, collection and delivery of data, data storage and its use by allowing each company to participate in its own area of specialisation. It is also forming a consortium consisting of user members of IoS-OP to manage the structure to provide permanent, fair, reliable and independent service. As of October 2018, around 50 shipping, shipbuilding, ship machinery and ICT companies have participated in the IoS-OP consortium and are promoting the use of the data platform. When the project first began, the plan was to collect data from 300 ships in 2018 and 550 ships by 2022. Now the aim is to expand the consortium to 85 companies and five service providers by 2022. Participation in IoS-OP is not restricted only to Japanese companies

Outline of IoS-OP

IoS-OP will support maritime cluster for their innovation, digital transformation and next generation business.



We propose that each stakeholders focuses on their own business if they use our platform for data collection and storing process with IoS-OP.

and participants are being invited from across the world.

Three areas of activity aimed at data usage

The IoS-OP has established three working groups involving three key areas: Rule Making/Data Governance, Solutions and Business Development. Each working group has carried out work such as setting up a test-bed, providing a place for business matching, and other measures to progress the use of industry data. Member companies participated in the working group of their choice. The Rule making/Data Governance working group is providing information on data laws, rules and guidelines and looking at the experiences of other industries. The Solutions working group is tackling areas such as preparing the ground for a Solution Service using IoS-OP, approaches to standardisation and a test bed management for the verification of interconnectivity of the solution and IoS-OP. The Business Development working group is lecturing on the use of data, looking at the needs of the market, forming a matching place for early stage technology and undertaking public relations activities to promote the work outside Japan and to other industries.

The IoS-OP test bed starts operations

In October 2018, ShipDC began operating an IoS-OP test bed at the ClassNK Information Center in Chiba prefecture, Japan as a service to the member companies.

By utilising IoS-OP, members can make technological verifications on the sensors and internal data collection systems onshore before their installations onboard.

There are issues arising such as the restriction of adjustments between related parties, the handing over of the vessel, and the operating schedule when onboard data is collected and sent through satellite communication systems and when the transmission tests are carried out.

For this reason, a platform provider data collection system and a replica of the onboard environment have been set up inside the ClassNK Information Center. Outside, it has set up a high end satellite antenna that can send information to the land based ShipDC data centre.

ShipDC has allowed member companies to freely use the equipment and test the connectivity of a variety of land based data collection systems and onboard ship application systems. The IoS-OP test bed is offering the opportunity to test the ship to shore satellite broadband connection and data transmission. From these tests, it is expected that the overall workload and the frequency of onboard tests can be reduced. Further, solution service providers can also introduce their services through a demonstration on the test bed.

The IoS-OP test bed involves Inmarsat, JRC and Sky Perfect JSAT in providing communication systems, BEMAC Corporation, JRCS, Terasaki Electric, Nippon Telegraph and Telephone, Furuno Electric, Akishima Laboratories (Mitsui Zosen) and MTI in providing onboard data collection systems and ClassNK in

providing facilities and equipment. Member companies can use the test bed, including satellite communications systems, at no charge.

International standards for ship data collection

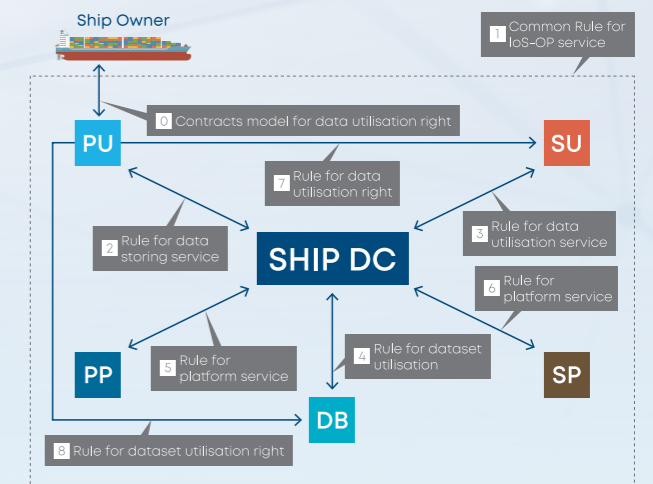
The Japan Ship Machinery and Equipment Association's newly formed Smart Ship Application Platform 2 Project (SSAP2) is attempting, together with the IoS-OP, to create an international standard which will be an essential requirement for the use of ship IoT data.

In 2015 Japan proposed to the ISO a standard for the onboard ship data server (ISO19847) and a standard for ship machinery and data equipment (ISO19848). In October 2018 these two standards became established and published by ISO.

For the comparison and utilization of a variety of data

Rules for IoS-OP

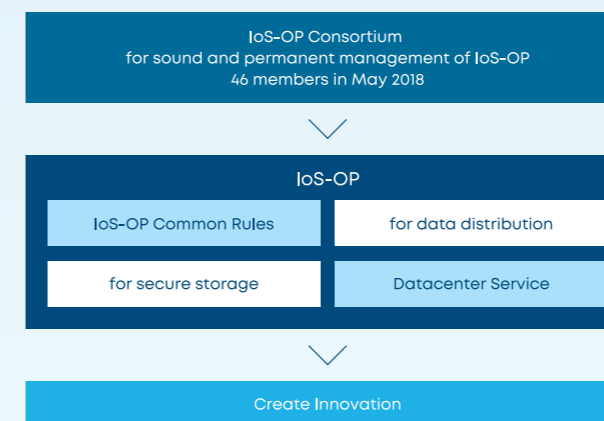
IoS-OP provides common and individual rules for each stakeholders in order to distribute IoS data among stakeholders equitably.



collected from ships a huge amount of work is required to align the numerous names and units that are used and this is a major barrier to the use of onboard data. Now the international standardization has been achieved it will hugely progress the accumulation and use of ship data across the industry. Through an open data platform using ship data and the creation of ISO standardization and common rules it will be possible for each company to develop products and improve their business using ship data. In the near future it is expected to lead to new business models at will improve each companies' competitive strength.

Through international standardization it is thought shipbuilding companies will adopt standardized technology that will increase the number of connected ships and accelerate these developments.

Outline of IoS-OP





ISSUE 7

The ballast water management convention has entered into force and the planned installation of ballast water treatment systems is now required.



SOLUTION

Japan has developed various types of ballast water treatment systems and can offer total support including retrofitting vessels.

In Japan it is possible to find a ballast water treatment system suitable for any ship type. The installation of ballast water treatment systems, especially for existing ships, is severely limited by space. But Japanese makers are meeting the customer's needs by developing compact and simple systems. Systems are also being developed to ensure that the equipment is in compliance with the regulation.

JFE BallastAce

The JFE Engineering developed JFE BallastAce is a chemical based ballast water treatment system. In November 2018 it became the first Japanese equipment maker (and the 13th in the world) to have its product approved by the United States Coast Guard (USCG). It is a system in which simplicity is its special feature. In the system ballast water is treated with chemicals after it has been passed through a filter.

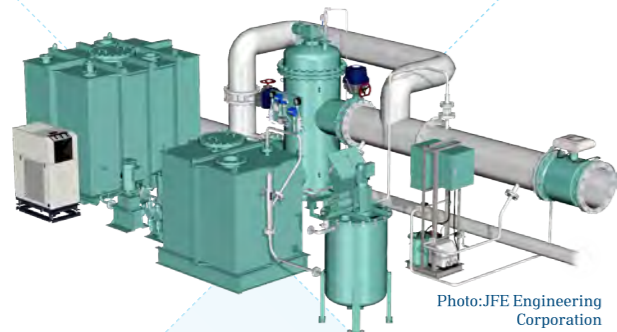


Photo:JFE Engineering Corporation

product is mainly aimed at the market for existing ships it has a simple construction in which the configuration can be freely adjusted.

HK

MIURA's ballast water treatment system HK uses its own independently developed filter in combination with UV. A compact version is now being marketed to broaden the ships types that can use the system. For the retrofit market MIURA is offering the 3D measurements performed by its own engineers and a supervisor support system.

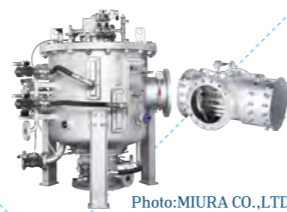


Photo:MIURA CO.,LTD.

Satake viable organism analyzer Ballast Eye / viable organism sampler

New portable viable organism analyzer was released in January 2019. Fast 1-minute test (10-15 minute sample preparation required) determines the number of both $\geq 50\mu\text{m}$ and $10\text{-}50\mu\text{m}$ surviving organisms. It utilizes Pulse Counting FDA method to detect both zooplankton and phytoplankton.

Viable organism sampler concentrates 1 cubic meter of ballast water into 100 ml to be used along with Ballast Eye.

This compact portable sample concentrator does not require power source and quickly connects to the existing line. Sales are planned from April 2019.



Photo:SATAKE CORPORATION

Kurita BWMS

Kurita Water Industries is increasing its efforts to market its filter-less ballast water treatment system (KURITA BWMS) outside Japan. As the development of the

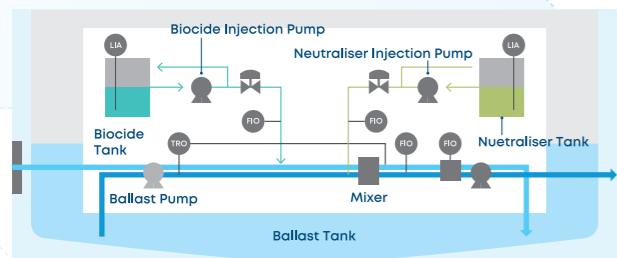


Photo:Kurita Water Industries Ltd.



ISSUE 8

Support provided to ships after they enter into service is often a concern. Shipowners want to entrust ships to a repair yard they can trust.



SOLUTION

Japanese ship repair yards have a good reputation for work quality and punctual delivery and a wealth of maintenance know how.

Japan does not only have newbuilding yards it also has a many ship repair yards. There are also some newbuilding yards with specialist divisions or subsidiaries that offer future support for the safe and continuous vessel operation of newbuildings.

There are many ship repair yards and specialist factories located throughout the country involved in inspection, conversion, retrofit and various other services providing a kind of "Dr Ship" support service for needs of shipowners.



Copyright Mitsubishi Heavy Industries, Ltd.



Photo:MES-KHI YURA DOCK CO., LTD.



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Photo:MUKAISHIMA DOCK YARD CO., LTD.



ISSUE 9

The shortage of seafarers is becoming serious and there is a need to reduce incidents involving human error. Is there a way to reduce seafarer's workload and achieve safer navigation?



SOLUTION

Japan's leading digital technology involves all crew and contributes to safe operations.

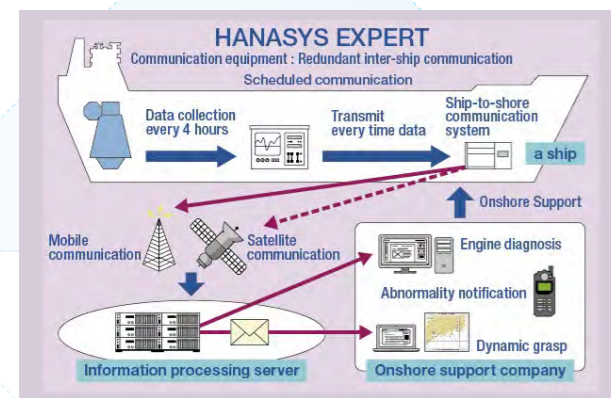
In Japan, using data collected from ships, there is technology available that can make it possible to understand the situation onboard in real time and discover irregularities at an early stage and to prevent the development of problems. The use of digital technology not only improves safety but also improves the efficiency of seafarers' work and can also be used for educational purposes.

Advanced Safety Management System

Japanese marine engine makers are progressing with the introduction of advanced support systems for ship management.

Advanced support systems for ship management allow the condition of the propulsion engine and generator to be monitored and diagnosed remotely from shore. The system makes possible advanced engine safety management, optimal maintenance and labour saving, contributing toward ship safety.

Mitsui E&S Machinery, Diesel United and others are providing services by using ClassNK's Ship Maintenance Management System (ClassNK CMAXS) to monitor the condition of the main engine. Yanmar Engineering, one of Yanmar's subsidiaries, is offering the technical support (SHIPS-SUPPORTER) by using engine data. Hanshin Diesel Works also has its own engine monitoring and ship support system (HANASYS EXPERT) installed on many ships.



Source: The Hanshin Diesel Works, Ltd.

SOPass

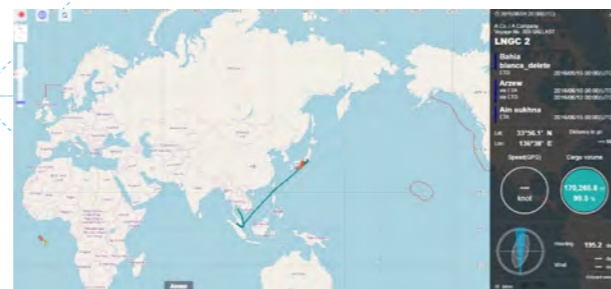


Photo: Kawasaki Heavy Industries, Ltd.

Kawasaki Heavy Industries' ship operation and performance analysis support system (SOPass) provides optimisation functions of ship's operation by analysing various data obtained from ship and weather forecast data. These functions include weather routing, performance analysis with forecast and maintenance management. In addition, specialised to LNG carriers, it manages the boil off gas during transportation with proposing the route that minimises fuel consumption and optimal heel amount.

Kirari NINJA

MTI and Daitron jointly developed a device (Kirari NINJA) to automatically photograph the interior of a vessel engine's combustion chamber. By utilizing the product, crew members don't need to enter the inside of the engine to inspect the combustion chamber, so that their workload is significantly



Photo: MTI Co., Ltd.

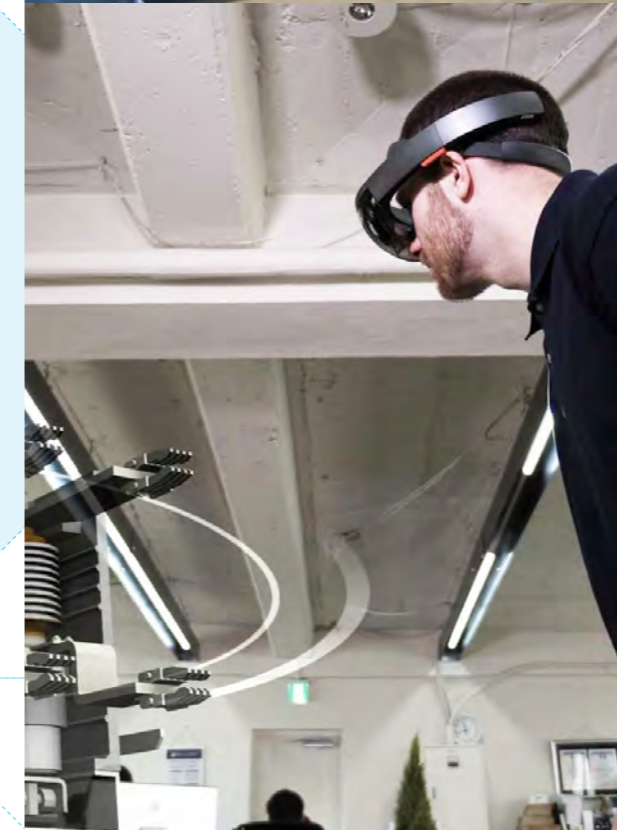
reduced. Nippon Yusen Kabushiki Kaisha (NYK) and MTI have also developed original software that uses photo data from Kirari NINJA to prevent accidents by quickly determining the cause of failures at an early stage.

INFINITY Training

JRCS is developing an education service for mariners that utilises "HoloLens", a mixed reality (MR) headset which assimilates reality with virtual space. The company aims to spread INFINITY Training by the use of Microsoft's HoloLens coupled with a translation function making remote training a solution that mariners can receive without the concern for location, time or language.



Photo: JRCS Mfg. Co., Ltd.



Training

Remote Boiler Burner Maintenance System

Sunflame is developing an auxiliary boiler binary remote maintenance system (Sunflame Smart Support System) to be used for trouble shooting and providing optimal operational support. Logging data is sent through the onboard server which is analysed in real time at a land based office to minimise the risk of an accident and to find early solutions to the development of trouble.



Photo: Sunflame Co., Ltd.
Sunflame Smart Support System's display screen image

Remote Monitoring System for Marine Pumps

In cooperation with Nippon Yusen Kabushiki Kaisha (NYK), MTI and Eagle Industry, Naniwa Pump Manufacturing is conducting research of diagnostic technology permitting remote monitoring system of marine pumps. The system aims at improvement of safe operation and reducing maintenance cost of marine pumps by shifting maintenance based on operating hours to the maintenance as required the actual state of the components.



Photo: Naniwa Pump Mfg. Co., Ltd.

Japan looks toward automated shipping

The primary theme of research and development in the maritime field is the autonomous ship. Japan has set 2025 as the target year to develop the autonomous ship and to achieve this is carrying out a variety of projects at an industry level.

Around 80% of maritime casualties are caused by human error. Through ship automation and independent operation, it will become possible to greatly reduce this type of human error and it is also expected to contribute toward reducing maritime accidents.

In addition, it is thought that automation and independent operation will also contribute toward reducing the burden on seafarers and it is expected to change the character of maritime transportation. The International Maritime Organisation(IMO) is exploring the development of regulation toward the realisation of ship automation.

To realise the autonomous ship, it will be necessary to develop two areas in tandem, that is, research and development projects for ships utilising the advanced technology such as IoT technology and big data analysis alongside the creating an environment for the realisation of autonomous ship such as development of safety criteria.

As for research and development for several years Japanese shipping and shipbuilding companies have been carrying out projects utilising IoT and big data analysis. Since 2016 the Ministry of Land Infrastructure

Transport and Tourism (MLIT) began the Maritime Productivity Revolution Programme, known as i-shipping, and through the project has been promoting research and development on digitalisation in maritime sector.

Also the MLIT has been developing the environment to realise the autonomous ship including the safety regulations through trial projects which began in 2018. At first it is tackling the three core areas of the autonomous ship which are automated steering, remote control and automated berthing functions. The trial project of automated steering is being handled by Oshima Shipbuilding and MHI Marine Engineering. To secure the safety of automated steering it is important to ensure the reliable operation of collision avoidance and grounding prevention functions. Through the simulation of automated steering the project conducts the collection of necessary data for development of generic method of safety verification on automated steering logic.

Eventually trial through actual ships in operation will take place and it is planned the information will be used in the creation of standards and other areas. The verification of the remote operation of ships is being carried out by Nippon Yusen Kabushiki Kaisha (NYK) group company MTI in a group of 16 companies. A computer will collect, integrate, and analyse information around the ship, prepare an action plan, and after the approval of operators at remote locations or on board, take action in accordance with the plan. Through data collection, simulation and verification this demonstration aims to create a system

that will bring this action plan into a real situation. The knowledge received from this demonstration can be used in studies into securing the safety of the system such as determining the required onboard functions, the data that should be sent from ship to shore and the safety requirements for data transmission.

Verification through simulation is the first step but from now on it is verification tests on real vessels in operation is planned.

Tests on automated berthing operations are being undertaken by four companies including Mitsui E&S shipbuilding and Mitsui O.S.K. Lines. Berthing is one of the most difficult aspects of ship operation and involves automation and autonomisation. The verification project involves discovering the technical issues by creating a virtual offshore quay where a real vessel will undertake automated berthing. Firstly the Tokyo Maritime University vessel *Shioji Maru* will carry out the first tests but in the future it is foreseen a large scale ship and a real quay will be used. The results will be used to make standards and other related measures.

Also, at the private company level, members of the Japanese maritime cluster have established a research platform aimed at realising the autonomous ship. In 2017 the Japan Ship Technology Research

Association(JASTRA), through the research platform, set up the Automated Seaborne Transportation System Research Committee involving the big three Japanese shipping companies, coastal operators, cruise ship operators, shipbuilders, ship machinery manufacturers, universities, research institutes, a classification society, insurance and communications companies.

Through these various institutions this research committee is taking a comprehensive view in areas including studying business models and technical concepts for automated vessels.

Since 2018, with the support of the Nippon Foundation, as part of a study into developing a business model for automated shipping, it researched an automated seaborne transportation system with an unmanned vessel and studied the efficiency of unmanned vessels and possible routes, cargoes and ship types.

Around the world this vision of an unmanned ship is being established and research and development extending beyond the frame of individual companies is progressing.

The 1961 built vessel *Kinkasan Maru* was the world's first autonomous ship. It had bridge control system allowing direct control of main engine room from the bridge and included a centralised supervisory and control system that intensively monitors and controls the engine room. Since then Japan has been taking the lead in developing automated technology.

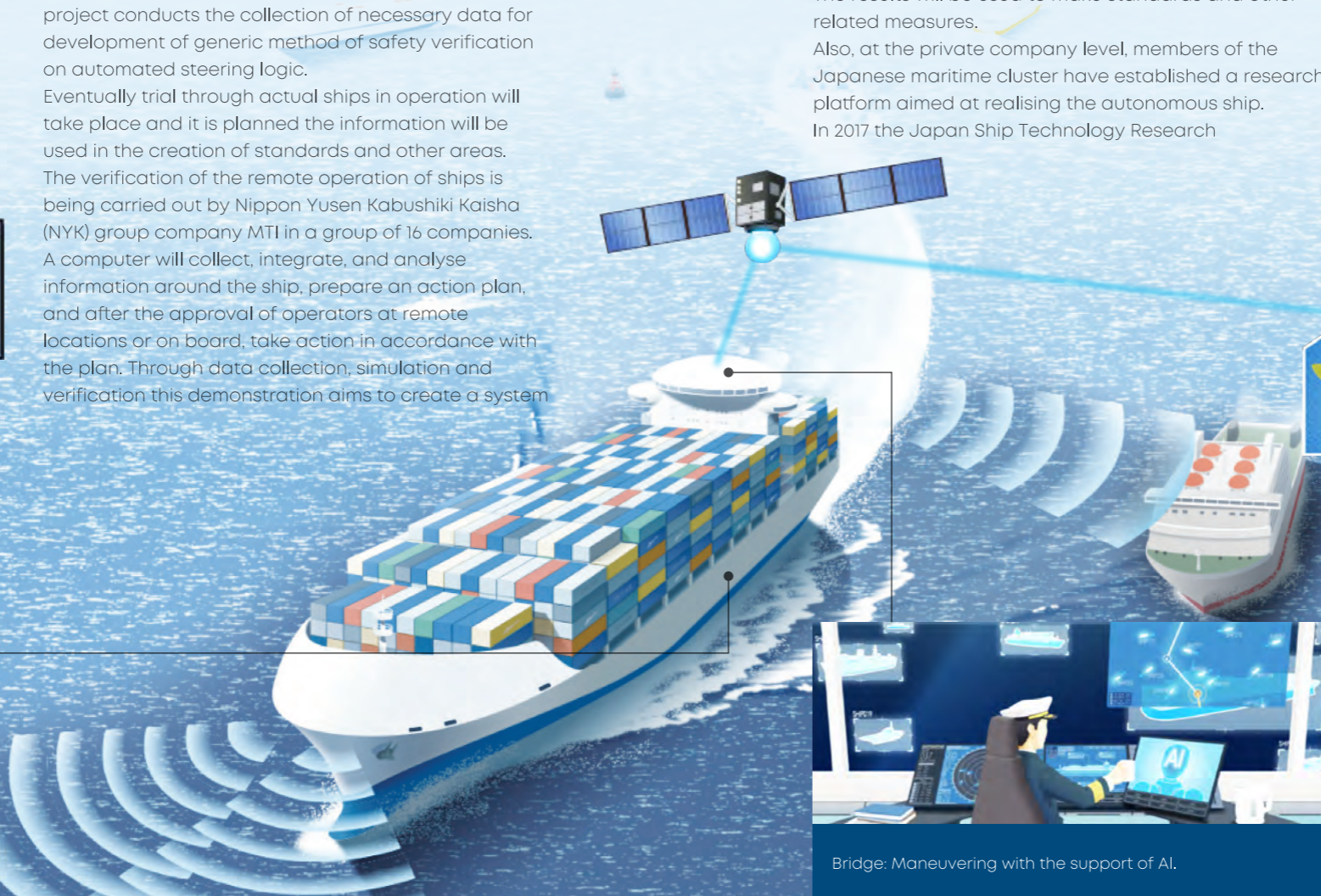
By bringing together technology and knowledge held by different companies Japan is aiming to realise the important theme of ship automation.



Berthing: Remote marine vessel maneuvering tag is also utilised for the berthing.



Onboard: Maintenance of ship equipment by augmented reality (AR) and support from shore side.



Shore side: Constant monitoring vessels and surrounding conditions. Provide assistance when necessary.



Bridge: Maneuvering with the support of AI.

Source: Japan Ship Technology Research Association



ISSUE 10

Market demand for ship types and ship sizes are constantly changing.



SOLUTION

Based on detailed market analysis Japanese shipyards are constantly supplying ships that meet with changes in seaborne trading conditions.

Optimal cargo lots and optimal ship sizes are constantly changing along with developments in trade conditions and patterns. Japan is continually monitoring such changes in the world's main ports, seaways and cargo trades and listening to the needs of shipowners to immediately produce ships that meet the demands of the age.

JMU's Malaccamax VLCC

Japan Marine United developed the JMU Malaccamax type VLCC as the optimal ship design for the oil trade between the Middle East and Japan with the main consideration the size limits of Japanese domestic oil terminals. Using the latest analysis techniques it developed a low resistance high efficiency hull form and applied Japan Marine United's own energy saving Super Stream Duct®, SURF-BULB®, ALV-Fin® to optimise the design and bring a significant reduction in fuel consumption.



63,000M.T. D/W Type Bulk Carrier

Imabari Shipbuilding has been a world leader in developing handymax bulk carriers over 60,000-dwt. With the beam dimension of the conventional 50,000-dwt bulk carrier not being changed and its high versatility maintained, a deadweight of the carriers has been steadily increased. The design of 61,000-dwt has proven a big success and got orders more than 120 units. Imabari has further developed the design and currently builds the 63,000-dwt bulk carrier. Its fuel consumption

performance has been significantly improved and the design has received a high praise in the market.



87,000-dwt Bulker "neo87bc"

Mitsui E&S Shipbuilding has developed a post panamax bulk carrier as a next generation Eco ship. The design has improved transportation efficiency and usability in the grain trades which do not transit the Panama Canal. Its shallow draft allows it to enter a wide range of ports and it also has a wide range of trading options and can also operate in the coal trades. The environmental features and fuel efficiency of the design have also been strengthened and it can meet also all the environmental regulations. The first ship will be delivered in 2020.

41,000-dwt Bulker

Sanoyas Shipbuilding has developed a new concept 41,000-dwt bulk carrier design based on a marketing survey of many of its customers. While being of double hull construction for cargo hold, it has achieved large cargo capacity of 50,000m³. The vessel is not only focusing on main dry bulk cargoes but on a wide variety of cargoes such as Lumber and steel products. The design's beam has been widened and it has a shallower draft than conventional handysize bulk carriers increasing its usability and allowing it greater access to ports and routes. It has also achieved a top class fuel efficiency performance among handysize bulk carriers.



ISSUE 11

There are issues that cannot be solved via infrastructures on land thus far such as in providing logistics services, power distribution and so forth.



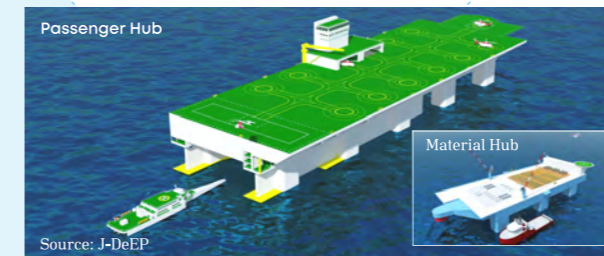
SOLUTION

Japan's floating structures can provide a variety of solutions.

Logistics

Today, as offshore oil and gas development takes place at an increasing distance from land, *J-DeEP Technology and Engineering Research Association provides a Logistics Hub System for passengers and for materials by placing a staging point between a base port and the offshore development field. J-DeEP consists of all the leading players in the Japanese maritime cluster which are fully equipped with the design and construction experience relevant to the realisation of this concept and other floating structures for various purposes such as a support platform for sub-sea equipment.

* Member Organisations of J-DeEP include: IHI Corporation, Japan Marine United Corporation, Mitsubishi Shipbuilding, Nippon Yusen Kabushiki Kaisha, Mitsui O.S.K. Lines, Kawasaki Kisen Kaisha, National Maritime Research Institute and ClassNK.



Electricity

An increase in demand for electricity is expected in developing countries. There are many islands where there are insufficient electrical power generation systems and there is a need for small scale rather than large scale power generation units. Large capacity diesel engine or gas turbine power generators situated on floating offshore structures could provide a solution to this problem. Such a system could also be used to provide electricity in developed countries while land based power generators are being updated. Mitsui E&S Group is utilising the technology of its group companies in LNG carrier construction, power

generation plant, gas engineering and floating offshore construction to offer an optimised LNG power generation barge. Kawasaki Heavy Industries has developed a highly efficient LNG floating power plant, for which two types of electrical power generation system (a gas engine power plant or a combined cycle power plant) can be selected. All components concerning the electric power generation systems, LNG tanks and floating unit can utilise Kawasaki's own technology.



Water and Electricity

MODEC's FSRWP® (Floating Storage, Regasification, Water and Power) is an originally designed multipurpose floating gas facility which not only provides LNG regasification but also gas electrical power generation and water desalination capability.



*FSRWP is a registered trademark of MODEC, Inc.



ISSUE 12

In some countries the ageing of the coastal fleets is becoming a serious problem because there is no domestic shipbuilding capacity available.



SOLUTION

Japanese shipyards are exporting various types of coastal vessels including survey ships and patrol boats.

Japanese shipyards are building ships specifically designed for the local conditions in each country including South East Asia. Patrol vessels and coastal vessels are also being supplied using Official Development Assistance (ODA) to strengthen cooperation in the marine industry.

Patrol Vessel

Sumidagawa Shipyard constructed two 30m Type Patrol Vessels for Sri Lanka Coast Guard on the basis of Japanese grant extended by Japan International Cooperation Agency (JICA). The Vessels are expected to contribute the maritime safety improvement in Sri Lanka by enhancing the ability to secure maritime safety and security.



Photo:Sumidagawa Shipyard Co.,Ltd.

Research Ship

The fishing industry is an important export industry for the Kingdom of Morocco but in recent years the



Photo:JICA

catch has become unstable and the long term management of the industry has become a major issue in the country. To upgrade the country's fishing research capability Mitsui E&S shipbuilding is building a state of the art offshore fisheries research vessel for the Morocco National Fisheries Research Centre. Toyota Tsusho Corporation is acting as main contractor and the vessel is scheduled to be delivered in 2021. The ship building finance has been arranged between the Japanese and Moroccan governments on a Japanese Yen loan basis.

River Ferry

Everyday around 30,000 people cross the river that dissects Myanmar's Yangon city. To replace the ageing fleet of ships that transit the river Nakatani Shipbuilding is supplying three twin engine twin propulsion system ferries the *Cherry-1*, *Cherry-2* and *Cherry-3*.

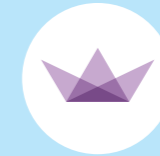


Photo:NAKATANI SHIPBUILDING CO.,LTD



ISSUE 13

A shipowner wants to build attractive passenger ship good enough to be called a cruise ship.



SOLUTION

Japanese built ferries are Eco-ships that can offer voyages aimed at the customer.

There are many Japanese built ferries operating along the Japanese coastline. On top of energy efficiency and safety, these ships also address the passenger's needs and have rooms and internal styling that match the routes in which they sail.

guntō

The TSUNEISHI SHIPBUILDING built *guntō* is cruise ship styled on a traditional high class Japanese guest house. All the 19 rooms onboard are suites. The extensive use of wood in the interior design is a unique feature of the ship which is also fitted with Japanese style open-air bath. Onboard there are also sushi and Japanese sweets on offer. The ship is powered by an electrical propulsion system that allows customers to experience a relaxed and quiet voyage.



©guntō

Silver Tiarra

The Naikai Zosen built ferry *Silver Tiarra* places importance on comfort and privacy and, as its name suggests, it shines like a jewel. There are a variety of rooms provided including rooms that can also be

enjoyed by pets and special rooms for women with small children. The ship also has low rolling in operation and a high manoeuvrability during berthing and unberthing.



Photo:Naikai Zosen Corporation

AZALEA

The Mitsubishi shipbuilding built *Azalea* is a new design ferry offering comfortable travel. Compared to earlier designs it has achieved both an increase in speed and a reduction in fuel consumption. The vessel has newly design hull form, "Proximity twin-screw system having shaft brackets", and the Mitsubishi Air Lubrication System (MALS) to achieve a 10% reduction in fuel consumption.



Photo:Mitsubishi Shipbuilding Co., Ltd.