



**PROPELLER BOSS CAP FINS**

**PBCF<sup>®</sup>**

# Birth of a New Innovation —the Advanced PBCF Following 30 Years of Experience and Trust

## What is PBCF?

Propeller Boss Cap Fins (PBCF) is a device that improves propulsive efficiency by recovering energy from the hub vortex generated behind a propeller. As a result, PBCF reduces fuel oil consumption. PBCF is the first energy-saving device developed with the aim of recovering energy by weakening the hub vortex. Its original design, as well as the technological innovation that has gone into its development, is highly regarded. Moreover, patents for PBCF have been obtained in various countries. Owing to continuous research and development, an achievement in itself, the advanced PBCF was released in May 2017. In addition, the new patents for the advanced type have been obtained in various countries.

As a pioneer in energy-saving device for vessels, PBCF has been installed on more than 3,300 vessels around the world since the technology was introduced in 1987. This is quite exceptional and reflects not only how effective PBCF is but also how well regarded it has become worldwide. Moreover, with the tremendous support of very reliable customers, PBCF has established a solid position in the industry.

### **5% Reduction in Fuel Consumption as well as Green House Gas Emissions**

- Resolves the propeller torque rich condition, reduces underwater noise and stern vibration, and prevents rudder erosion

### **Simple and Quick Installation, Regardless of Vessel Type or Size, and Suitable for Both New and Existing Vessels**

- Vessel and propeller modifications are not required, and no welding work is necessary
- Can be installed on either a Fixed Pitch Propeller (FPP) or Controllable Pitch Propeller (CPP)
- Optimized design and custom made for every propeller profile
- No specific maintenance is required after installation

### **PBCF remains effective over the lifetime of the vessel**



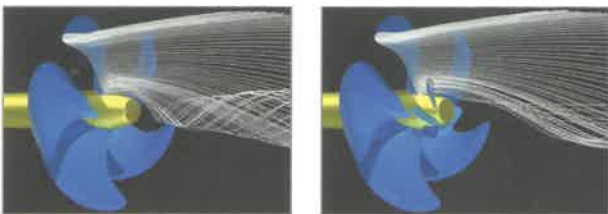


# The Advanced PBCF with Our Aim for Extensive Optimization

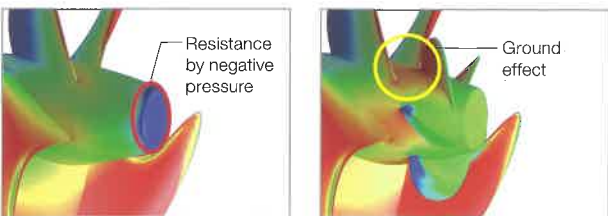
With extensive optimization and refinement of the fin shape, as well as adjustments to height, the advanced PBCF enhances propeller thrust and torque. Tests of the device on actual vessels have confirmed energy savings of around 5% compared to sister vessels without a PBCF. The advanced type is highly regarded as a breakthrough technology. Therefore its new patents have been obtained in a number of countries.

## CFD Analysis

Through ongoing research and development, the evolution of PBCF continues. Furthermore, a number of experiments on PBCF have been undertaken since the technology was first introduced. CFD analysis has enabled to clarify the streamlines behind the boss cap, pressure distribution, velocity distribution, and vorticity distribution after due consideration for the viscous effect around the propeller blades, fins, and boss surface. As shown in the figure, a significant difference of the pressure distribution on the surface and the aft end of the boss cap can be seen for cases with and without a PBCF. This demonstrates the supremacy of the advanced type from the viewpoint of hydrodynamic mechanisms.



The hub vortex is visualized by CFD simulation. Left: normal cap, Right: with PBCF



Pressure distribution showing low (blue) and high (red) pressures. Left: normal cap, Right: with PBCF

## Design Changes Lead to Big Savings

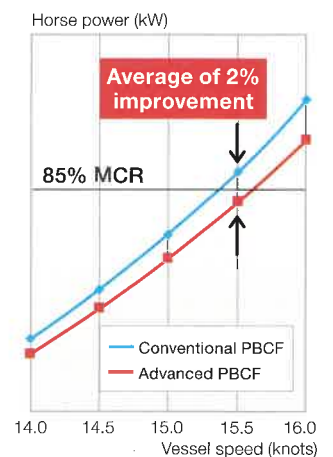
The extensively optimized design of the advanced PBCF allows for an additional 2% savings (average) in fuel consumption compared to the conventional type. Economic-related benefits for several types of ships are shown in the table. The payback period is within a year, even at times of low oil price rates, such as in recent years. In short, greater fuel savings can be expected by those using the advanced PBCF.

## Principles

PBCF is capable of reducing resistance by eliminating the hub vortex, increasing thrust with the ground effect, and gives the fins a strong push in the same direction as the main propeller rotation. After installing a PBCF, the hub vortex at the boss end will be reduced. This will result in a 5% increase in propeller propulsion efficiency, achieved through recovery of the energy loss caused by the hub vortex.

## Conventional vs Advanced on Actual Vessels

Evaluation tests, showing energy savings of around 3%, were conducted on more than 100 vessels equipped with a conventional PBCF. A comparative analysis of sister vessels, equipped with either a conventional type or an advanced type, was conducted to determine the effectiveness of the devices. The results show that the improvements in the advanced type make it more effective than the conventional type, on average by around 2% additional fuel savings.



Sea Trial Result of 60,000 DWT Bulk Carrier

### Payback period in less than one year

Vessel type	Fuel Oil Consumption	5% fuel savings with advanced PBCF	
		Payback Period (month)	Cost Savings (US\$/year)
Container (8,000 TEU)	100	4.0	<b>\$500,000</b>
VLCC	90	3.5	<b>\$500,000</b>
CAPE BC	60	4.5	<b>\$300,000</b>
HANDY BC	30	6.0	<b>\$150,000</b>

Note: Fuel oil price is IFO380 US\$350/MT, and figures for the fuel consumption rate are used in accordance with the actual state.

# Contributing to Society with the Environmentally Friendly PBCF

## Reduction of 1.2 million tons of CO<sub>2</sub> equivalent

PBCF, introduced over 30 years ago, has already reduced the equivalent of 1.2 million tons of CO<sub>2</sub> by lowering vessel fuel consumption. Considering the world's growing focus on global environmental problems, the advanced PBCF allows for further energy savings and CO<sub>2</sub> reduction.

## Selected for Equipment Designated by the Port of Vancouver EcoAction Program



The Vancouver Fraser Port Authority in Canada has selected PBCF as an underwater noise reduction technology for vessels as part of their EcoAction Program. The program offers vessel operators discounted rates on harbor dues if voluntary emission reduction measures or other environmental practices have been implemented. As of January 1, 2017, vessels with PBCF that call the Port of Vancouver are eligible for bronze level recognition and a 23% discount on harbor dues. PBCF not only saves energy, but it also contributes to environmental protection in a number of other ways, including protecting whales and other marine mammals by reducing underwater noise.

## Participated in Green Award Marine Environmental Protection Program Run by Green Award Foundation

MOL Techno-Trade, Ltd. has joined a Green Award Program as an incentive provider aimed at promoting high-quality and eco-friendly shipping since February 2019. Vessels and shipping companies that have acquired Green Award Foundation certification receives 3% discount from contract price of PBCF.



## Received the 2017 Nikkei Global Environmental Technology Award

PBCF received the "2017 Nikkei Global Environmental Technology Award" presented by *Nikkei Inc.* All of these accomplishments reflect our steadfast efforts to contribute to global environmental conservation, with PBCF sales for over 3,300 vessels. Moreover, they represent the continual challenges MOL Techno-Trade, Ltd. has overcome throughout more than 30 years of PBCF development.

**PBCF—Simple and Tough—  
Environmental Technology that Continues to Evolve.**

PBCF was jointly developed by Mitsui O.S.K. Lines, Ltd. (MOL), West Japan Fluid Engineering Laboratory Co., Ltd., and Mikado Propeller Co., Ltd. (presently owned by Nakashima Propeller Co., Ltd.), and is currently being marketed by MOL Techno-Trade, Ltd. The advanced PBCF is jointly being developed by Mitsui O.S.K. Lines, Ltd. (MOL), Akishima Laboratories (Mitsui Zosen) Inc., and MOL Techno-Trade, Ltd.

The MOL Group will continue to contribute to environmental conservation at ports and at sea around the world. Furthermore, through the "ISHIN NEXT - MOL SMART SHIP Project," it will step up its efforts to ensure safe operations and lower environmental impact.



**MOL MOL Techno-Trade, Ltd.**

### PBCF Department

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# MOL Tech

Products and Services



To be the No.1 technology-specialized trading company in terms of environmental protection and safety-related business, especially in the field of maritime affairs.



### MOL Group Network

Taking advantage of the MOL Group's extensive worldwide network, MOL Tech continues to take on new challenges through concerted efforts by all employees, seeking to fulfill the MOL Group's vision and mission.



### Technological Capabilities

Drawing upon decades of experience and know-how in a broad range of services, MOL Tech meets the needs of the times with advanced technological capabilities in safety and environmental protection.



### Creativity and Ingenuity

MOL Tech offers optimal solutions in various value chains such as production and infrastructure, as well as ocean transport.

MOL Tech is a solution provider backed by a full lineup of resources and assets, with the ideal mix of personnel, products, services, financing, and information.







Propeller Boss Cap Fins (PBCF)



Propeller Boss Cap Fins (PBCF)

## Propeller Boss Cap Fins (PBCF)

### The world's top-selling marine energy-saving device helps protect our oceans and the global environment

PBCF is an energy saving device installed on the hub of a vessel's propeller. It improves propeller efficiency by weakening the hub vortex generated behind the rotating propeller and reduces fuel consumption by about 5%. On a large containership, for example, that adds up to a 9,000-ton reduction in annual CO<sub>2</sub> emissions.

PBCF was co-developed by Mitsui O.S.K. Lines, Ltd., West Japan Fluid Engineering Laboratory Co., Ltd., and Mikado Propeller Co., Ltd. It has earned high regard all over the world since sales began in 1987, and has been installed on more than 3,700 vessels. In 2021, PBCF was officially certified as the world's "Best-selling Energy-Saving Ship Appendage Brand (Cumulative)." In addition to outstanding sales, PBCF has earned a solid reputation among shipowners around the world for its quality and performance.

Another benefit of PBCF is the reduction of underwater noise in a specific frequency range by 3 to 6 decibels, as confirmed by water tank testing. This led to its selection as a vessel noise reduction technology in the "EcoAction Program" implemented by the Port of Vancouver, Canada. The product not only reduces CO<sub>2</sub> emissions, but also contributes to environmental conservation on a broader scale, protecting whales and other marine mammals from underwater noise.

(Environment and Safety Related Devices Department)

Ship Energy Saving Consultant:  
ISHIN Ship DesignShip Energy Saving Consultant:  
Containership Bow Wind-Shield

## Ship Energy Saving Consultant

### Offering solutions that leverage our know-how backed by years of research and development

MOL Tech works to reduce greenhouse gas (GHG) emissions from vessels, as the MOL Group's strategic R&D subsidiary. We have continually studied energy-saving solutions for many years based on the development of devices such as PBCF, and accumulated a solid record in cooperative research with government agencies, research institutes, and corporate partners, both in Japan and overseas.

Our research encompasses not only energy-saving performance under the water, but wind power as well. We developed the unique "ISHIN ship design" \*1, which reduces wind resistance around the hull and uses lift force generated by wind against the hull to maximize propulsive force, and the "Containership Bow Wind-Shield" \*2, which reduces wind resistance on containerships and also generates thrust.

We are now moving ahead with the development of data-driven energy-saving solutions, in collaboration with MOL's FOCUS Project, which is using big data from vessel operation to open up new horizons in vessel safety, fuel efficiency, and environmental performance.

MOL Tech's data-driven approach will pay off with reduced fuel consumption and in turn lower CO<sub>2</sub> emissions from vessels.

\*1. The "ISHIN ship design" has been adopted on four "FLEXIE Series" next-generation car carriers and two cutting-edge LNG-powered ferries.

\*2. The "Containership Bow Wind-Shield" is installed on the bow of the containership ONE Marvel, significantly reducing wind resistance.

(R&D Promotion Office)

## Energy-saving Rudder with Bulb Fins

### Aiming to improve energy-saving performance with our innovative rudder

This innovative energy-saving rudder with bulb fins was jointly developed by four companies—Japan Hamworthy Co., Ltd., Mitsui O.S.K. Lines, Ltd., Akishima Laboratories (Mitsui Zosen) Inc., and MOL Tech—with the twin objectives of enhancing steering effectiveness and saving energy. The rudder has been patented based on laboratory tests with a model and demonstration tests of a prototype installed on an in-service vessel.

An energy savings of more than 5% was verified with the rudder alone, and further effectiveness was confirmed in combination with the fins and ducts. Ongoing measures to improve performance are building an even stronger record of success for this advanced rudder.

(Environment and Safety Related Devices Department)



Energy-saving rudder with bulb fins

## Ballast Water Variable Organism Analyzer

### The “BALLAST EYE” Ballast Water Variable Organism Analyzer

This inspection device is designed to estimate the number of large and small marine organisms regulated by “D-2 standard in the International Convention for the Control and Management of Ship’s Ballast Water and Sediments, 2004.” It works quickly, generating results in only 15 minutes, and is compact and easy to carry on board. The BALLAST EYE can also be used for Port State Control (PSC) and volunteer inspections.

### “BALLAST CATCH” Ballast Water Variable Organism Sampler

Inspection using with the “BALLAST CATCH” requires the connection of just a single tube, in contrast to previous systems that required at least two specialists to manually concentrate the sample water using a sampling net. It is also compact, lightweight, and requires no power source. It can even be carried onboard in a backpack.

(Environment and Safety Related Devices Department)



“BALLAST EYE”  
Ballast Water Variable Organism Analyzer



“BALLAST CATCH”  
Ballast Water Variable Organism Sampler

## Norsepower Rotor Sail

### Contributing to global environmental protection by using natural energy from wind

The Rotor Sail is an auxiliary wind propulsion system based on the Flettner rotor, which uses wind power, and was developed into a modern, sophisticated system by Norsepower.

In principle, it uses the “Magnus effect,” a phenomenon in which lift force is generated on an object rotating in a flow. The Rotor Sail produces a thrust force due to the Magnus effect, which creates a pressure difference around the spinning cylindrical rotor when wind conditions are favorable.

It generates higher propulsion efficiency because it directly uses natural energy without converting it to electricity, or other types of power. Performance depends on wind conditions, route, voyage period, the number of Rotor sails installed, and so on, but annually it can reduce fuel consumption by an average of 5%~20% with a corresponding reduction in CO2 emissions. As of June 2022, Rotor sails were installed on seven vessels. The sails have been operating reliably, and reports indicate that they are reducing fuel consumption and CO2 emissions on vessels in service.

(Environment and Safety Related Devices Department)



Photo credit:  
Norsepower on the Maersk Pelican deck



Photo credit: Sea-Cargo in an aerial photo of the SC Connector





Eco-SeTRA:  
CG rendering of hybrid-type cruise ship



Eco-SeTRA project



SHE's project

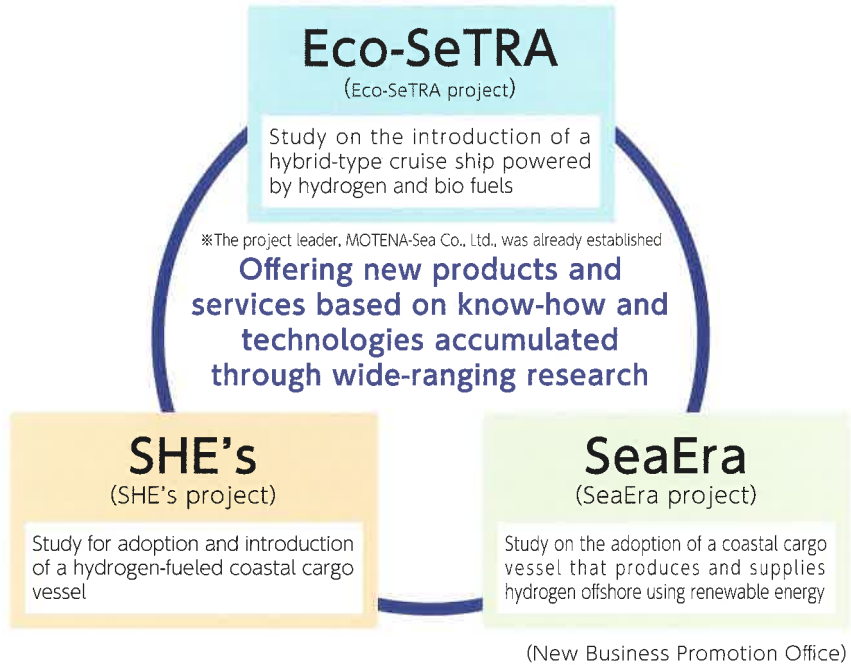


SeaEra project

## New Business Development

### Seizing Times of Change as Opportunities to Create Future Business

MOL Tech is pushing forward with the "Create," "Deliver," "Use" project for hydrogen, an attractive alternative fuel, toward realizing the MOL Group's target of achieving net zero GHG emissions by 2050 through concerted group-wide efforts. It is also exploring new ship supplies and services that contribute to safer vessel operation.



Surveillance cameras



Air-powered Garbage Compactor



LED Searchlight

## Marine Equipment/Products

### Contributing to a cleaner environment and safer ships with advanced devices and products

MOL Tech supplies high-quality ship devices and products that contribute to the protection of the environment and ensure the safe operation of vessels, and adds even greater value through engineering and consulting capabilities. We procure and supply a broad range of equipment and safety-related items for onboard use, drawing upon our extensive know-how and track record to constantly enhance our services.

#### Surveillance cameras

We leverage our expertise to provide system solutions designed especially for maritime use, such as onboard fire safety, cargo handling, and security monitoring. Careful consideration of the on-site situation provides a new dimension of support for your safety measures.

#### Air-powered Garbage Compactor

With proper management and disposal of onboard waste in the spotlight, we developed a garbage compactor powered by compressed air. The simple design requires no electricity, and the device is easy to operate, simplifying the task of sorting different types of waste and reducing disposing costs.

#### LED Searchlight for Anti-piracy Measures

This powerful LED searchlight was developed for anti-piracy measures. Easily portable on deck, it increases your margin of nighttime safety in dangerous waters.

(Environment and Safety Related Devices Department)

## Marine Devices/Products

### Fe-Asy Checker26

Engine trouble caused by abnormal friction on the cylinder liner in the main engine can be monitored with this kit that analyzes total iron content in the engine oil. The colorimetric method enables extremely accurate analysis of iron content by using a specific wavelength filter for a photoelectric colorimeter and a special mix of two kinds of reagents.

### Life rafts

This is a basic but critical product that protects human life during the evacuation of a vessel. It shelters crewmembers from wind and rain to prevent hypothermia. Life rafts are also stocked with food and other essential supplies.

### Immersion suits/Fire-protective clothing

We supply immersion suits that offer high durability and excellent heat retention, and can be donned quickly in an emergency, as well as fire-resistant protective wear and firefighting suits.

#### Product Lineup

##### ●General ship equipment

CCTV surveillance system/Anti-piracy LED searchlight/Automatic tracking BS forecast receiving device/Ship-to-shore image transfer system/Garbage compactor/ Ballast water variable organism sampler/Ballast water treatment system/Emission gas cleaning device/life rafts/Life jacket/Immersion suit/Fire-protecting clothing/Shaft horsepower meter/Screw compressor/Air compressor/Fender/Onboard simple kit that analyzes total iron content/High-pressure washer/Dust filter/Propeller/LNG bunkering related equipment/Hull stress monitoring system/Ultra high-pressure washing device (Water blast machine), other

(Environment and Safety Related Devices Department)



Fe-Asy Checker26



Life rafts



Immersion suits, fire-protective clothing

## Fuel/Lubricant Supply Service

### A broad range of products, from conventional fuels and lubricants to the newest, most advanced options

MOL Tech provides ship fuels and lubricants not only in Japan's domestic market but also worldwide, for coastal ships and ocean-going vessels alike. We have five of our own fuel supply vessels providing swift, efficient service to vessels calling in Tokyo and Osaka bays.

We are upgrading our owned and operated fuel supply vessels to add even greater value, meeting the needs of the times with enhanced with the environmental performance and safety equipment. In Tokyo Bay, we launched our new fuel supply vessel, the Techno Star, in 2017, followed by the Techno Ace in April 2022.

The Techno Ace is Japan's first fuel supply vessel to earn the top rating of five stars for its superior environmental performance in the Ministry of Land, Infrastructure, Transport and Tourism (MLIT)'s energy conservation rating system for Japanese coastal ships. We developed the Ship-to-Ship (STS) auxiliary device that uses electromagnetic force to connect vessels, acquired the patent, and installed it on vessel. Looking toward the next generation of ship equipment, MOL Tech, as a physical supplier of fuels, continues R&D on improved operating safety and innovative fuel supply technology.

In addition, as an initiative on new fuels, we procure and sell LNG fuel in Japan as a bridge solution toward zero emissions in the future. In addition, as an initiative on bio fuel, we conducted a sea trial for mixed fuel combining biofuel and LSA heavy oil using our own fuel supply vessel, aiming at future procurement, transport, and sales.

(Fuel Department)



Fuel supply vessels in Tokyo Bay (Techno Star, Techno Ace)



Bunkering a large ocean-going vessel





LNG-related equipment and supplies

## LNG-related equipment and supplies

### Supporting a safe supply of LNG fuel

MOL Tech offers a full lineup of refrigerated liquefied gases including LNG, based on LNG handling technology developed over the years by the MOL Group.

Today is a period of transition for marine fuels, marked by a shift from conventional heavy oil to environment-friendly fuels including LNG. We support our stakeholders while moving ahead with technological innovation.

(Environment and Safety Related Devices Department)



Dual-fuel diesel engine (ME-LGI)

## Ship parts/Ship's supplies/Ship's store/Ship documents

### Meeting customer needs with high-quality products, technology, and services

MOL Tech offers an amazing selection of products for vessels, from the mooring wires that secure huge tankers to toothpicks for the elegant dining tables of luxurious cruise ships. We also support the operation of all types of vessels with a range of marine products such as paints, high-pressure washing equipment, and special cleaning agents, along with supplies required for safe and smooth cargo handling.

Our network encompasses not only Japan, but ports around the world as well. We can supply about 30,000 items, including our main products—equipment and parts, wire, hawsers, brackets for shipping containers, vehicle lashing belts, and hold cleaning equipment and agents, anywhere, and anytime.

### A comprehensive worldwide supplier of ship maintenance and repair essentials

MOL Tech can reliably supply competitive, high-quality products—and the service to back them up—as well as engineering and technology consulting, based on procurement volume and credibility far beyond the reach of any other company.

As the core company in charge of procurement for the MOL Group, we offer the best prices, manufacturer's warranties, and technical support thanks to the sheer volume of our business and the decades-long trust we have developed with manufacturers.



Heavy lifting spreader



Brackets for shipping containers

### Product Lineup

#### ●Ship equipment manufacturers

IHI Power Systems Co., Ltd. / Alfa Laval / Kawasaki Heavy Industries Ltd. / Sasakura Engineering Co., Ltd. / Suction Gas Engine Mfg. Co., Ltd. / Japan Engine Corporation / Shinko Ind. Ltd. / Taiko Kikai Industries Co., Ltd. / Daihatsu Diesel Mfg. Co., Ltd. / Tanabe Pneumatic Machinery Co., Ltd. / Teikoku Machinery Works, Ltd. / Nakakita Seisakusho Co., Ltd. / Naniwa Pump Manufacturing Co., Ltd. / Nishishiba Electric Co., Ltd. / Nihon Boshoku Kogyo Kabushiki Kaisha / Hitachi Zosen Corporation / HSN-Kikai Kogyo Co., Ltd. / Mitsui E&S Machinery Co., Ltd. / Mitsubishi Kakoki Kaisha, Ltd. / Yanmar Co., Ltd. ,many others

#### ●Ship paint manufacturers

International Paint Co., Ltd. / Kansai Paint Marine Co., Ltd. / Chugoku Marine Paints, Ltd. / Nippon Paint Marine Coatings Co., Ltd. / PPG PMC Japan Co., Ltd., many other

#### ●Ship wire and rope manufacturers (alphabetical order)

Obamaseikou / DSR Corporation / TESAC Corporation / Tokyo Rope MFG. Co., Ltd. / Naroc Rope Tech., many other

#### ●Ship cargo handling equipment manufacturers (alphabetical order)

Ashimori Industry Co., Ltd. / Koei Kinzoku Kogyo Kabushiki Kaisha / GERMAN LASHING / SEC / MACGREGOR / Minato Seiki Iron Works Co., Ltd. / Rexxam Co., Ltd.



Antibacterial coating

## Ship parts/Ship's supplies/Ship's store/Ship documents

### Offering the latest products and services that meet needs of the times

MOL Tech contributes to your sustainable development goals (SDGs) by offering today's most advanced products and services to prevent infection, including sterilizing filters and antibacterial coatings, as well as hydroponic systems for ship.

(Fleet Logistics Department A, B)



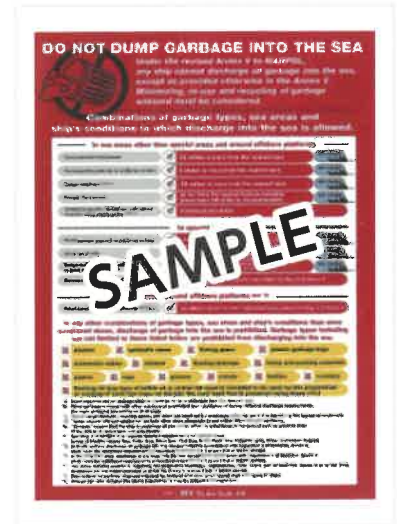
Hydroponic systems for ship

### Marine placards and documents

We offer a wide selection of marine placards and documents that must be posted onboard or prepared in compliance with laws such as the Act for the Prevention of Marine Pollution and Maritime Disasters.

Waste disposal placards, shipboard generated waste antipollution guidelines, waste disposal record logs, emergency oil spill prevention manuals, emergency hazardous liquid spill prevention manuals

(Related Business Department)



MARPOL placard

## Sales of navigational equipment/Other equipment and related services

### Supporting safe voyages

MOL Tech sells new navigational/communication equipment and provides retrofitting, registration, inspection, maintenance, and repairs. We also provide electronic countermeasures for onboard Information Technology (IT)/Operational Technology (OT) cybersecurity and GPS navigation systems.

Our battery of experts supports customers in ship safe operation.

### Installation and maintenance of onboard electronics

MOL Tech offers periodic maintenance and legally required inspections for radio systems, and can arrange emergency repairs in the event of problems with all types of communications equipment, including the Global Maritime Distress and Safety System (GMDSS), and keep sophisticated equipment such as marine radar and compasses functioning at peak performance. We can also update or replace aging equipment.

We have our own licensed technicians to install and repair radio and radar equipment. And we strive to promote the adoption of new systems that leverage cutting-edge digital information and telecommunication technology to monitor signs of failure in a vessel's electric equipment while underway.

We provide our services 24/7 to over 250 merchant vessels to support global ocean logistics.

### Cyber security at sea

The communication environment at sea is still limited compared to land-based capabilities, but is being improved every day thanks to technological innovation and the efforts of telecommunication companies around the world. Most of today's merchant vessels are equipped with computers, which not only provide email and web services like their shoreside counterparts, but also manage advanced functions such as radar and electronic charts, autopilot, and engine controls, and are linked by onboard communication networks.

Risks of cyberattack are growing in step with the digitalization of onboard system, too. Potential crimes include theft of customers' important cargo data or kidnaping data and demanding huge ransoms.

When nautical equipment and engines are invaded by malware, the vessel can be crippled at sea, and in the worst-case scenario, can be at risk of grounding or collision.

We offer various cyber security services to protect today's merchant vessels from cyber-attacks.

We diagnose and address vessels' vulnerabilities to cyber-attacks and continually monitor risks of cyberattacks and so on.

(Electrical Engineering Department)



Cyber security at sea



Supporting safe voyages



Sales of navigational equipment/Other equipment and related services



SecureSync



Anti GPS jamming antenna



BroadSense nano



GPSdome



mRO-50

**GPS jamming/spoofing measures**

MOL Tech offers various equipment for vessels as an agent of OROLIA, a leading global provider of solutions to prevent GPS jamming and spoofing.

GPS is an essential maritime technology, but since around 2016, there have been a growing number of incidents in which criminals jammed the radio communications of vessels underway, and using spoofing technology to send fake positioning information. Protecting vessels from GPS jamming and spoofing attacks requires technology to detect and eliminate radio jamming and install systems that can continually provide accurate positioning data.

MOL Tech protects vessels' positioning systems with OROLIA'S anti-GPS jamming and anti-spoofing technology.

**Business**

- Inspection and maintenance/repair of various types of nautical equipment and radio equipment, installation of new equipment/arrangement and consultation on replacement
- Diagnosis, countermeasures, consultation on onboard cybersecurity
- Supply of products/parts
- Arrangement of radio inspections

ClassNK: Certificate No.22EQ259RC  
 Registered inspector: Registration No. Kan2 No.0015  
 Telecommunication business: Kanto Telecommunication Information Electricity No. 1200

**Ultra-small rubidium atomic clock**

Realizing autonomous vessel operation requires the onboard computer system, which controls various systems, to link their functions while accurately maintaining time synchronization. The rubidium atomic clock achieves this by generating a standard time signal. OROLIA is the leading company not only in GPS positioning signals, but also in the field of precision time signal generators.

OROLIA's ultra-small rubidium atomic clock has been incorporated into all kinds of familiar systems such as mobile phone base stations, terrestrial digital broadcasting stations, and artificial satellites. MOL Tech markets OROLIA'S atomic clocks for various applications, not only for ships, but also for shoreside use.

(Electrical Engineering Department)

## Engineering Services

### Ship maintenance/inspection services

MOL Tech's subsidiary in Singapore supplies parts and provides engineering services for vessels calling and docking in Singapore. We meet a broad range of customer needs for deck, engine, and cargo loading equipment.

#### Offering technical services meeting customers' needs

MOL Tech's subsidiary in Singapore supplies parts and provides maintenance services for vessels calling and docking in Singapore. We meet a broad range of customer needs for deck, engine, and cargo loading equipment.

#### ●Main maintenance work

- Valve Remote Control System
- Level Gauge System: "Cargo, Ballast & Draft Gauge"
- Remote Pressure Indication System
- Viscosity Control System
- Pressure & Temperature Gauges, Flowmeter calibration
- COW Machine Overhauling
- FFA & LSA servicing
- Emerson Radar inspection & repair
- 440v Switch Board inspection & repair

(MOL Techno-Trade Asia Pte. Ltd.)

### Supporting major projects with advanced maintenance technology

MOL Tech meets customer needs by developing advanced maintenance technology, backed by decades of accumulated expertise. One of our most important tasks is supporting massive projects such as shipbuilding and construction of marine structures. Our participation begins at the planning stage. Our advanced technology and comprehensive experience are leveraged in different phases, from building supervision including process management and quality management, to on-site inspections to other related work.

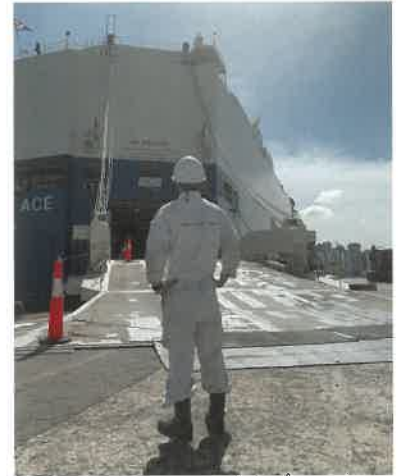
Our work spans the entire marine industry, from Japan's national oil storage project—survey drawings and engineering of eight oil storage vessels, construction supervision, maintenance, and management—to consulting on maintenance and repair of various types of ships from tankers to tour boats. We have earned high regard and immense praise for our capabilities. In 2000, we acquired international quality management certification under ISO9001 (in 2017, ISO9001 compatible with 2015 version), and we continue to operate the system in our repair and management of oil storage vessels.

#### Main services

#### ●Shirashima National Oil Storage Base (storage vessels)

- (1) Study new technology and economics related to mid-to-long-term repair and maintenance
- (2) Supervision of maintenance and management
- (3) Management of overall inspection work at anchorage, which in principle is done every five years on empty vessels.

(貯蔵船技術部)



Vessel maintenance and inspection services (vessels calling/docking in Singapore)



Periodic inspection of instrumentation device



Shirashima National Oil Storage Base



Technical support for offshore oil stockpiling base backed by advanced technology





Gift flowers



SANWA Aerator



BY-FAR Z oil spill cleaning agent

## Other

### Gift flowers

MOL Tech operates Elega Florist website to offer various kinds of gift flowers such as Phalaenopsis Orchids.

### SANWA Aerator

This revolutionary new aerator produces ultra-fine air bubbles and generates powerful mixing force. It has great promise in wastewater treatment, water purification, and other processes.

### Oil spill cleaning agent: BY-FAR Z

BY-FAR-Z is an environment-friendly multi-purpose cleaning agent that alters oil's physical properties to degrade it naturally.

It prevents cross contamination by miniaturizing molecules of oil and quickly hydrolyzing them. It contains a very small amount of surfactant—less than 10%—making it the earth-friendly solution.

With high cleaning power and superior biodegradability, Z-K is effective for vessel galleys, factories, and food processing facilities, and Z-M is the answer for cleaning parts and machinery and treating oil spills.

(Related Business Department)

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