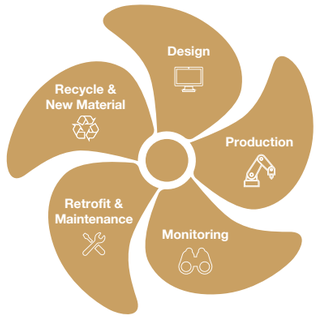
NAKASHIMA

Beyond Propulsion

Contents.



Ships of the world and a future together

Since its foundation in 1926, Nakashima Propeller has been pursuing “what NAKASHIMA can do” for all types of vessels, from small ships to large tankers.

From providing equipment to providing optimal propulsion performance We will transform our mission from providing equipment to providing optimal propulsion performance.
We have defined our business vision “Vision 2026” for our 100th anniversary and set life cycle propulsion engineering (LPE), where propulsion performance is optimized according to a ship’s life cycle, as our ideal.

The company aims to increase the lifetime value (QOL) of ships by helping reduce their environmental impact through propulsion performance optimization solutions, including integrated designs for optimizing propulsion performance, thorough maintenance and repair for maintaining design performance, and propeller retrofitting and verification of energy saving devices according to operational conditions.

As a specialist in moving ships forward, Nakashima Propeller considers each ship as a whole, imagines the happiness of those involved in the ship, and challenges innovation in the world’s ships with technical capabilities that only we can offer.

PRODUCT and SOLUTION

Nakashima Propeller is a manufacturer of marine propulsion equipment, with a leading market share in marine propellers. We are headquartered in the Setouchi region, a major center of the shipbuilding industry in Japan. Nakashima Propeller has been advancing the propulsion performance of ships to provide safety, security, and comfort.

From a propeller manufacturer to an optimal creation company

As a specialist in optimizing ship propulsion performance, we will evolve to accompany ships throughout their lives, providing technologies and solutions that will promote a sustainable future for the world’s oceans.

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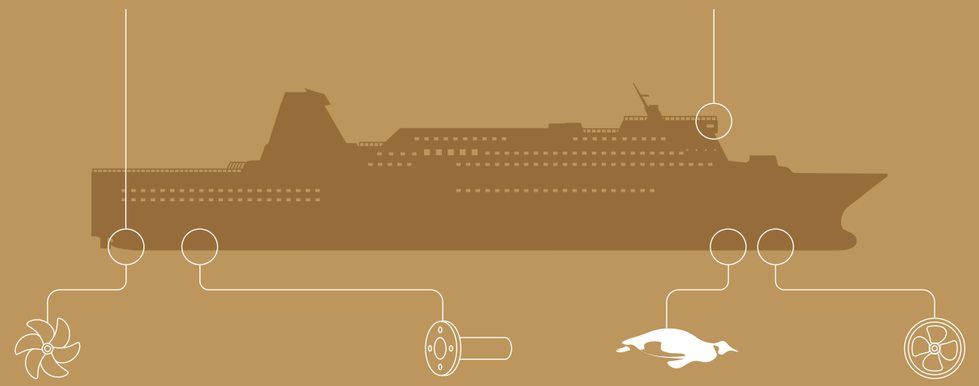

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Hull form design to catch the wave

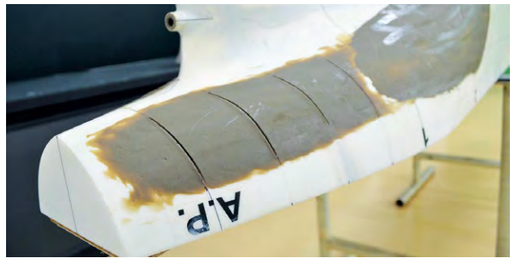
As the energy saving requirements of the shipping industry will continue to increase in the future from both economic and environmental perspectives, further innovative advances are required in the fields of hull and performance design. The results of model tests on numerous energy saving devices show differences in the fuel consumption reduction effects of different hull forms. Through our business alliance with Fluid Techno Co. Ltd., we have gained access to hull form design know-how and focused on the integration of stern, propeller, and energy saving devices, which is an indispensable technical element in the integrated design of stern shapes, propellers, and energy saving devices.

Collaboration with iFTC

The inputs in the initial design of a ship are the ship type, deadweight, main engine information, and planned speed. The designer's role is to achieve the highest propulsion efficiency after meeting these requirements. Fluid Techno (iFTC), a Sasebo-based ship design company, proposes cutting-edge hull forms based on the results of numerous hull form data and model tests developed in the past.

CFD analysis and model test

Although computational fluid dynamics (CFD) calculations have recently become the main method of performance evaluation, we conduct final performance checks through model tests.
Minute irregularities, which are difficult to see using computer-aided design (CAD) software, increase hull resistance. Fairing the surface of a model ship enables the accurate estimation of the resistance of a real ship. In this way, every detail is refined to create the Ultimate hull form.

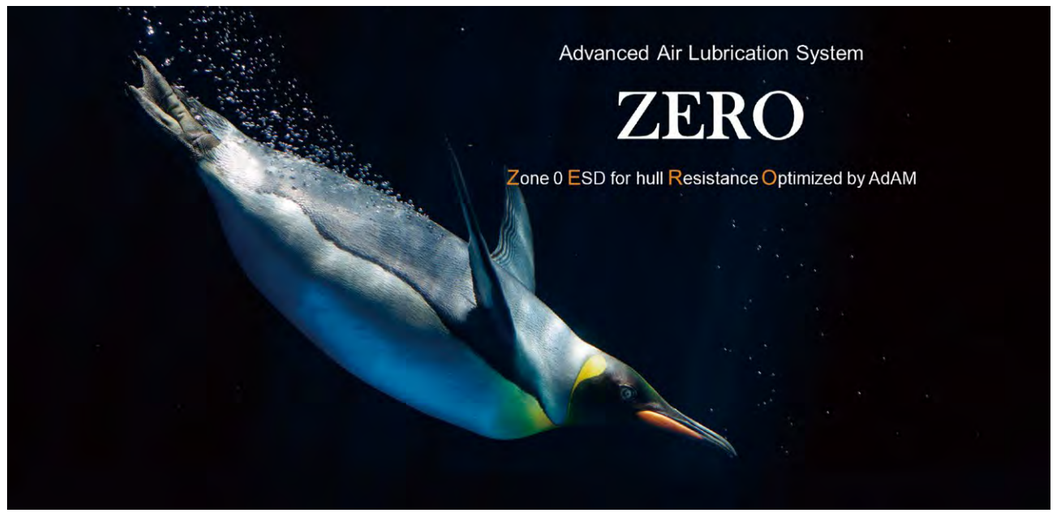


Optimization with Monster package

High-performance propellers and energy saving devices are essential for maximizing vessel efficiency. Their performance also highly depends on the stern shape and Wake distribution. Nakashima Propeller and Fluid Techno share the shapes of hull forms, propellers, and energy saving devices with each other to optimize propulsion performance by considering interference effects.

ZERO air lubrication system

Penguins swim as if they are flying. The small bubbles of air stored in their feathers are released into the water, acting as a lubricant and reducing water resistance. Our ZERO air lubrication system was developed in collaboration with the National Maritime Research Institute (NMRI), which is under the National Maritime, Port, and Aviation Research Institute (MPAT), Japan.
ZERO is a new concept system that blows air intermittently. This air is blown out by a blower from the hull bottom to form a bubble stream on the hull surface. This reduces frictional resistance between the hull and seawater, thereby reducing hull resistance.



Further energy saving

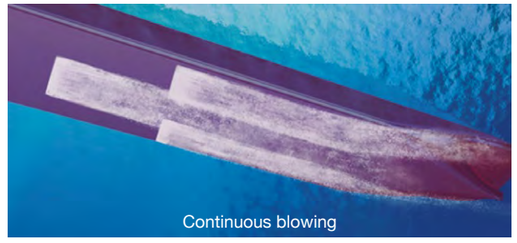
In recent years, air lubrication systems have attracted considerable attention as a technology for improving propulsion efficiency and reducing resistance. The unique air lubrication system ZERO, developed and commercialized by Nakashima Propeller, has a new blowing method and outlet shape that enhance energy saving compared with conventional systems. An average energy saving effect of approximately 3%–10% can be expected at each draft.

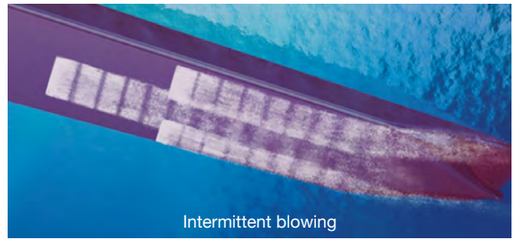
Intermittent blowing system

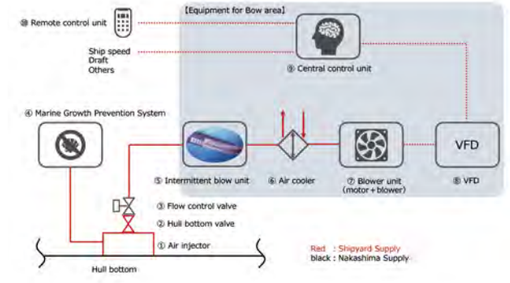
The system uses an intermittent blowing system with a constant air discharge cycle. This blowing method offers greater frictional resistance reduction than the conventional continuous blowing method. Recent research shows that periodic bubble flow is more effective in reducing resistance than continuous bubble flow. Hence, a periodic blowing device is installed onboard and the air outlet is switched sequentially to achieve periodic blowing at the bottom of the vessel.

Low-pressure- drop air outlets

The discharge pressure of the blower must be greater than the seawater pressure at each draft to blow a given volume of air from the ship's bottom. Reducing the air pressure loss in the piping path from the blower to the ship's bottom can reduce the blower horsepower required to blow air out and improve system performance. Our newly developed outlet reduces the pressure loss in forming an air film with constant thickness compared with conventional outlets.







*This diagram shows an example. The system configuration may vary depending on ship type, specifications, and conditions of use.

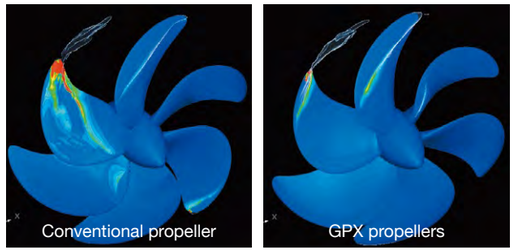
GPX Propeller

SMALLEST BLADE AREA PROPELLER

Design technology with CFD

Highly accurate cavitation prediction is essential for the design of propellers with minimized blade areas, aimed at reducing fuel consumption and maximizing energy savings. Our large-scale CFD system, equipped with 8,000 cores, enables us to conduct various cavitation simulations, leading to high-performance designs in a short timeframe. Furthermore, while many companies invests significant amount of time and money on model tests during development, we leverage our large-scale CFD system to verify energy saving effects at the scale of the actual ship, ensuring delivery of optimal designs.

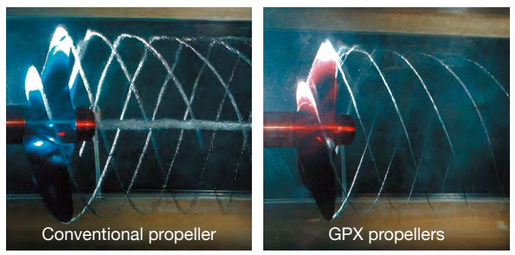
Example of cavitation analysis via CFD



Integration of smallest blade area and NHV technology

The GPX propeller, born from a joint research with the Ministry of Land, Infrastructure, and Transport as part of the latter's greenhouse gas (GHG) reduction project, integrates minimized blade area with NHV (non- hub-vortex) technology further improves the performance by reducing frictional resistance through minimizing the blade area and utilizing the hub vortex recovery effect of NHV technology, which separates our GPX propellers apart from conventional ones.

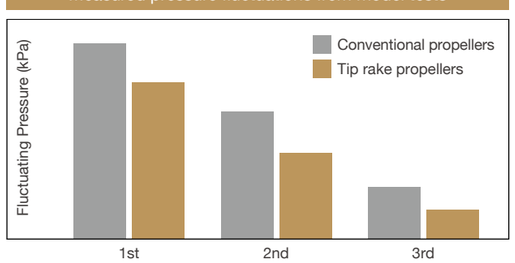
Propeller hub vortex cavitation comparison



Tip rake for cavitation reduction

Generally, a reduction in the propeller blade area increases cavitation. However, the GPX propeller, with its tip rake design, overturns this conventional wisdom. The tip rake, which is the angle formed by the locally curved tip of the blade, suppresses cavitation, reducing erosion risk and pressure fluctuations. Our tip rake technology simultaneously achieves the generally contradictory phenomena of a small blade area and improved cavitation performance.

Measured pressure fluctuations from model tests



Verification on actual vessels

The efficiency of the small blade area propeller has been verified not only in calculations and model tests but also on actual ships. These details, including service records, were presented at the Conference of the Japan Society of Naval Architects and Ocean Engineers.

Research on a smallest blade area propeller 1st report; the design, model tests and full scale measurements of a small blade area propeller / Conference Proceedings of the Japan Society of Naval Architects and Ocean Engineers, Vol. 16, No. 2013S-GS4-9

Research on a smallest blade area propeller 2nd report; the design, model tests and full scale measurements of a smallest blade area propeller / Conference Proceedings of the Japan Society of Naval Architects and Ocean Engineers No. 16, 2013S-GS4-10

Performance verification on actual vessels

Type of vessel	Comparison of efficiency with presently equipped propellers (%)		
	Propeller open water efficiency	Self propulsion test	Actual vessel/sea trial
Chemical tanker	+2%	+4%	+4.5%

Tamashima factory

Propellers should be manufactured exactly as designed to optimize their propulsion performance. High-performance propellers are produced using state-of-the-art equipment (including high-precision blade milling machines and propeller overturning machine for enhanced safety), skilled workers who can recognize 1/100 mm errors, and production management that utilizes the Internet of Things.

In addition, the scope of Nakashima Propeller's quality control is not limited to inspection upon completion. Product quality is monitored in all stages, from order receipt (incoming inspection) to product completion (inspection of the finished product). Moreover, quality is ensured by inspecting and verifying products that pass standards until they are delivered to the customer.

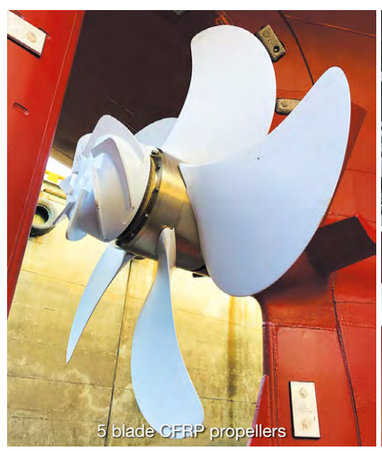
Blade-surface-milling machines

Propeller overturning machines

CFRP propeller

Carbon Fiber Reinforced Plastics

Nakashima Propeller developed the world's first CFRP propeller for general commercial vessels. In 2015, for the development of the world's first propeller made of CFRP for energy saving in merchant ships, the company was awarded the Prime Minister's Prize at the 6th Monodzukuri Nippon Grand Awards. In 2017, the company installed a large X-ray computed tomography (CT) system for non-destructive testing to enhance product safety and reliability.



Features

(i) Light weight

mass of approximately one-fifth of that of conventional copper alloys, reducing weight and improving installation process
Reduced moment of inertia, Light shafting system

(ii) High strength

Higher fatigue strength and reliability in seawater than those of conventional metal materials

(iii) Low vibration

Vibration reduction due to low weight and high Attenuation rate
Improved onboard living conditions

(iv) Overload reduction

Blade shape deformation for matching flow and reducing overloading, such as in rough weather

(v) High efficiency

High efficiency due to larger diameter realized by light weight
Cavitation suppression by blade tip deformation

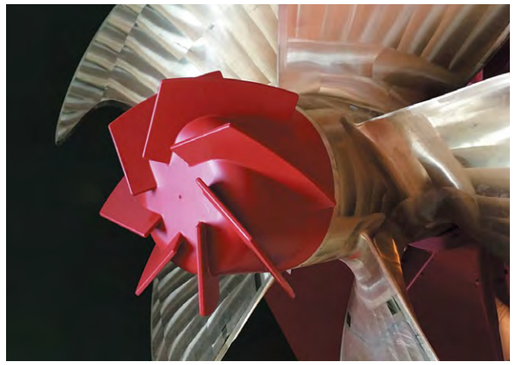
(vi) Improved maintainability

Stocking of spare blades, enabling quick response in case of damage
No expertise required for replacement, Reparable

ECO-Cap

Energy saving device for Zone-2

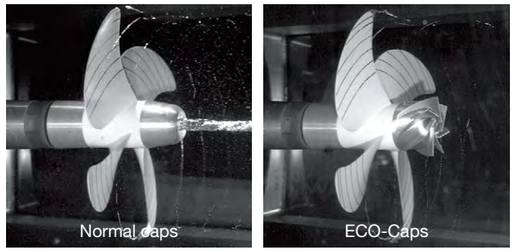
ESD ENERGY SAVING DEVICES 1~3% Improvement



Hub-vortex-diffusing propeller cap

The circumferential flow generated from the trailing edge of the propeller generates a hub vortex at the aft end of the cap, which dissipates energy. Therefore, over 500 different cap shapes were trial-designed to identify one that can diffuse the hub vortex and recover the energy losses. Numerous trial designs showed that a cap with multiple wings was the most effective, so this became the prototype for the ECO-Cap. The diffusion of hub vortices was confirmed in model tests in a circulation water tunnel

Visualization of hub vortices via model tests

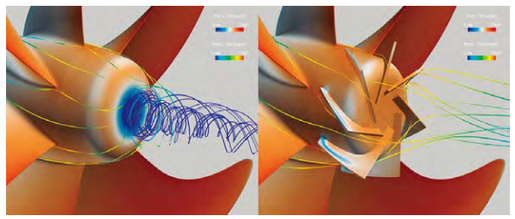


Increase of propeller cap thrust

The pressure distribution at the rear end of the cap shows that a normal cap has greater resistance due to negative pressure, whereas the ECO-Cap generates thrust due to positive pressure, resulting in increased propulsive force. In model tests, the efficiency of an ECO-Cap is higher by approximately 1.0%–1.3% than that of a normal cap.

Although model tests generate only weak hub vortices and smaller energy losses than actual vessels, the energy loss recovery (amount of efficiency improvement) induced by the ECO-Cap is expected to be greater in actual vessels.

Pressure distribution at aft end of cap
(blue: negative pressure; red: positive pressure)

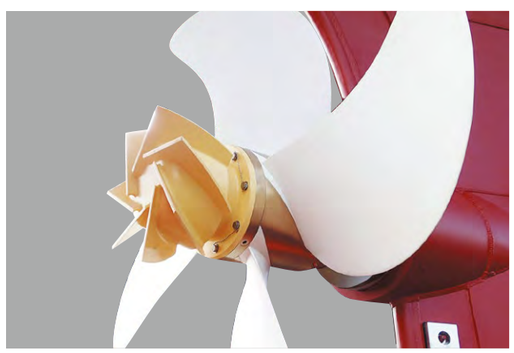


Normal caps ECO-Caps

Energy saving in actual vessels

The ECO-Cap for actual ships uses very thin blades made of FRP to reduce resistance; these are mounted on a cap body made of copper alloy. The use of FRP material also minimizes the mass difference with the standard cap.

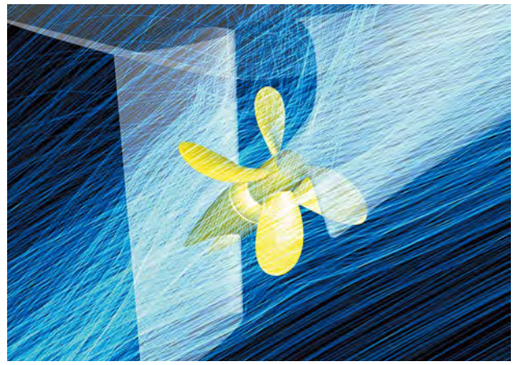
Verification checks of the energy saving effects of installing ECO-Caps on existing vessels showed an improvement in fuel consumption of approximately 2.8% compared with that before the ECO-Caps were installed.

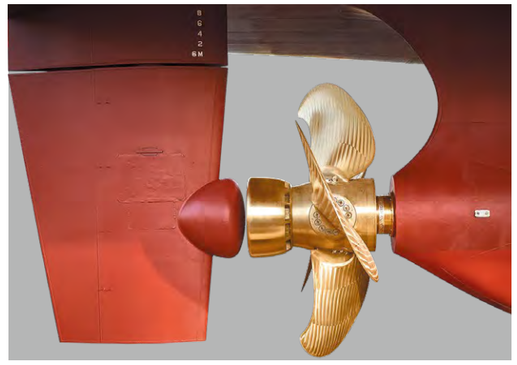


Ultimate rudder bulb

Energy saving device for Zone-3

ESD ENERGY SAVING DEVICES 3~6% Improvement





Rudder bulb closest to the propeller

Three main factors contribute to the efficiency gains made by rudder bulbs.

(i) Reduction of hub vortices occurrence

(ii) Increasing wake gain and uniformity of propeller wake

(iii) Improved interference effects between propeller and rudder

As a rudder bulb closer to the propeller is more effective, the Ultimate rudder bulb has a rounded cap to ensure that the bulb is positioned closest to the propeller.

Ultimate rudder bulb profile

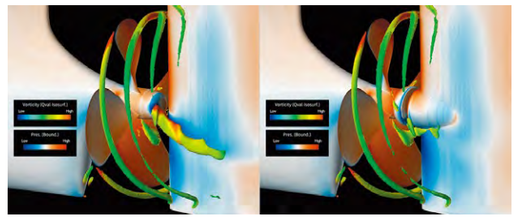
Normal rudder Ultimate rudder bulb

Increase of rudder thrust

A strong hub vortex, which normally causes energy losses at the rudder, is generated from the aft end of the cap toward the port side of the rudder. A strong hub vortex hitting the rudder leads to increasing rudder resistance. The Ultimate rudder bulb reduces rudder resistance by increasing the negative pressure at the leading edge of the rudder as the bulb head suppresses the hub vortex.

Self-propulsion test results on the Ultimate rudder bulb on a 208BC model ship showed an efficiency improvement of over 5%–6%, and the lift–drag ratio was comparable to that without the rudder bulb in a rudder angle change tests.

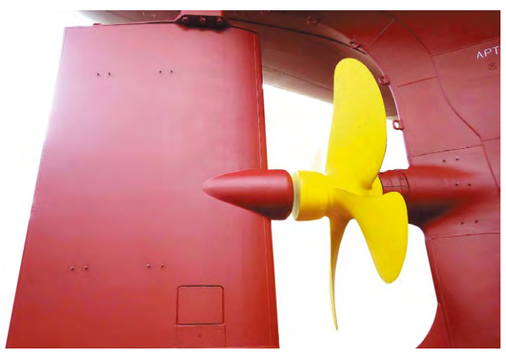
Example of hub vortex analysis by CFD



Normal rudder Ultimate rudder bulb

Delivery record

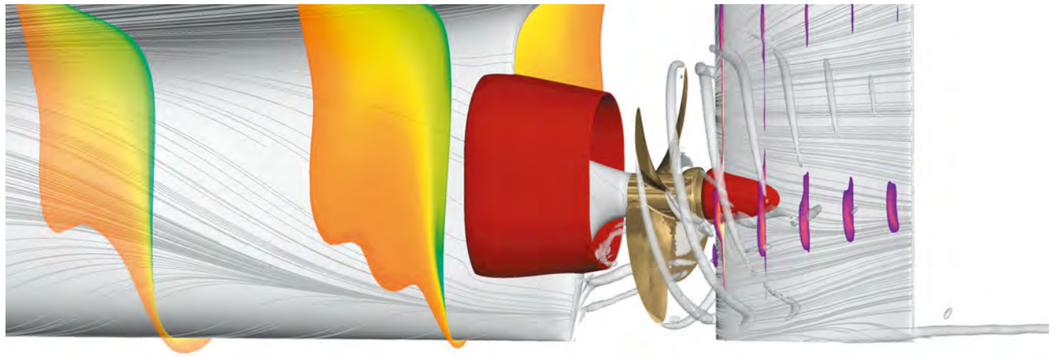
Several existing vessels in service are using the Ultimate rudder bulb. They are used in both low- and high-speed vessels and on both fixed- and controllable-pitch propellers.



Neighbor duct

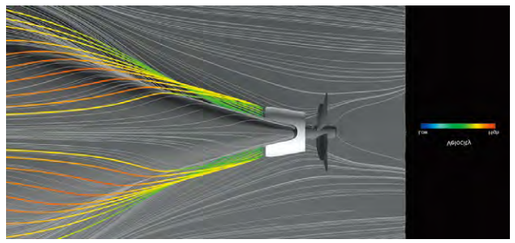
Energy saving device for Zone-1

ESD ENERGY SAVING DEVICES 4-7% Improvement



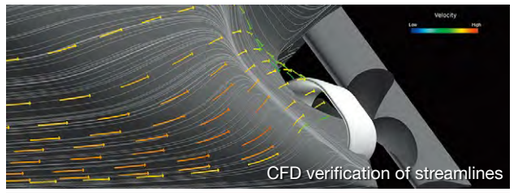
Generate propulsion by bilge vortices

Neighbor duct is an energy saving device (patented), focusing on reducing hull resistance by using the flow along the hull sides to generate thrust in the forward direction. A Neighbor duct, a completely new type of stern duct, is a longitudinal oval and installed close to the stern. Neighbor ducts are designed using hull geometries and model test results, such as findings of barehull self-propulsion tests and resistance tests and wake field measurement.

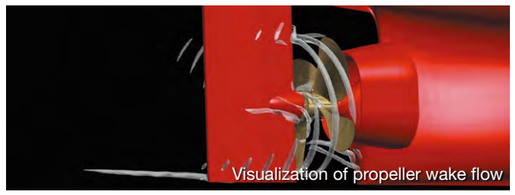


Increase of duct thrust

CFD analysis is performed using hull geometries to check the streamlines under barehull conditions. Next, a parameter survey of the duct width, angle of attack, mounting position, and other parameters of the Neighbor duct is conducted to optimize the duct shape. Further CFD self-propulsion calculations are then performed to check detailed fluid phenomena, such as changes in the self-propulsion factor and the longitudinal vortex behavior, to complete the design.



CFD verification of streamlines

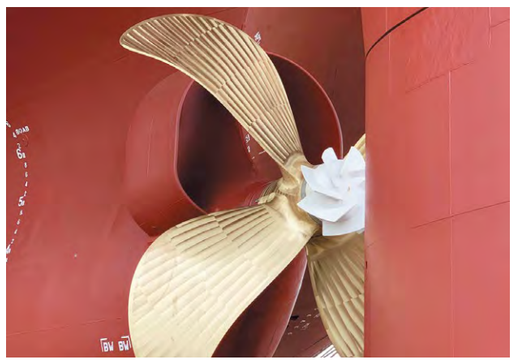


Visualization of propeller wake flow

Energy saving effects on actual ship

A horsepower reduction of 4.7% was obtained in self-propulsion tests conducted in collaboration with the NMRI of the MPAT using an 82BC model ship. The thrust reduction coefficient was effectively improved, verifying the effectiveness of the increased thrust provided by the Neighbor ducts.

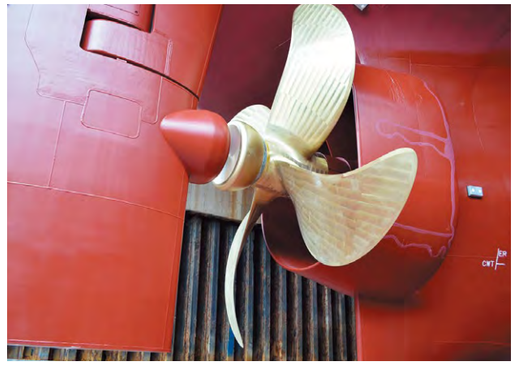
Test results obtained by installing the Neighbor ducts in an actual vessel confirmed the same energy saving effects as in the model tests.



Monster package

Total optimization with propeller and ESDs

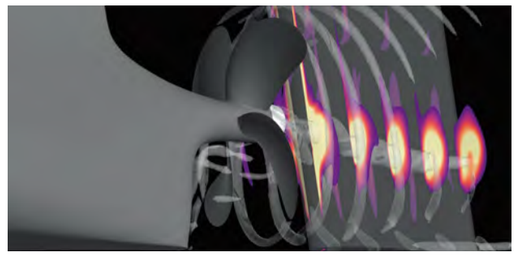
ESD ENERGY SAVING DEVICES 8.7% Improvement

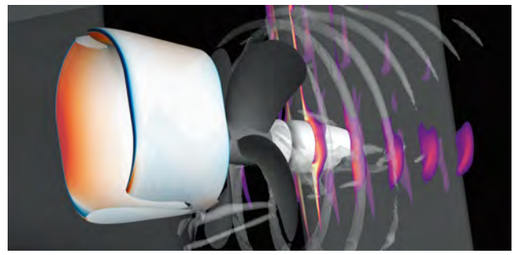


Integrated design with energy saving device

Product development accelerated following the success of the ECO-Cap. The company developed the Ultimate rudder bulb, which reduces the hub vortices and swirls generated by the propeller, and the Neighbor duct, which uses the bilge vortices generated at the stern to generate propulsion. These energy saving devices are combined in the Monster package to further improve propulsion.

The ongoing co-creation efforts between Nakashima Propeller and Becker Marine Systems, Germany, is accelerating overall optimization via CFD and model testing, with both companies sharing the geometries of propellers and energy saving devices with each other.
In self-propulsion tests conducted by the NMRI, the energy saving effect obtained when the energy saving devices were used alone was 2.9% for the ECO-Cap, 3.9% for the Ultimate rudder bulb, and 4.7% for the neighbor duct. Combining the Ultimate rudder bulb and neighbor duct achieved energy savings of 8.7%.





Composite stator

NEW CONCEPT STATOR for Zone-1

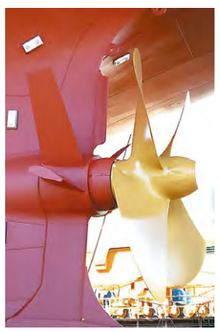
ESD ENERGY SAVING DEVICES 4-5% Improvement

Collaboration with iFTC

Variable pitch stator by GFRP

The Eco-Stator is a stator on the stern tube in front of the propeller. This energy saving devices, manufactured by Fluid Techno (iFTC). improves thrust by radially mounting (wing-like plates) and controlling the flow at the stern.

The Composite Eco-stator made of glass fiber reinforced plastics (GFRP) was jointly developed by Nakashima Propeller and Fluid Techno. Taking advantage of the characteristics of GFRP material, the angle of attack can be changed by twisting the stator to design the optimal shape. The stator can then be easily attached to the hull using steel shoes. (Jointly patented)

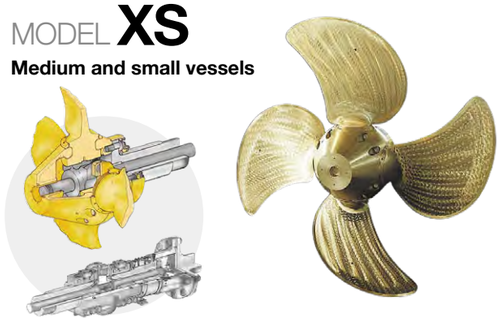


Controllable-pitch propeller

CONTROLLABLE PITCH PROPELLER

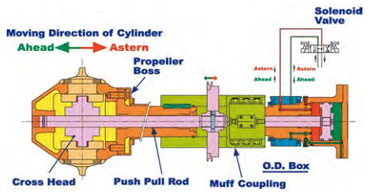
MODEL **XS**

Medium and small vessels



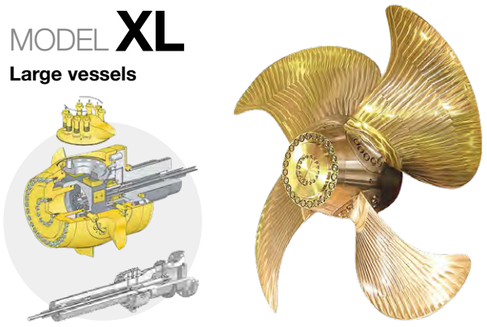
This type is mainly used in small and medium vessels. The hydraulic cylinder controlling the blade angle is in the intermediate shaft on the inboard side of the vessel. The oil from the pump of the hydraulic unit enters the oil distribution (OD) box of the cylinder shaft through a solenoid valve. When the pitch control handle is moved, a signal is produced and pressure oil enters the cylinder from the OD box via a pilot check valve, pushing the piston. Movement of piston is transmitted to the crosshead via the push-pull rod, which modulates the blade. This simple construction reduces maintenance costs. The inside of the hub is lubricated using grease, eliminating the possibility of oil leakage from the inside of the hub and thus any risk of environmental pollution.

[Schematic diagram]



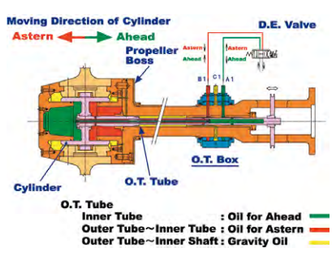
MODEL **XL**

Large vessels



This type is mainly used in large vessels. The hydraulic cylinder controlling the angle of rotation is installed inside the propeller hub on the outside of the vessel. The hydraulic cylinder moves the propeller blades directly to change their angle. As no spindle torque acts on the OT Tube, OT Tube will not be deformed and the accuracy of blade angle control is superior to that of rod systems. Furthermore, the use of proportional control valves ensures smooth, accurate blade angle control, even minute blade angle control, such as Auto Load Control. The machine is equipped with a double hydraulic system consisting of normal and emergency control valves and pumps for main and auxiliary use..

[Schematic diagram]



What is a controllable-pitch propeller?

This propeller facilitates forward, stop, and backward movements by finely controlling the blade angle. In combination with side thrusters, this propeller facilitates smooth entry/exit and berthing/unberthing operations, which require frequent changes in vessel speed. It can also instantly respond to emergency stops, from ahead max to astern max. Blade angle adjustment allows the vessel speed to be adjusted flexibly while keeping the engine running at the most efficient load, thus reducing fuel consumption and nitrogen oxide emissions. Because of these advantages, controllable-pitch propellers are widely used in a wide variety of vessels, including fishing vessels, tankers, ferries, and tugboats. A unique design method derived from our know-how on fixed-pitch propellers is used to determine the optimal pitch and camber distributions, resulting in a highly efficient propeller. The blade cross section is shaped to facilitate a flat pressure distribution on the propeller surface, thereby improving cavitation performance.

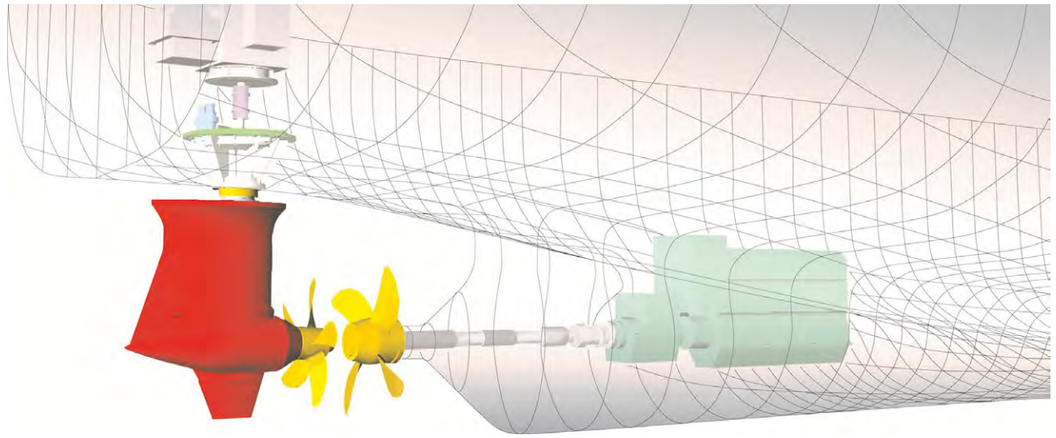
Features

(i) The main engine power can be operated in a manner that makes effective use of the main engine power and minimizes fuel consumption.
(ii) Continuous control of the blade angle from ahead max to full astern max results in efficient operation, excellent stopping performance, and reduced berthing/unberthing times.
(iii) Fuel consumption is reduced by operating at the optimal efficiency point, which comprehensively considers propeller propulsion efficiency, main engine fuel consumption, and other factors.
(iv) The required ship speed or thrust can be obtained, even for vessels with highly duty conditions, such as trawlers and towing vessels.
(v) The torque rich of the main engine is avoided by reducing the propeller pitch angle during operation in rough weather compared with normal operation.

Product Lineup | Main propulsion

Azimuth propeller

AZIMUTH THRUSTER



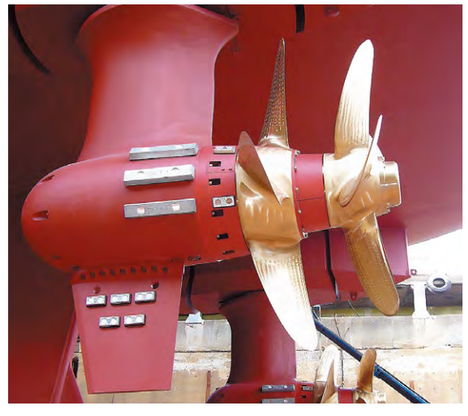
Electric propulsion systems are attracting increasing attention as environmental concerns grow. Nakashima Propeller developed the tandem CRP (contra-rotating propeller) propulsion system and the contra-rotation azimuth propulsor.

Tandem CRP propulsion system

The tandem CRP propulsion system consists of an azimuth propeller as a rudder behind a normal controllable-pitch propeller, with each propeller inverted against each other to form a contra rotating propeller. Propeller efficiency is improved by the double-reversing effect, where the turning energy of the front propeller is recovered by the rear azimuth propeller. Aside from improving redundancy through the duplicaqted propulsion system, the azimuth propeller, which acts as a rudder, can generate 360° thrust in any direction, thus dramatically improving the ship's maneuverability. This system is particularly effective for coastal vessels that enter and leave ports frequently. Hybrid types, in which the forward propeller is driven by an engine and the rear azimuth propeller is driven by an electric motor, can reduce electrical conversion losses compared with systems that are entirely driven by electric motors.

Double-reversing propeller azimuth propulsion system

For azimuth propulsors, which can dramatically increase a ship's maneuverability, We developed a system combining contra-rotating propellers. Two propellers are placed on the same axis and rotated against each other. In this manner, the rotating flow generated by the forward propeller can be recovered by the rear propeller, reducing propeller energy loss and improving propulsion efficiency.



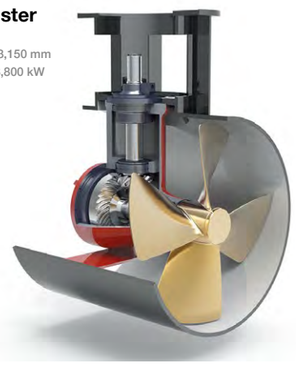
Tunnel thruster

TRANSVERSE THRUSTER

MODEL **NT-F**

Fixed pitch thruster

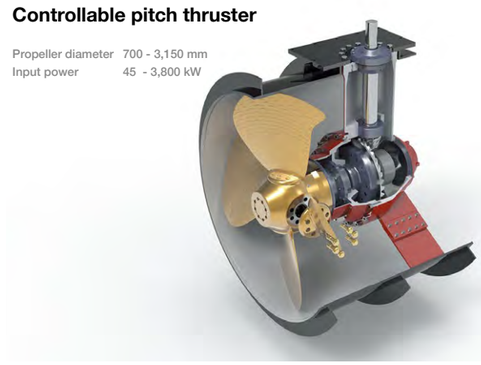
Propeller diameter 295 - 3,150 mm
Input power 10 - 3,800 kW



MODEL **NT-C**

Controllable pitch thruster

Propeller diameter 700 - 3,150 mm
Input power 45 - 3,800 kW



Powerful thrusters with improved thrust

The optimal blade shape for the thruster was selected from numerous design shapes using analysis technology based on a large-scale CFD system developed. The result is a compact, powerful thruster whose nominal thrust is approximately 20% greater than those of our previous products. The compact design not only allows for greater freedom of placement, but also enables the thrusters to be positioned further forward of the hull, which increases the turning moment of the hull and helps improve maneuverability. The small tunnel bore also helps reduced hull resistance.

Optimal response to every requirement

Special propeller shapes have been developed for considerate underwater noise, such as research vessels, to reduce such noise. A special seal enables thruster operation without usage restrictions, even in the presence of a large draft difference during operation, such as in heavy-lift vessels. We can provide optimal designs based on our experience with all types of vessels. Special wing thruster

Special propeller shapes thruster

Reliable construction based on a proven track record

Since 1976, when the company started manufacturing tunnel thrusters, it has been consistently developing, manufacturing and marketing highly reliable high-performance thrusters, with more than 7,000 units having been adopted. The knowledge we have developed on the basis of our experience in manufacturing numerous products has enabled us to create highly reliable thrusters. Our thrusters can be used safely as thruster operation systems, such as peripheral equipment.

- We have simple and robust units for both controllable pitch and fixed pitch types. The thruster body can be taken from hull easily, facilitating maintenance and inspection on-shore.
- The propeller shaft seals is of the same type as the main propulsion stern tube seal. Biodegradable oil (EAL) can be used to comply with the US Environmental Protection Agency's Vessel General Permit. The hydraulic and lubricating oils used for blade angle control are used together, and are thus easy to manage.
- The standard header tank for controllable pitch thrusters are fitted with a high-performance filter to keep the lubricating oil and controllable pitch hydraulic oil clean.
- The remote control unit of the controllable pitch thruster is equipped with a liquid crystal display(LCD) screen, enabling centralized control of a substantial amount of information. Operators can use the console stand on the ship's bridge to circum. It is used to recognize the status of the thruster system, including peripheral equipment, and maintain safe operation.
- Service agencies offering maintenance and after-sales support can be found in Asia, the Middle East, Europe, Africa, North America and South America.

Product range

MODEL **NT-F**

Fixed pitch thruster

Thruster Model	Input Power(kW)
TFN-15S	27
TFN-25S	45
TFN-50S	57
TFN-75S	83
NT-F005	140
NT-F007	215
NT-F010	285
NT-F020	365
NT-F030	520
NT-F040	670
NT-F050	830
NT-F060	1,005
NT-F070	1,250
NT-F080	1,500
NT-F090	1,800
NT-F100	2,150
NT-F110	2,500
NT-F120	3,000
NT-F130	3,800

MODEL **NT-C**

Controllable pitch thruster

Thruster Model	Input Power(kW)
TC-70N	115
NT-C010	285
NT-C020	385
NT-C030	520
NT-C040	670
NT-C050	830
NT-C060	1,005
NT-C070	1,250
NT-C080	1,500
NT-C090	1,800
NT-C100	2,150
NT-C110	2,500
NT-C120	3,000
NT-C130	3,800

This lineup table shows the approximate output of the drive unit when used as an auxiliary propulsion unit (short time, intermittent operation specifications). Ship classification, continuous operation specifications and special specifications are considered separately. Please contact us for details. Some models include previous types.

*Elements are subject to change without notice.

Integrated Maneuvering System **NATA*x***

INTEGRATED MANEUVERING SYSTEM

Single control unit in vessels

The integrated maneuvering systems integrates the control of all propulsion equipment (actuators) into a single control unit in vessels that require simultaneous operation of multiple propulsion systems (main propulsion, transverse thrusters and rudders).

With the use of a three-axis joystick mounted on the operating unit, the propulsion equipment are controlled simultaneously to provide the optimal thrust distribution in the vessel movement direction.
The liquid crystal display (LCD) on the operating unit shows all information related to unberthing and berthing.

This system simplifies to control of propulsion equipment. It leads to shorten the time required for maneuvering and reduce the operator's workload. In addition, the operator maneuver with keep the heading direction and hull position by connecting this system to common onboard navigation equipment (GNSS, gyro sensors, anemometers, and speedometers).

NASCA operational monitoring system

Nakashima Ship Cruise Assist System

The need to monitor operational data to reduce GHG emissions from ships and fuel consumption in actual operations is increasing. Moreover, improvements in the maritime communications environment are driving the introduction of monitoring systems. The NASCA provides real time information about vessel speed, horsepower, fuel consumption and propeller efficiency.
In the future, the company intends to expand its functions for use in safe, energy saving operations, such as the monitoring of the transverse metacenter height (GM an indicator of encountered sea conditions and dynamic vessel resilience), in conjunction with Fluid Techno's Oceanus system for estimating sea conditions in ship encounter areas, depending on the purpose.

NASCA configuration system

NASCA (Nakashima Ship Cruise Assist System)
The basic features of NASCA are a high-precision Shoyo Engineering shaft horsepower meter and an application with a simple interface, which makes it easy to check operational data using a smartphone or a tablet in a telecommunications environment.

Axial horsepower gauge by SEC

Shoyo Engineering Co Ltd(SEC) in Ayase, Kanagawa Prefecture.

The shaft horsepower meter measures the transmitted horsepower from the main engine to the propeller by measuring the torsion of the rotating shaft. When torsion occurs, the change in the tension of the metal film inside the sensor mounted between the sensing rings is detected. This change is converted into the amount of torsion and the torque is calculated. The shaft horsepower meter, is used to determine the operating status of the vessel and the operating status of the main engine accurately on the basis of horsepower, thereby increasing vessel safety. The data from the shaft horsepower meter can also be used to support an optimal operation schedule.

Oceanus marine weather estimation system for ship encounters

Fluid Techno Co. Ltd. (iFTC) in Sasebo, Nagasaki.

Oceanus measures the motion of ships in operation in real time and estimates the sea conditions encountered (wave height, period, and direction).

Shaft horsepower and thrustload meter

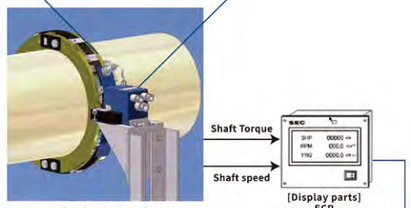
Shoyo Engineering Co., Ltd.

Detector Ring

- **Tolerance of dimension of detector ring : +/-0.5%**
- Measuring shaft diameter Minimum 50mm~Max. 1000 mm
- Available to install in narrow space (Shaft length 200mm or more)
- Installation space on the shaft 160mm + Service space (About 50mm)
- Available to installed on the high-speed of shaft rotating vessel

Contactless Power Supply Unit

- Power supply to the sensor by the non-contact
- Transmission of the sensor signal by wireless
- Available Power supply voltage AC100~220V
- Attached Speed detector sensor (Proximity sensor or infrared photo sensor)



Data Processing Display Unit

- **SE104CN:** only display SHP(kW), Shaft Speed (min⁻¹), Torque(kNm)
- **SE207CN:** can be display a performance curve, the related FO consumption and the other performance data
- Automatic input of zero point
- Selectable of the sampling time (0.1/1/5sec)(20msec is option)
- Available to communicate with the external devices
- Specification customizable upon request

The Shoyo Engineering shaft horsepower meter consists of a sensing ring mounted on the intermediate shaft, an electromagnetic induction unit (vibrates the metal film of the horsepower sensor and supplies power for transmitting and receiving the sensor signal), and a shaft horsepower and torque calculation and processing unit that calculates the horsepower and torque from the rotation signal and sensor frequency signal transmitted from the shaft horsepower meter sensing unit.

A data processing and display unit calculates and displays the horsepower and torque from the rotation and sensor frequency signals transmitted from the shaft horsepower transducer detection unit. The shaft horsepower meter can also be installed in vessels in service, for which installation at the port of call is also possible. The shaft thrust load cell measures the compressive (longitudinal) strain on the shaft caused by propeller propulsion.
With the shaft thrust load and torque measured by the shaft horsepower meter, propulsive performance can be accurately determined. Furthermore, any change in propulsive performance can be assessed by determining whether the cause is an increase in hull resistance or a reduction in propeller efficiency.

When installed together with the shaft horsepower meter and the shaft thrust load meter, the NASCA enables the timing of maintenance to be determined. This not only reduces maintenance costs, but also enables fuel efficiency and safety monitoring through the constant monitoring of propeller efficiency.

Axial system

SHAFTING SYSTEMS

Nakashima Propeller also supplies shafting systems. The shafting system transmits the rotary power of the main engine to the propeller while transmitting the thrust generated by the propeller to the hull. It consists of a shaft body, bearings, stern tube sealing device and other parts. We offer the optimal combination of oil and seawater-lubricated types, as well as along with flexible responses to customer needs.

Seawater lubricated system

The seawater lubricated system takes in seawater from the outside and pumps it into the stern tube for cooling and lubrication. The pumped seawater passes through the stern tube and is discharged overboard. The seawater lubricated system is most commonly used in small vessels and cargo ships in classes of 10,000 - 20,000 tonnes and below.

Oil lubrication system

In the oil-lubricated type, the stern tube is filled with lubricating oil, which is circulated for cooling and lubrication. Most large vessels have oil-lubricated systems.

Maintenance

Nakashima Propeller attaches great importance to LPE, which accompanies the life cycle and enhances the QOL of a ship. We support propulsion optimization through maintenance and repairs to maintain propulsion performance at the time of design, propeller replacement in accordance with operating conditions, and verification of energy saving devices. A worldwide service and support system is in place to maintain the health of our vessels at all times and provide reliable support to our customers worldwide.

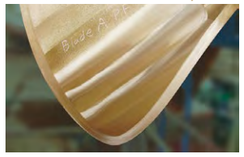
Advanced repairs by craftsmen

Propeller repair (Ni-Al-Bronze)

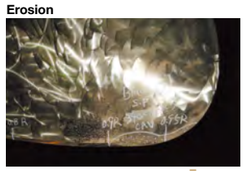
1 Straightening of bend | **2 Reconditioning of cavitation erosion** | **3 Build up welding to cracks, missing etc** | **4 Welding with new blade tip**

Bending

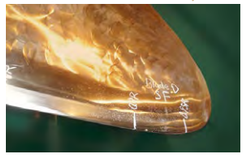
after repair



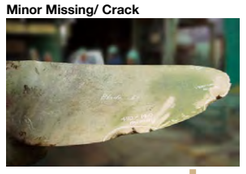
Erosion



after repair

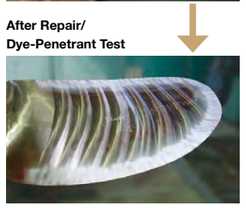


Minor Missing/ Crack

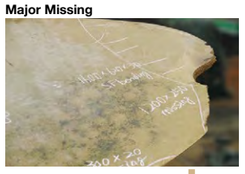


Build-up welding

After Repair/ Dye-Penetrant Test

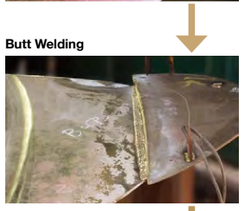


Major Missing

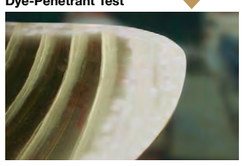


Welding Preparation

Butt Welding



After Repair/ Dye-Penetrant Test



Propellers must be repaired according to the appropriate procedures by experienced professional technicians. With over 90 years of experience and expertise in propeller manufacturing technology, we can recommend the most appropriate and effective measures for each customer's situation and support them throughout the repair work.

[Information to be provided at the time of inquiry]

- ☐ Damage reports (such as damage photos, damage diagrams, and diver reports)
- ☐ Current operational status of the vessel (data on the main engine, vessel speed, and presence or absence of abnormalities "such as vibrations and unusual noise").

[Support contact details]

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Cavite Economic Zone, Rosario, Cavite, Philippines, 4106

NAKASHIMA PROPELLER MARINE ENGINEERING (SHANGHAI) CO.
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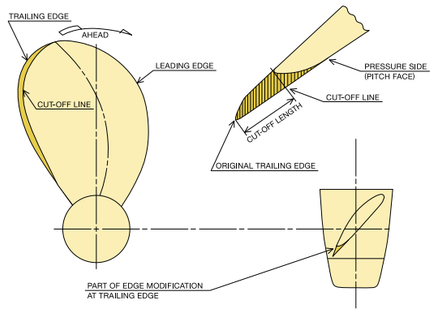
https://www.nakashima.co.jp/contact/service

Blade edge Modification

Rotational improvement

5% Improvement

As a ship ages, its main engine may develop torque rich. This increases the exhaust temperature of the main engine and fuel consumption. Edge cutting is recommended as the most reliable and effective measure to eliminate this torque rich. This method involves machining and shaping the trailing edges of the propeller blades and can increase the rotational speed by up to approximately 5%. This method, which has been established over many years of our propeller manufacturing technology, has been used in many vessels received well by our customers, leading to improved maintenance of the engine.

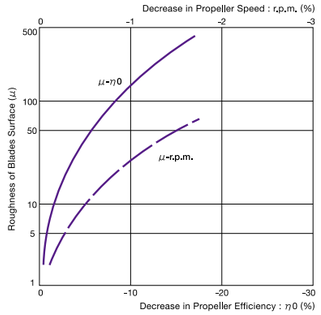


Propeller Polishing

Energy saving grinding of propellers

3.5% Improvement

Although differences occur depending on operating conditions, many vessels suffer from marine organisms on the propeller blade surfaces. Surface roughness increases over time, resulting in a reduction in propeller propulsion efficiency. Maintenance should be performed to clean and polish propellers and improve blade surface roughness thus, reducing fuel consumption. According to various data and tests a propeller with a clean, polished surface (roughness of 12 μRZ approximately 3 μRa) has a propeller efficiency difference of approximately 3.5% compared with a rough, grinder-finished surface (50μRa, approximately 10 μRa).



Propeller replacement

Retrofit by latest design

5% Improvement

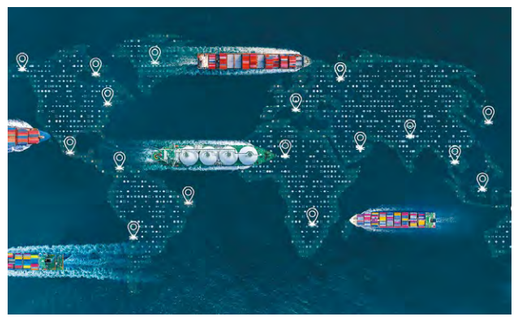
Propellers are designed under conditions that are optimized by considering when the main engine is at maximum power. However, in the future they will also be used for EEXI (Energy Existing ship Index) and CII(Carbon Intensity Indicator). Power restrictions and slower operation speeds may be implemented to comply with fuel efficiency performance rating systems for ships. Therefore, the operating conditions of a should be determined, and its propeller should be replaced with one that is most suitable for operation. This process, called retrofitting, improves propulsion efficiency.
Nakashima Propeller uses its many years of design and manufacturing experience and high-performance CFD (Computational Fluid Dynamics) capabilities to propose the latest propeller design for each vessel, according to its current or planned operating conditions (main engine departure and ship speed).

Retrofitted propellers

Repair locations around the world

Service network in 30 countries

Nakashima Propeller's main products, fixed pitch propellers of various sizes, are used worldwide. Hence, service agents have been established in the main regions of 30 countries to provide troubleshooting services.
Depending vessel schedule and other factors, immediately conducting permanent work may be difficult. In such cases, temporary work can be performed at sea or in the water to minimize the length of time the vessel is at anchor, and support is provided to ensure safe operation until the permanent work is completed.



Company

Symbols and slogan

The “N” mark features the initial “N” of Nakashima as a motif. Its colors represent the sea (navy blue) and the passion of its employees (red). This depicts the strength of the Nakashima Group, which is active freely in a wide range of fields, from propellers to medical care and the environment. The slogan “We Go Beyond” is a broad declaration of the Group’s mission to pursue new optimal solutions constantly and shape the unlimited possibilities that lie beyond. We consider it a challenge to do what no one has done or can do yet.

NAKASHIMA

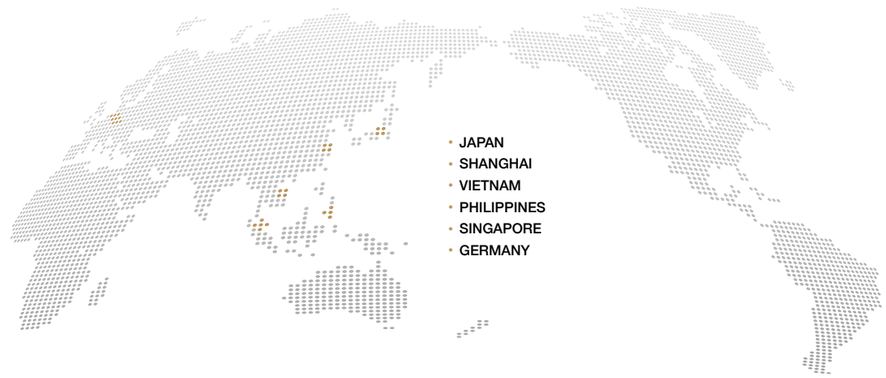
We Go Beyond

Sustainable Development Goal (SDG) initiatives

As a company heavily involved in the sea, which comprises 70% of the planet, Nakashima Propeller is committed to the SDGs by helping protect the environment, such as by reducing GHG emissions through improved fuel efficiency and reusing materials used in manufacturing processes and decommissioned propellers.
The company is actively involved in the We also aim to contribute to the economy by improving efficiency by developing integrated ship handling systems and automatic takeoff and landing systems and promoting employment in the marine industry involved in their development.

Global expansion

Vessels equipped with Nakashima Propeller propulsion equipment are active on the world’s oceans. Today, Nakashima Propeller has established backup systems not only in Japan but also in other countries worldwide. Its field of activity is expanding globally, including through technical cooperation with overseas companies and the training of engineers.



Nakashima Group history

1926
- Zenichi Nakashima founds the Nakashima Foundry in Shimoishii, Okayama, and starts manufacturing propellers for fishing boats.

1930
- Its small propellers are named Mitsuwa propellers, and the associated trademark has three overlapping rings.

1938
- Nakashima Foundry is incorporated as an unlimited partnership.

1948
- Nakashima Foundry Co. is established to meet the increasing demand for propellers.

1952
- Nakashima Foundry Co. becomes a large propeller manufacturer in preparation for the increasing sizes of ships.

1955
- The associated trademark is changed to an eagle mark.

1967
- A new factory is completed in Kitagata, Joto-cho, Joto-gun, Okayama Prefecture (now Joto-Kitagata, Higashi-ku, Okayama City), and all departments are transferred to the new factory.
- The company name is changed to Nakashima Propeller Co.
- The company is recognized by the Ministry of Transport as an establishment under the Ship Safety Act.

1971
- Keyless propellers are successfully developed.


Large propellers from the Nakashima Foundry period


Development of keyless propellers


Technical collaboration with Stone Manganese Marine

1972
- The company engages in technical collaboration with Stone Manganese Marine Ltd. (UK) on variable-pitch propellers and side thrusters.

1973
- A large host computer is introduced.

1974
- Large NC wing surface machining centers are established.


Large NC blade milling machine


Hi-Skew propellers


PC CAD system ANDES

1978
- The company engages in technical cooperation with Willi Becker GmbH, Germany, for the Becker rudder.

1981
- The Hi-Skew propeller is developed.
- TThe equipment design division is spun off to form Nakashima Engineering Co.

1983
- The Systems Division is established and starts selling the personal computer CAD system ANDES.

1984
- Surface propellers are developed.

1985
- The Systems Division is spun off to expand business in the information and communications field. Systems Nakashima Co., Ltd. is established.
- CI is implemented, and the trademark is changed to an “N.”
- The Melody Bell (propeller for boat racing) is developed using structural analysis and electronic control technology.

1987
- Nakashima Engineering is in charge of planning and marketing these products as environmental performance products.
- The company is licensed by the Ministry of Health and Welfare to manufacture medical devices and develop titanium alloy prostheses.


Artificial joints


SOUP optical modeling machine


Propellers for boat racing


Melody Bell

1991
- The SOUP optical molding machine is introduced.
- The company engages in sales partnership with SCHOTTEL, Germany, for pump jets, rudder propellers, and other propulsion equipment.

1993
- The NUC Corporation, a sales company for office equipment, is established jointly with Uchida Yoko Co.
- The Medical Business Office is established at Nakashima Propeller.

1994
- In-house power generation equipment is completed using a cogeneration system.
- Approval for the manufacture of artificial knee joints is obtained.
- The Medical Business Office is reorganized into Nakashima Propeller’s Medical Division.

1995
- Nakashima Propeller’s main factory becomes the first in the propeller industry to receive ISO 9001 certification.

1996
- A boat racing propeller factory is completed at Nakashima Propeller’s headquarters.
- Nakashima Propeller’s new main office is completed.
- The company receives a Nikkei New Office Award.

Trademark transition


Mitsuwa propeller trademark

Eagle trademark


“N” trademark

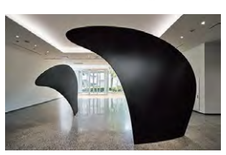
Company building transition and introduction


Factory at time of foundation

Nakashima Propeller completion ceremony


Head office main building


Tamashima Plant


NX Building entrance

Nakashima Holdings Ltd. **Nakashima Engineering Ltd.** **Systems Nakashima Ltd.**
Nakashima Propeller Co., Ltd. **Teijin Nakashima Medical Ltd.** **NUC Inc.**

1997
- NICE80, developed by Systems Nakashima as an in-house intranet, wins the Minister of International Trade and Industry’s Award for Excellence in Information Systems.

2000
- The company engages in technical cooperation with KT Electric, South Korea, to produce TCT-type thrusters.

2001
- The medical wing is completed..
- A propeller for a large ship is donated to the Museum of Maritime Science in Yashio, Higashi, Tokyo, to celebrate the 75th anniversary of the company.

2003
- The Okayama Keiretsu Square, a local version of Microsoft’s Keiretsu Square, is developed and operated. Okayama Keiretsu Hiroba operation begins.

2004
- A research and development (R&D) center is completed at Haga Research Park, Okayama.
- The Medical Division receives ISO 13485 certification.

2005
- The Tamashima plant, which manufactures large marine propellers, is completed.
- Employee Hisayuki Miyata receives the Prime Minister’s Award at the 1st Monodzukuri Nippon Grand Awards.

2006
- His Imperial Highness the Crown Prince visits the factory.

2007
- The National Equipment IT Promotion Association is established.
- The Nakashima Vietnam Co. factory is completed in Hai Phong, Vietnam, and starts operating.

2008
- The Nakashima Group is restructured, with Nakashima Holdings Ltd. at its core. The slogan is changed to “We Go Beyond.”
- The Medical Division is spun off to form Nakashima Medical Co.
- Takashima Medical receives Super Special Zone status.

2009
- A second Nakashima Vietnam factory is completed and commences operation.
- Mikado Group joins the Nakashima Group. Mikado Group’s small- and medium-sized propellers World in the field of Strengthening overseas business development using global brand strength.

2010
- Nakashima Medical expands its R&D center (Haga, Kita-ku, Okayama).

2011
- Nakashima Asia-Pacific Pte. Ltd. is established as a sales company in Singapore.

2012
- Prime Minister Noda (as of August 2012) visits the factory.
- Mikado Japan K.K. changes its name to Nakashima Mitsuwa Propeller Co.
- Mikado Philippines Corporation changes its name to Nakashima Philippines Corporation.

2013
- Capital participation in Michigan Wheel Co., US.
- The Nakashima Memorial Foundation is established.

2014
- The Nakashima Memorial Foundation is transformed into a public interest incorporated foundation.
- Nakashima Medical establishes Nakashima Medical Technical Center Ltd. (Thailand).

2015
- Nakashima Medical changes its name to Teijin Nakashima Medical Ltd.
- Nakashima Mitsuwa Propeller receives the Prime Minister’s Award (Monodzukuri Nippon Grand Award) for its CFRP propellers.
- President Motoyoshi Nakashima receives the 14th Shibusawa Eiichi Award.
- The Takamatsu Sales Office is opened in Kagawa Prefecture to expand services to the Shikoku area.

2016
- Nakashima Mitsuwa Propeller changes its name to Nakashima Propeller Co.
- The Nakashima Propeller Marine Engineering (Shanghai) Co. Ltd. service base is established.
- The voluntary organization National Equipment IT Promotion Association is converted into a general incorporated association, and a paid membership service is launched. Started

2017
- Nakashima Asia-Pacific acquires Mentrade Group’s marine propulsion equipment business.

2018
- The spine business of Century Medical Inc. is acquired.

2019
- The Tamashima plant manufactures a cumulative total of 5,000 large propellers in its 13th year of operation.
- The denim furniture business is recognized as an Okayama Prefecture New Business Field Pioneer with New Products.

2020
- Shoyo Engineering Corporation joins the Nakashima Group.

2021
- German company Becker Marine Systems joins the Nakashima Group.

2022
- The spine and trauma business of KISCO Corporation is acquired.

2023
- A new company building (NX Building) is constructed and opened in Nakashimada-cho, Kita-ku, Okayama.
- Nakashima Europe is established in Germany.

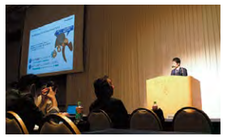
2024
- Kibi Kogen N Square is established in Kibichuo Town, Okayama Prefecture, as a center for innovation creation.


Kibi Kogen N Square

2026
- Nakashima Propeller celebrates its 100th anniversary

Human resource development and overseas training


Vision review meetings

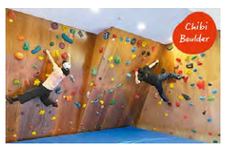

Lectures at technical seminars


Participation in international maritime exhibitions


Global agency meetings


Volunteer activities

We Go Beyond



In-house crafan activities


Free-address offices

New business research

Company Profile

Company Name	Nakashima Propeller Co., Ltd.
Founding	May 1926
Established	August 2009
President	Takayoshi Nakashima
Capitalization	100 million yen
Number of employee	453 (as of April, 2024)
Head Office	688-1, Joto-kitagata, Higashi-ku, Okayama, 709-0625, Japan
Tamashima Works	8259-12, Tamashima Otoshima, Kurashiki, Okayama, 713-8103, Japan
Tokyo Branch	10th Floor,DLX Bldg,1-13-1 Nishishinbashi,Minato-Ku,Tokyo 105-0003, Japan
Osaka office	1-3-1-900 Umeda, Kita-Ku, Osaka, 530-0001, Japan
Fukuoka office	1-16-14, Hanmichibashi, Hakata-ku, Fukuoka
Nakashimada office	NX Building, 2-3-19 Nakashimada-cho, Kita-ku, Okayama 700-0982
Home page	https://www.nakashima.co.jp/
Brand site	https://propelling.jp/eng/

Corporate　Propelling　YouTube　Instagram　Line

Nakashima Group companies

The Nakashima Group, led by Nakashima Holdings, has expanded its business areas from marine propulsion equipment to artificial joints and is developing its business worldwide.

Nakashima Holdings Ltd.

[Founding] May 1926
[Establishment] November 1948
[Capital] 100 million yen
[Business activities] Businesses related to the management and administration of Group companies and real estate management and leasing
[Location] NX Building, 2-3-19 Nakashimada-cho, Kita-ku, Okayama 700-0982
Tel. : +81 86-230-4111
https://www.nakashima.jp/

Nakashima Propeller Co., Ltd.

[Establishment] August 2009
[Capital] 100 million yen
[Business activities] Development, manufacture, and sale of marine equipment; development, manufacture, and sale of environmental improvement equipment
[Location] 688-1 Joto-Kitakata, Higashi-ku, Okayama 709-0625
Tel. : +81 86-279-5111
https://www.nakashima.co.jp/

Nakashima Engineering Ltd.

[Establishment] February 1981
[Capital] 20 million yen
[Business activities] Technical consultancy, after-sales service, planning, installation, and sales of environmental performance products for marine propulsion equipment
[Location] 688-1 Joto-Kitakata, Higashi-ku, Okayama 709-0625
Tel. : +81 86-279-5111
https://nel.nakashima.co.jp/

Teijin Nakashima Medical Ltd.

[Establishment] September 2008
[Capital] 100 million yen
[Business activities] Development, manufacture, and sale of medical equipment
[Location] 688-1 Joto-Kitakata, Higashi-ku, Okayama 709-0625
Tel. : +81 86-279-6278
https://www.teijin-nakashima.co.jp/

Systems Nakashima Ltd.

[Establishment] April 1985
[Capital] 100 million yen
[Business activities] Development and sale of CAD/CAM systems and business systems; sale of computer-related equipment
[Location]
Head Office: 688-1 Joto-Kitakata, Higashi-ku, Okayama 709-0625
Tel. : +81 86-279-7700
Administration Headquarters: 2-3-19, Nakashimada-cho, Kita-ku, Okayama 700-0982
Tel. : +81 86-234-8111
https://www.systems.nakashima.co.jp/

NUC Inc.

[Establishment] December 1993
[Capital] 30 million yen
[Business activities] Sale of office equipment and OA supplies
[Location] 3F NX Building, 2-3-19 Nakashimada-cho, Kita-ku, Okayama 700-0982
Tel. : +81 86-230-1330
http://www.nuc-ok.co.jp/

NAKASHIMA VIETNAM CO., LTD.

[Establishment] December 2005
[Business activities] Manufacture of various types of marine propellers
[Location] Land Plot CN2.2B, Dinh Vu Industrial Zone, Hai An District, Hai Phong, Vietnam

NAKASHIMA ASIA PACIFIC PTE. LTD.

[Establishment] December 2011
[Business activities] Manufacture of various types of marine propellers
[Location] 6 Temasek Boulevard # 29-03, Suntec Tower Four, Singapore 038986

NAKASHIMA PHILIPPINES CORPORATION

[Establishment] February 1989
[Business activities] Manufacture of various types of marine propellers
[Location] Cavite Economic Zone, Rosario, Cavite 4106 Philippines

NAKASHIMA PROPELLER MARINE ENGINEERING (SHANGHAI) CO., LTD.

[Establishment] October 2016
[Business activities] Installation, adjustment, repair, and regular maintenance of various marine propellers and side thrusters
[Location] Rm.702 Neiwailian Building, 518 Shangcheng Road, Pudong New District, Shanghai 200120 China

Nakashima Memorial Foundation

[Business activities] Support for international students and sports in Okayama Prefecture Established for the purpose of promoting

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