



Fixed Pitch Propellers



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Fixed Pitch Propellers from ZF Marine

Manufacturing Location

ZF Marine Zhuhai

ZF Marine acquired FPS-(Zhuhai) in 1998 since then the facility has been improved and expanded at a continuous pace, and in 2010 a major investment has been implemented, with completely renewed and additional facilities at the company grounds at the previous area of 46,000 sqm. Total covered area of the future plant will be 20,000 sqm, which includes a foundry, a gear manufacturing and assembly facility, a location to assemble controllable pitch propellers (CPP) and complete propulsion systems. Capacity of the new plant for CPP equals to an annual production of up to 250 units.

The new facilities at the premises of ZF Marine Zhuhai include a new foundry with state-of-the art technology and certified quality processes according to ISO 9001, to produce components at highest quality levels for controllable pitch propellers up to a diameter of 5.7 m.

In addition a large factory with 1,500 sqm has been build for testing complete propulsion systems, including controllable pitch propellers, propeller shafts, transmissions and all auxiliary equipment. Final testing of all equipment is according to processes in line with ZF Group guidelines and ISO certification norms.

The increased capacity build up at the Zhuhai plant is in line with ZF Marine's strategic plan to expand with high priority its activities for production and marketing of products for commercial vessels in the important asian market and world-wide.



Zhuhai facility

ZF Marine Kaohsiung

Faster Propulsion System Co. Ltd. was established in 1988 in Kaohsiung, Taiwan.

The design and manufacture of propellers started in 1989, specifically targeting the high quality market with Class S and Class 1 standard propellers according to ISO 484. ZF Marine, the world's largest manufacturer of marine transmissions, established a Joint Venture with Faster Propulsion System Co., Ltd. in 2000. Within four years, ZF Marine acquired 100% shares and the company was named ZF Faster Propulsion System Co., Ltd.

The Research and Development team at Kaohsiung has built up a wealth of experience in designing propellers. The aim is to achieve optimum propulsive performance in respect of speed, comfort, and economy according to customer requirements. Every propeller is NC (Numerical Control) machined to a very high accuracy using a 3-D CAM (Computer Aided Manufacturing) system specifically designed for machining propeller blades.

Quality milestones

Quality system approved by DNV: ISO 9001; OHSAS18001; ISO 14001 and ISO 27001
Certification by LR, GL, DNV, BV, ABS, RINA, RRR, and CR.

The product range of ZF Marine includes fixed pitch propellers up to 3 meters diameter, suitable for all types of vessels e.g. yachts, commercial vessels, ferries, military vessels, patrol craft and work boats.

The high manufacturing quality is complemented by the expertise of ZF Marine's Sales and Service Organization which guarantees fast delivery and 24/7 worldwide support.



Kaohsiung facility

Fixed Pitch Propellers

Highest performance, custom design and high quality means excellence

Propellers for Speed & Performance

ZF Marine specializes in custom designed and standard propellers using CAD-CAM technology. Whether your vessels are yachts, commercial vessels, ferries, military vessel, patrol crafts, work boats or fishing boats, custom made propellers from ZF Marine offers you more choice and flexibility in design to achieve the optimum propulsion system. Careful design and selection of the propeller series with respect of blade profile and propeller parameters accurate sizing can lead to better speed and performance. This is the expertise of ZF Marine!

High Precision for Quality and Smoothness

All ZF Marine propellers are NC (Numerical Control) machined to very high accuracy. The special blade machining center is integrated with the CAD-CAM software. High precision, NC-machining minimizes cavitation and excitation forces and dynamic balancing provides extra smoothness at high speeds. This also results in lower levels of noise and vibration, even with high power engines. You can rely on ZF Marine propellers!

Custom Design & Manufacture for Ultimate Efficiency & Design Flexibility

The CAD-CAM system permits a wider selection in number of blades, diameter, pitch, expanded area ratio, propeller series, foil sections and other geometry features such as skew, rake, cupped and blade section thickness. The propellers can be precisely designed to meet your exact requirements. This results in propellers with optimum efficiency. Horsepower is expensive, but efficiency is not. — With ZF Marine propellers!

Propellers with the same diameter, pitch and series can be customized for different blades thickness and for different strength requirements, also in accordance with Customer's or Registers' specifications.

Propellers for all Vessels

Pleasure Craft Applications

The ZF Marine fixed pitch propeller range covers a wide variety of pleasure craft including ski-boats, sport fish, cruisers and luxury motor yachts. They are ideally suited to the complete propulsion packages offered by ZF Marine.

Many different propeller designs are available for precise matching to the characteristics of each vessel, ensuring best performance, silent operation and optimum fuel efficiency. Propellers from ZF Marine allow smooth cruising during leisure time.



Fast Craft Applications

Fixed pitch propellers for fast craft applications such as customs and coastguard vessels, as well as fast ferries, are specially designed to match to the high performance needs as defined by ship design engineers and naval architects.

These products are subject to the highest quality control regulations to meet stringent environmental and technical specifications where safety, availability and reliability are of the utmost importance. This ensures the operating profiles of these vessels can be fully satisfied.



Commercial Craft Applications

ZF Marine also supplies fixed pitch propellers which are robustly built to achieve high reliability throughout the long life of commercial vessels. Such ships are required to operate continuously in the most demanding weather conditions.

These heavy duty propellers are suitable for all types of vessels from tugs to tankers – fishing boats to factory ships. Many models are available, perfectly engineered and integrated with the complete propulsion system to meet the customer's exact requirements.



Design and Manufacturing Process

Precision means customer satisfaction

Design

Design engineers of ZF Marine work closely with the customers and provide full technical support and advice. This service also extends outside the offices to our experienced field technicians. Throughout the project phase, design phase and after sales, ZF Marine offers excellent customer support.



CAD System

The Computer Aided Design system ensures every propeller is designed for optimum performance. This leading edge software permits more selection and flexibility to meet all customers' requirements.

CAM System

The Computer Aided Manufacturing systems generate a precise cutting tool path for propeller machining. Every detail of the manufacturing process is simulated and checked before cutting commences.



NC Cutting

Numerical Control machining of propeller blades ensures high precision blade section geometry and the 4-axis machine center system is integrated with the CAD - CAM software. This leading edge technology production assures propeller manufacture to the highest geometrical tolerances required by the ISO R484 Class S standard.

Casting

High quality bronze alloys, carefully chosen with the exact composition to meet Classification Society requirements, are used for casting ZF Marine propellers. The chemical composition and physical properties are precisely controlled and tested for each cast.

New Series Development

ZF Marine also has joint venture programs with various research establishments to develop advanced technology propulsion system. Latest research includes a new surface - piercing propeller and new-foil section series propeller with excellent low cavitation characteristics.

Products

Series Propellers

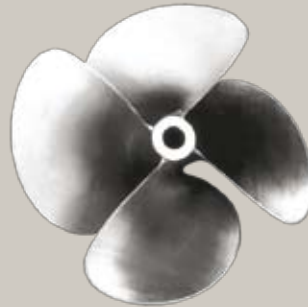
ZF FP KCA - Series

Blades : 3, 4, 5, 6
 Pitch Ratio : 0.60-2.00
 Area Ratio : 0.20-1.10
 Skew Angles : 0 degree
 Section Type : Ogival
 Remarks : Most widely use propeller series.
 Suitable for most applications.
 Cupped available.



ZF FP KCA - S Series

Blades : 3, 4, 5, 6
 Pitch Ratio : 0.60-2.00
 Area Ratio : 0.50-1.10
 Skew Angles : 25 30 35 degrees
 Section Type : Ogival
 Remarks : Modified from standard KCA series for smooth application.
 Suitable for most applications.
 Cupped available.



ZF FP NR - Series

Blades : 3, 4, 5
 Pitch Ratio : 1.00-2.00
 Area Ratio : 0.50-1.00
 Skew Angles : 0 30 degrees
 Section Type : Crescent
 Remarks : Suitable for higher speed range in trans-cavitating applications.

ZF FP KCA - C Series

Blades : 3, 4, 5
 Pitch Ratio : 0.60-2.00
 Area Ratio : 0.50-1.10
 Skew Angles : 25 30 35 degrees
 Section Type : Ogival
 Remarks : Modified from standard KCA series for commercial application with specific thickness.



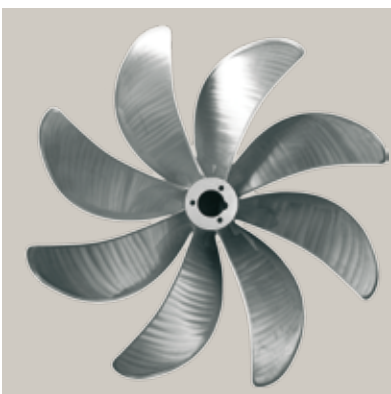
ZF FP EV - Series

Blades : 3, 4, 5, 6, 7, 8
 Pitch Ratio : 0.80-1.60
 Area Ratio : 0.50-1.40
 Skew Angles : According to design
 Section Type : Mixed Foils
 Remarks : Theoretical design propellers series for better cavitations control.



ZF FP NACA - Series

Blades : 3, 4, 5, 6, 7, 8
 Pitch Ratio : 0.80-1.60
 Area Ratio : 0.50-1.40
 Skew Angles : According to design
 Section Type : Aerofoil
 Remarks : Theoretical design propellers series.



ZF FP NF - Series

Blades : 3, 4, 5, 6, 7, 8
 Pitch Ratio : 0.80-1.60
 Area Ratio : 0.50-1.40
 Skew Angles : According to design
 Section Type : New Foil
 Remarks : Theoretical design propellers series.



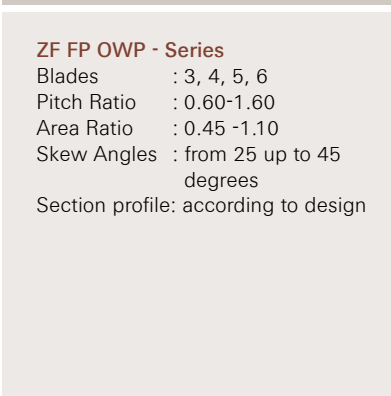
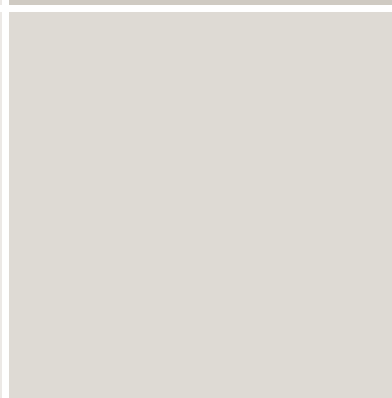
ZF FP SPP - Series

Blades : 5, 6
 Pitch Ratio : 0.90-1.8
 Area Ratio : 0.70-1.10
 Skew Angles : According to design
 Section Type : SPP, SC
 Remarks : Suitable for different surface drive applications.



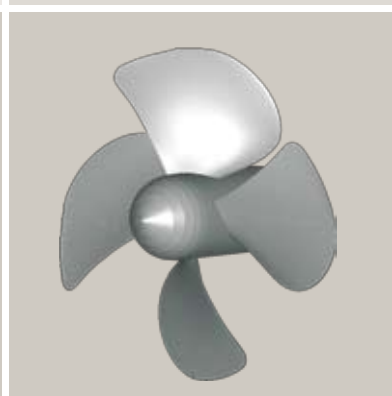
ZF FP KA - Series

Blades : 3, 4, 5
 Pitch Ratio : 0.60-1.60
 Area Ratio : 0.55-0.75
 Skew Angles : 0 degree, skew available
 Section Type : Aerofoil
 Remarks : Suitable for accelerating nozzle propellers and bow or stern thrusters.



ZF FP OWP - Series

Blades : 3, 4, 5, 6
 Pitch Ratio : 0.60-1.60
 Area Ratio : 0.45 -1.10
 Skew Angles : from 25 up to 45 degrees
 Section profile: according to design



ZF FP DUCT - Series

Blades : 3, 4, 5
 Pitch Ratio : 0.60-1.60
 Area Ratio : 0.45 -1.10
 Skew Angles : from 25 up to 30 degrees
 Section profile: according to design

Products

Special Propellers

Impellers

ZF Marine has supplied a 3.44 m (11 ft, 3in) diameter propeller for a cavitation research tunnel at the National Taiwan Ocean University. This impeller is designed with adjustable pitch for different water speed.



Model Test

Test propellers for models require the highest geometrical precision to ensure accurate test results. This precision is possible using advanced machining technology.

Keyless

For large propellers, hydraulic keyless hub fitting methods are commonly used. ZF Marine has wide experience and expert technicians to provide best solutions for fitting keyless hub propellers.

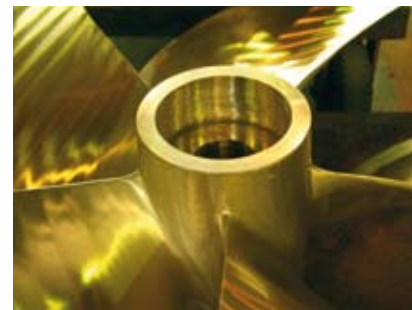
Nozzled

Nozzled propellers generate more bollard pull for tugs. ZF Marine offers a wide selection of different designs.



Propeller Materials

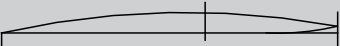
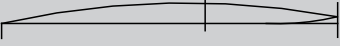
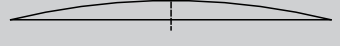
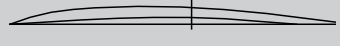

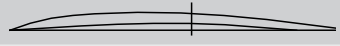
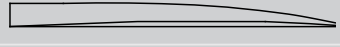
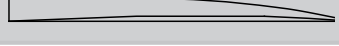
ZF Marine can offer various propellers with the materials of manganese bronze, and nickel aluminum bronze to high strength, special alloys. This means requirements for all types of applications can be met.



Optimum Propeller Selection

In order to select a suitable propeller with optimum efficiency and ensure low cavitation, low exciting force characteristics at the design point specified by the customer, the shape of the blade section (i.e. camber and thickness

distribution chord-wise) must be carefully considered in addition to the skew, rake and pitch distribution in radial direction. Guidelines for choosing suitable blade sections are shown in the following table.

Ship speed (knots)	Propeller blade section	Related propeller series
< 25	Aerfoil 	Mau, Wagenengen-B, NACA
25 - 35	Aerfoil 	Mau, Wagenengen-B, NACA
	Ogival 	Gawn, Gawn-Burrill (KCA)
	Crescent 	NR, NF, EV
35 - 40	Crescent 	NR, NF, EV
40 - 50	Crescent 	NR, NF, EV
	SC or SPP 	SUS
> 50	SC or SPP 	SUS

For sub-cavitation applications (vessel speed less than 32 – 33 knots) the theoretical design method according to NACA 66 is the optimal solution. When shaft inclined angle is less than 10 degrees.

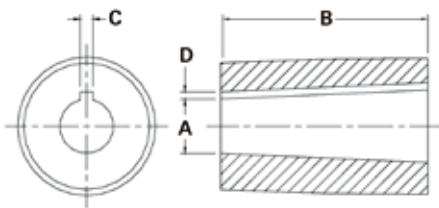
The NF section is especially designed for fast vessels running in the partial cavitation field (non-uniform flow) typically experienced in installations using high shaft angles as well as fast container ships.

In the partial cavitation field (vessel speed more than 32 – 33 knots) empirical result data is needed, e.g. from a cavitation tunnel. Each year, ZF Marine tests a new NF and EV design section, with modified Blade Area Ratio, Pitch Ratio and / or Camber Ratio. By this means, a wealth of data has been collected which can be used to develop NF section propellers for the most demanding applications.

Technical information

Hub Dimensions

Taper 1:16



- SAE J755 Standard. (All dimensions in inches)
- Special hub dimensions available upon request

Nominal Diameter	Small End Dia. A		Length B	Keyway C	Keyway D
	Min.	Max.			
1-1/2	1.218	1.220	4-1/2	3/8	3/16
1-3/4	1.421	1.423	5-1/4	7/16	7/32
2	1.624	1.626	6	1/2	1/4
2-1/4	1.827	1.829	6-3/4	9/16	9/32
2-1/2	2.030	2.032	7-1/2	5/8	5/16
2-3/4	2.233	2.235	8-1/4	5/8	5/16
3	2.437	2.439	9	3/4	5/16
3-1/4	2.640	2.642	9-3/4	3/4	5/16
3-1/2	2.843	2.845	10-1/2	7/8	5/16
3-3/4	3.046	3.048	11-1/4	7/8	5/16
4	3.249	3.251	12	1	5/16
4-1/2	3.796	3.798	11-1/4	1-1/8	3/8
5	4.218	4.220	12-1/2	1-1/4	7/16
5-1/2	4.640	4.642	13-3/4	1-1/4	7/16
6	4.749	4.751	15	1-3/8	1/2

Materials

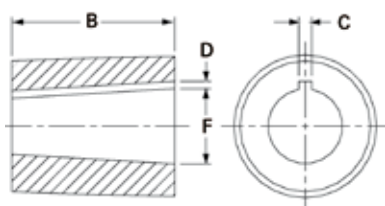
Chemical Composition

Composition	Cu	Zn	Mn	Al	Ni	Fe	Sn	Pb
Material								
Manganese Bronze	52-62	35-40	0.5-4.0	0.5-3.0	<1.0	0.5-2.5	<1.5	<0.5
Nickel Aluminium Bronze	77-82	<1.0	0.5-4.0	7.0-11.0	3.0-6.0	2.0-6.0	<0.1	<0.03



Hub Dimensions

Taper 1:10



- ISO 4566 Standard. (All dimensions in mm)
- Special hub dimensions available upon request

Nominal Diameter	Large End Dia. F		Length B	Keyway C	Keyway D
	Min.	Max.			
50	50	50.062	120	14	5
55	55	55.074	130	16	5
60	60	60.074	140	18	5.5
65	65	65.074	150	18	5.5
70	70	70.074	160	20	6
75	74.5	74.574	170	20	6
80	79.5	79.574	180	22	7
85	84.5	84.587	190	22	7
90	89.5	89.587	200	25	7
95	94.5	94.587	210	25	7
100	99	99.087	220	28	8
110	109	109.087	240	28	8
120	119	119.087	260	32	9
130	129	129.100	280	32	9
140	139	139.100	300	36	10

Materials

Mechanical Properties

Material	Item	Tensile Strength (N/mm ²)	0.2% Proof Stress (N/mm ²)	Elongation (%)	Classification Society Equivalent		
					CR	ABS	LR
Manganese Bronze		460	175	20	NF1A	Type 2	Cu1
Nickel Aluminium Bronze		590	245	16	NF2A	Type 4	Cu3

Data Sheet for Propeller Design

Shipyard: _____
Boat's Name or Nr. Project: _____
Contact: _____
Phone: _____
Fax: _____
E-mail: _____

ZF Marine Kaohsiung
TEL: +886-7-787-1831
Fax: +886-7-787-1833
E-mail: info.kaohsiung@zf.com
Project Nr. : _____
Date: _____

The propeller suggestion can only be as accurate as the information that you provide.

Boat Information

Type of Analysis: Powerboat Sailboat Repower
Year: New Old years _____
Boat Use: Work/Commercial Towing Pleasure
Hull Type: Displacement Semi-Disp. Planing
Bottom Design: Open Tunnel Pocket
Appendage: Skeg Wedge Stabilizer Rope cutter
Hull Material: Fiberglass Wood Aluminum
Register Application: ABS BV DNV GL Lloyds RINA Other _____

1. Hull Data

Light Load Displacement: _____ t/lbs Half Load Displacement: _____ t/lbs Full Load Displacement: _____ t/lbs
Length Overall: _____ m/ft Length Waterline: _____ m/ft Bpx (Max. Chine Beam): _____ m/ft
LCG From Transom: _____ m/ft Deadrise Angle at Midship: _____ °, at Transom: _____ °
Draught at Full Load: _____ m/ft, at Mid Ship: _____ m/ft Shaft Angle: _____ °
Max. Diameter: _____ m/ft Clearance: _____ m/ft Distance between Hull and Center of Prop. shaft: _____ m/ft
Shaft Diameter: SAE Metric Size _____

2. Existing or New Engine Data

Number of Engines: Single Twin Triple Other Manufacturer: _____ Model: _____
Maximum Engine Rating: _____ HP KW Cv @ _____ RPM
Make and Type of Gearbox: _____ Reduction Ratio: _____ : 1
Demand Speed, or Not: Yes _____ knots @ _____ tons, No if no, suggested by ZF Marine

If repower, fill in the above with NEW engine data and try your best to fill in the item 3 for existing propeller data and item 4 for repower data

3. Existing Propeller Data

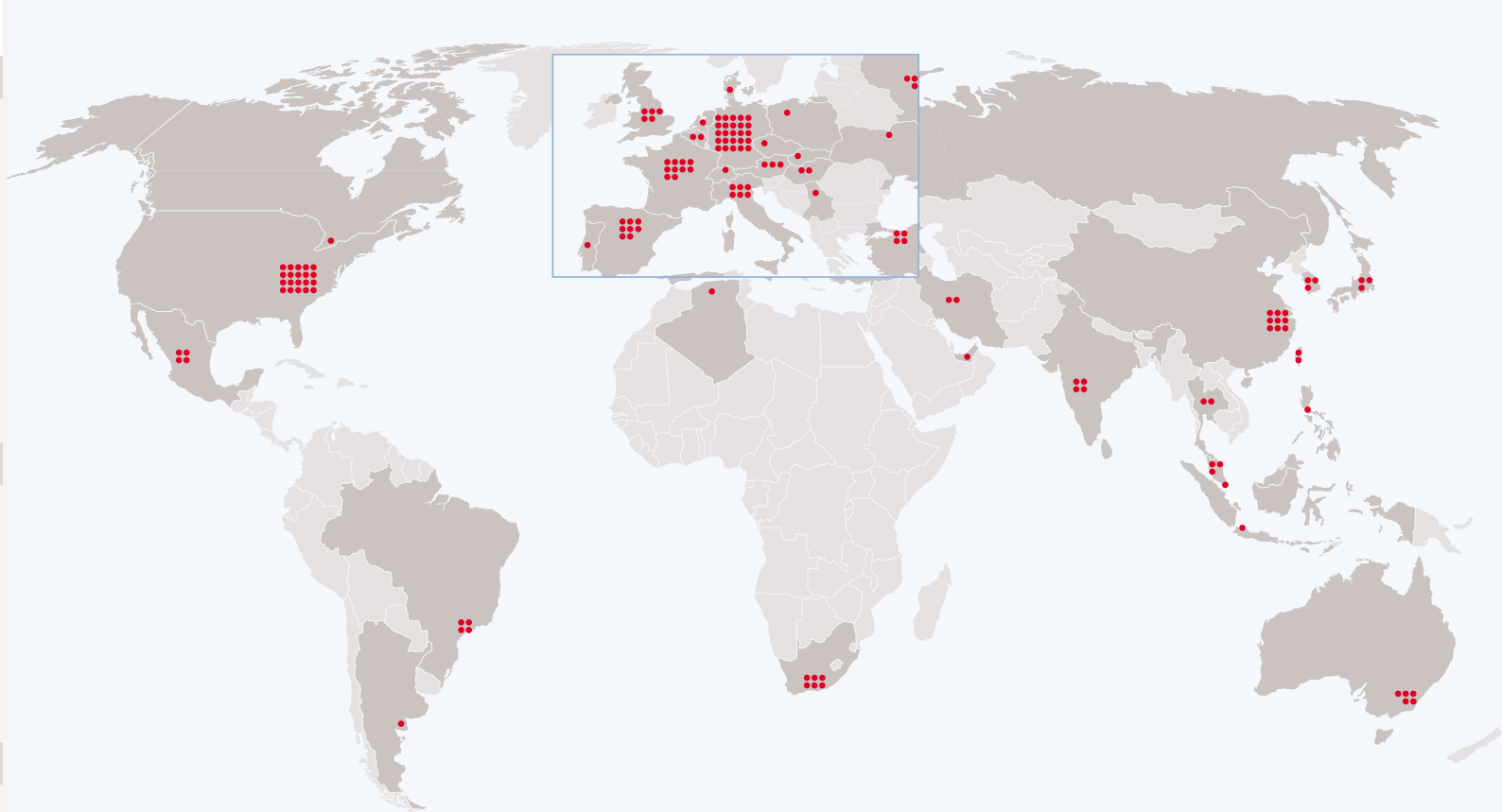
Manufacturer: _____ Model/Series: _____ Material: MnBr NiAlBr Stainless Steel
Propeller Size: Diameter: _____ x Pitch: _____ x Blade: _____ x Area Ratio: _____
Existing Performance: Full Throttle ship Speed _____ MPH Knots @ _____ tons (sea trial Disp.)
Full Throttle Engine RPM _____ RPM @ Engine load _____ %

4. Re-power Data (Old Engine Information)

Number of Engines: Single Twin Triple Other Manufacturer: _____ Model: _____
Maximum Engine Rating: _____ HP KW Cv @ _____ RPM
Make and type of Gearbox: _____ Reduction Ratio: _____ : 1
Existing Performance: Full Throttle ship Speed _____ MPH Knots @ _____ tons (sea trial Disp.)
Full Throttle Engine RPM _____ RPM @ Engine load _____ %

Remarks

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