

# APPLICATIONS FOR SHIPS AND BOATS





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# CONTENTS

## THE COMPANY AND ITS SOLUTIONS

03 Page

### CONTENTS

---

04 Page

### EXPERIENCE HAS FUTURE

---

06 Page

### OUR STRENGTHS

---

06 – 07 VULKAN COUPLINGS COMPETENCE

08 – 09 VULKAN COUPLINGS RELIABILITY

10 – 11 VULKAN COUPLINGS PRESENCE

12 – 13 VULKAN COUPLINGS SERVICE

14 Page

### OUR SOLUTIONS

---

14 – 15 VULKAN COUPLINGS TECHNOLOGY FOR SHIPS AND BOATS

16 – 27 CARGO VESSELS

28 – 37 PASSENGER SHIPS

38 – 49 PLEASURE BOATS

50 – 65 WORK BOATS

66 – 75 SPECIAL VESSELS

76 – 79 AUXILIARY DRIVES

80 Page

### OVERVIEW

---

80 – 81 VULKAN SYSTEM SOLUTIONS

82 Page

### IMPRINT

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# EXPERIENCE HAS FUTURE

The VULKAN company has been owned solely by the Hackforth family since 1889. The VULKAN Group companies are committed to a common set of values from the tradition grown out of a medium-sized family business.

Closeness to our customers and the translation of special customer requirements into products and services in the market sectors in which we work define VULKAN's approach to customer service. It is a case of finding the balance between traditional values such as reliability and technical ability on the one hand and increasingly

cost-oriented solutions on the other, whether for customized or standard models. The foundations are and continue to be the ability and potential of our company to make changes to existing products and processes in such a manner that a high level of customer benefit always results.



VULKAN's history began following the foundation of **MASCHINENFABRIK LOUIS SCHWARZ** in Dortmund. The company initially functioned as a supplier of brewing equipment, tanks and low pressure compressors for the already well-established Dortmund breweries.



The merger of Maschinenfabrik Louis Schwarz and the company Heinrich Behrend resulted in the establishment of **DORTMUNDER VULKAN AG**.



Maschinenfabrik HACKFORTH & Co. took over the production from VULKAN Kupplungs- und Getriebebau GmbH. This resulted in the foundation Stone for the **CO-OPERATION BETWEEN "VULKAN" AND "HACKFORTH"** being laid.

1889

1898

1918

1926

1941

1949

The world's first clutch, which was capable of being activated under load, was produced for use in lifting machinery, hoists and reversing gearboxes. It was manufactured by Louis Schwarz and it marked the beginning of **VULKAN COUPLINGS**.



Foundation of **MASCHINENFABRIK HACKFORTH & CO.** by the engineer Bernhard Hackforth Sr (1871 – 1954) in Herne. The company was primarily involved in repair work and small amounts of contract work for the local mining and foundry industries.



**BERNHARD HACKFORTH JR** (1914 – 1990) assumed sole responsibility for the business from his father. As a result, Maschinenfabrik HACKFORTH & Co. passed to the second generation.



By maintaining close contact with the customer and paying attention to product life cycles and market conditions, we constantly find new inspiration for products and services. Our customers' requirements for punctual delivery, quality, product safety and eco-friendliness with reduced costs are and continue to be a constantly growing

challenge. Our aim is to offer benefits to the user from development and production to the marketing of products and services. All members of the family provide maximum support to reach this goal, now and in the future.



VULKAN acquired the sole manufacturing and global marketing rights for a highly flexible coupling, named the **"HIGHLY FLEXIBLE VULKAN EZ COUPLING"**.



VULKAN Kupplungs- und Getriebebau developed a coupling with an extremely high torsional flexibility, which bore the name RATO. Following this, the manufacturing of the patent-registered **RATO S** coupling began.



VULKAN Couplings established the **ACOTEC (ADVANCED COUPLINGS TECHNOLOGY)** strategy. ACOTEC is an integrated approach bringing together all competences in-house, ensuring that the best possible products and services can be provided.

1951

1977

1982

2005

2010

2012

201

**BERND HACKFORTH** (1949) joined the company as joint owner. This resulted in the third generation of the Hackforth family taking over a share of the responsibility.



VULKAN Kupplungs- und Getriebebau established an **IN-HOUSE VULCANISATION** ensuring the control, knowhow and reproducible quality of a core process. From natural rubber elastomer the vulcanisation produces components with volumes from 0.4 to 140 litres for all highly flexible couplings.



After working with the management of VULKAN Lokring for four years, **SEBASTIAN HACKFORTH** (1978), the son of the sole proprietor Bernd Hackforth, was appointed President of the Hackforth Holding GmbH & Co. KG. This meant that the fourth generation had now taken co-responsibility for the VULKAN Group.

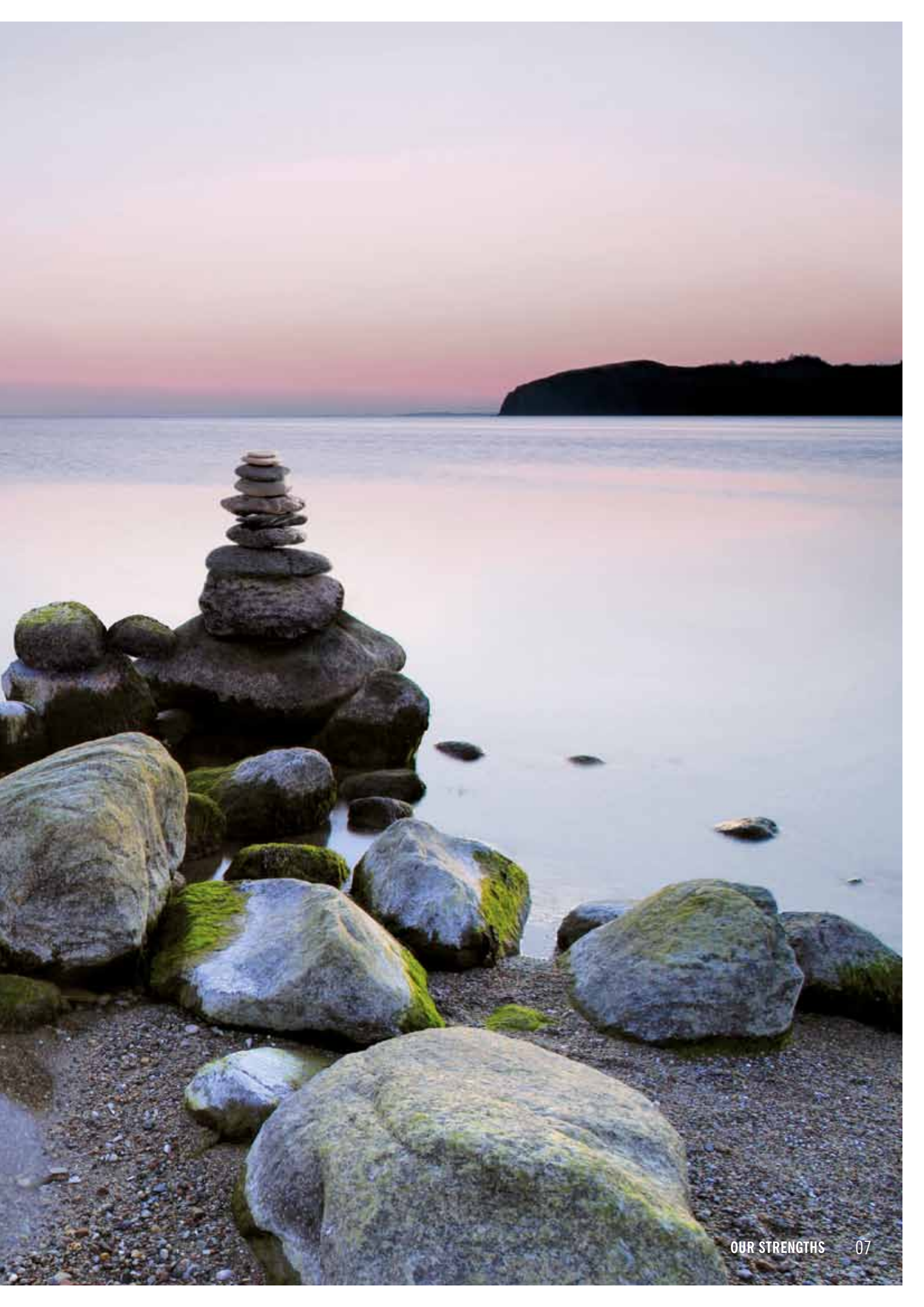


# VULKAN COUPLINGS COMPETENCE

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For over 120 years our ambition is to create comprehensive solutions in propulsion. Starting in the late 19th century with one of the first flexible couplings, over a constant enhancement of our products to a system solution partner.

This development gives us the know-how and competence our over 1000 customers worldwide appreciate. But our aim is to push the limits and develop already outstanding solutions further. Latest proof is the unique ACOTEC technology, which is the achievement of decades of experience in vulcanisation and production. To meet our claim over 50 engineers and experts in our research department with fully equipped Inhouse-Test-Center are verifying the capacity of our current products and working on the solutions of tomorrow. A complete solution might look simple at the end, but it is perfectly balanced with regard to our customer's needs.



# VULKAN COUPLINGS RELIABILITY

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Reliability is essential – especially in propulsion systems. The complete package and its constituent parts and materials have to perform constantly for a long period and have to withstand the rough conditions of daily operation on the ocean.

Our accomplishments have enormous significance for our customers. It is important to us that they can rely on the products and services we provide. To achieve this we give our customers 120 years of experience and high quality fabrication made by VULKAN. VULKAN couplings stand for highest reliability. As individually adapted solutions they are also convincing owing to highest product quality and long service life.



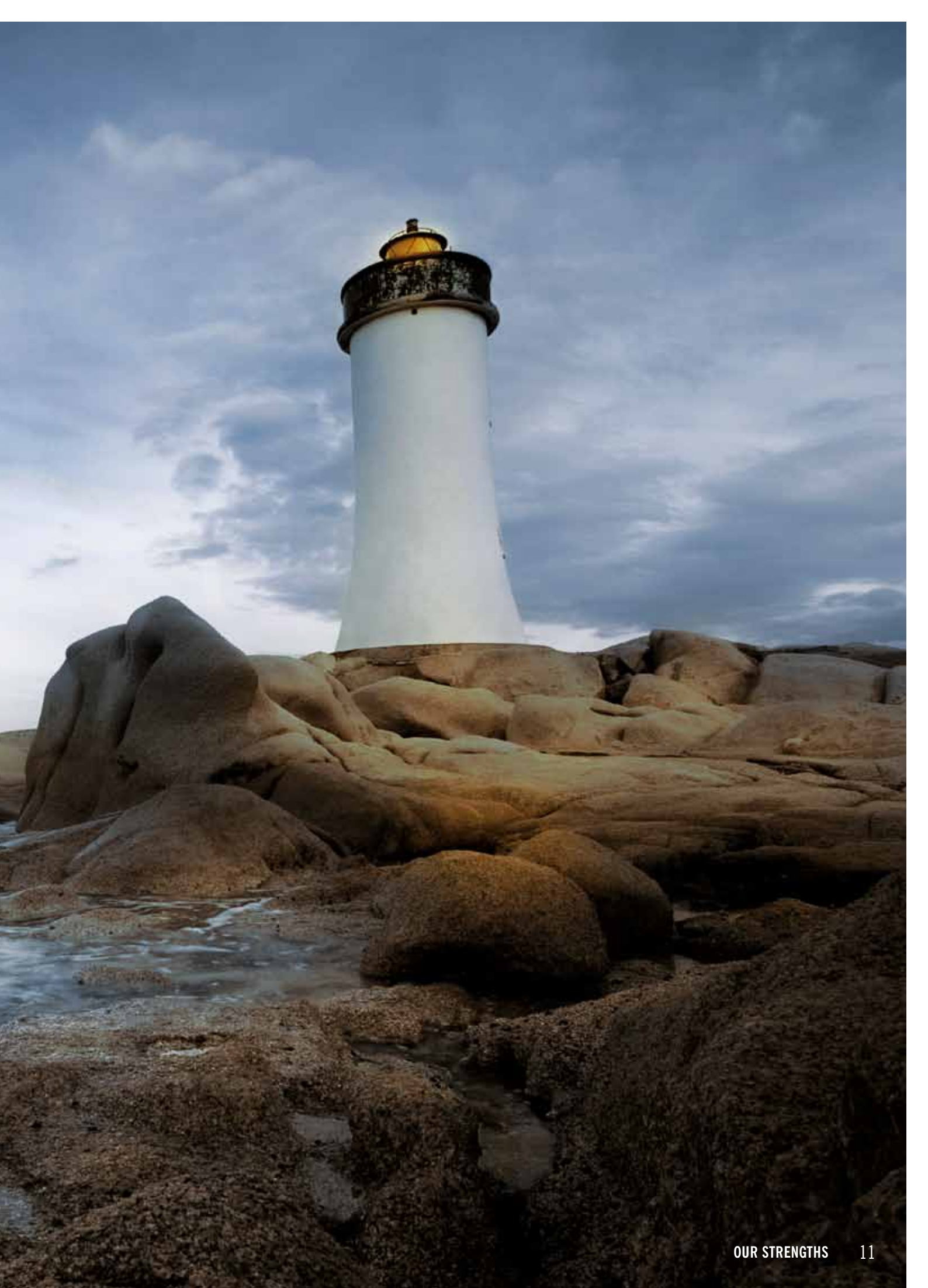


# VULKAN COUPLINGS PRESENCE

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Requirements and preferences differ. For this reason we consider it necessary to be right next to our customers – wherever they might be.

VULKAN Couplings produces and markets its products in all the important centers of the shipbuilding industry worldwide. Our production sites and technical centers are located close to our customers in order to ensure efficient delivery of our world-class service and high-quality products. Customers can benefit from our extensive know-how and expertise based on our global network. We employ over 1,000 people in 24 countries. With our 13 subsidiaries worldwide we are able to provide our customers with a unique combination of global resources, recognized technical expertise and deep local knowledge. VULKAN Couplings is showing face, worldwide, in good times and in challenging times, but always at your disposal.

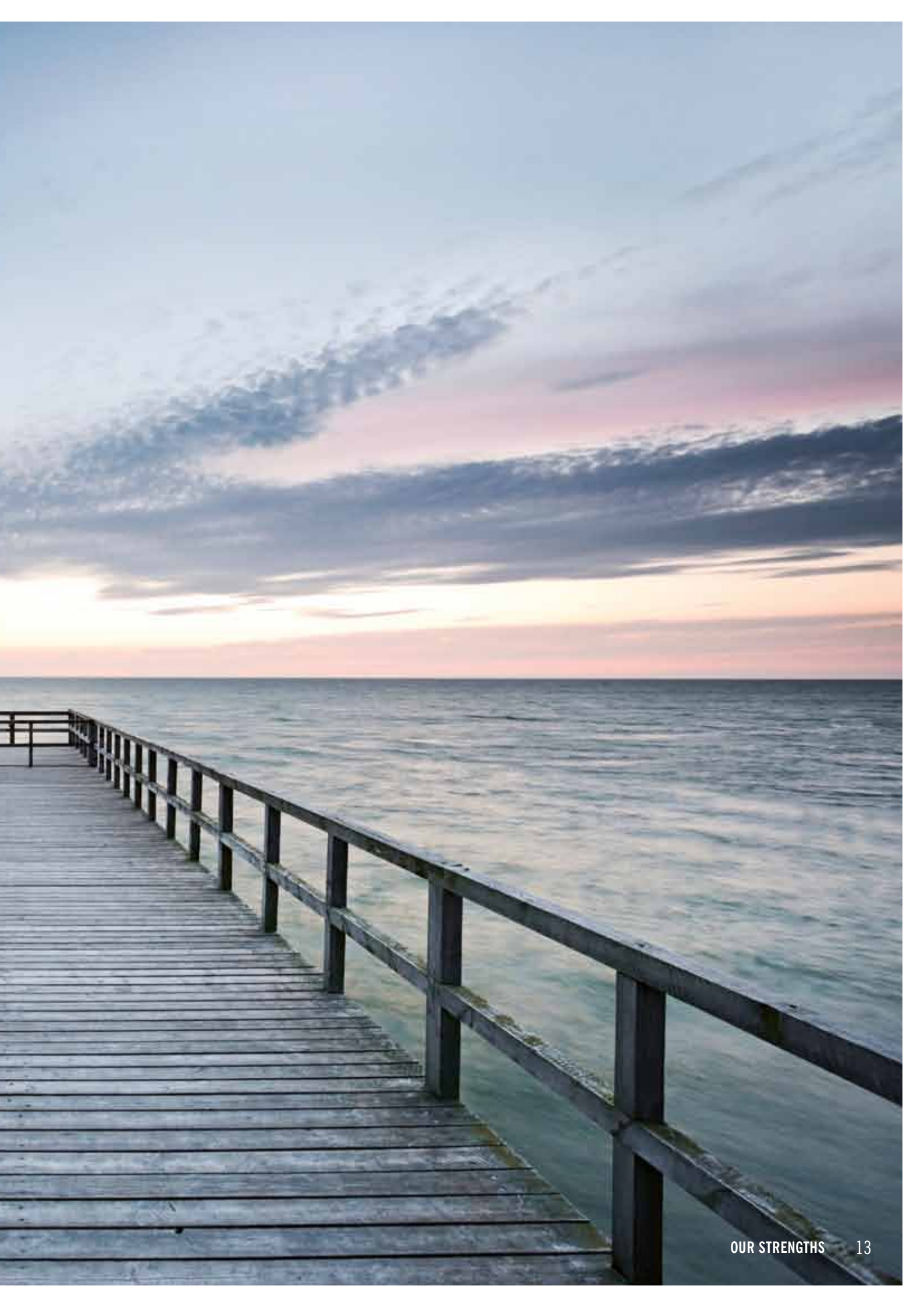


# VULKAN COUPLINGS SERVICE

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**Our ambition is not only to sell couplings – it is much more comprehensive. We broaden horizons and conceive our service as a system solution partner for our customers all over the world.**

Starting with consultancy and engineering, delivering top-quality products, over installation, monitoring and inspection – with our world-wide 24-hour service we clear your way to success. This integrated support concept is the basis for long-term customer relationships founded on trust and cooperation.





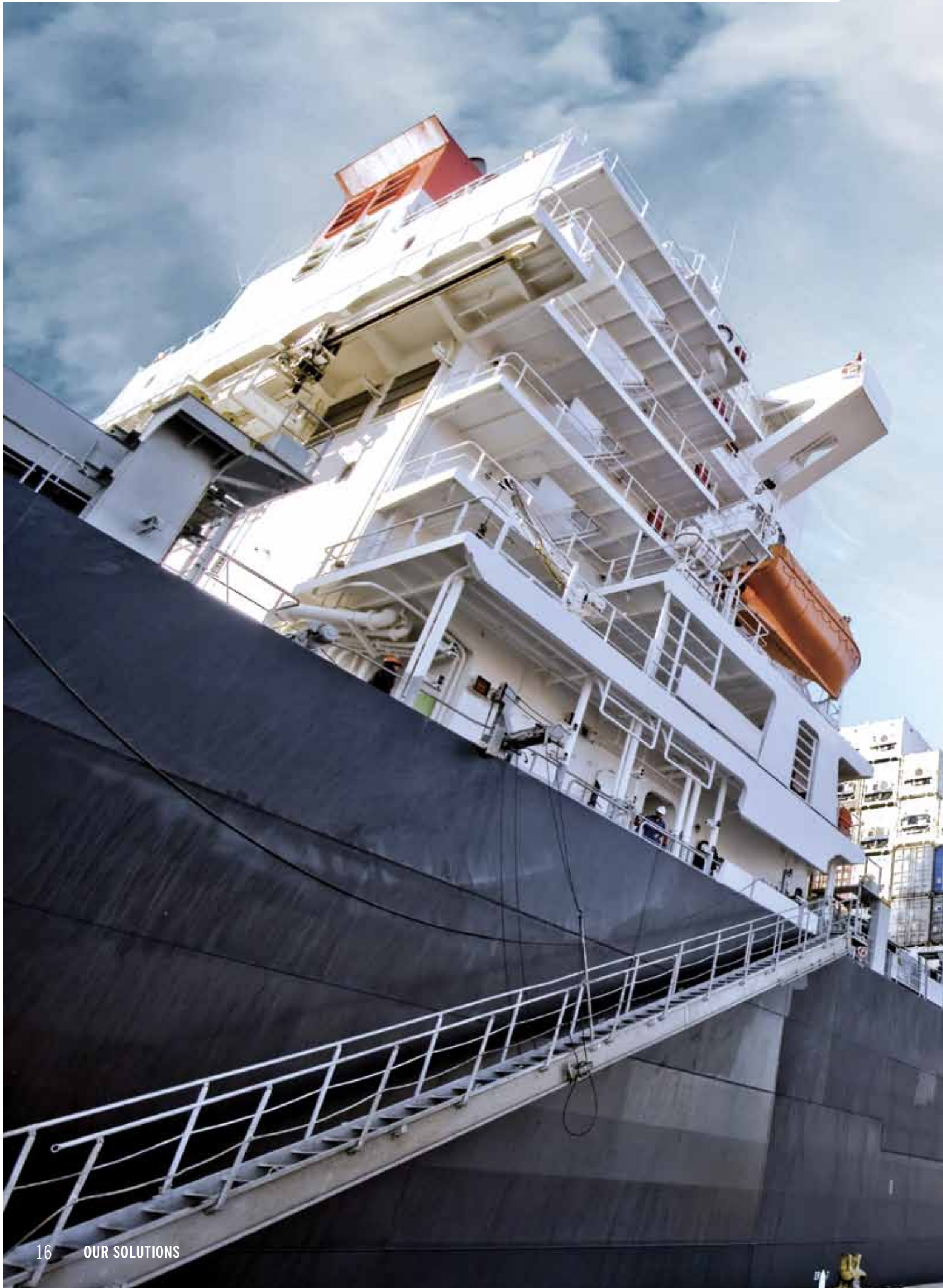
# VULKAN COUPLINGS TECHNOLOGY FOR SHIPS AND BOATS

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**The VULKAN Group works with 20 companies worldwide. Since 1889, the name VULKAN has stood for quality, technology leadership and customer satisfaction.**

The business segment VULKAN Couplings has the strongest sales activity in the VULKAN Group. Soon it concentrated on diesel engine applications in shipping and generator equipment. The use of flexible couplings in diesel engines requires the most demanding combination of power transmission, balancing of displacement and torsional vibration damping. The specialists at VULKAN have built an unique

knowledge base over many decades in the area of torsional vibration and earn their reputation as leading problem solvers. VULKAN has always conducted the rapid development of diesel engines with higher performance and more effective couplings. For more than 50 years, VULKAN couplings have been used on nearly all types of ships with diesel mechanic or diesel electric drive concepts. Large cruise ships such as the Queen Mary II, workboats such as the world's largest ship Pieter Schelte and boats for leisure activities can all benefit from the outstandingly dynamic properties and the long product lifetime of the couplings made in Herne/Germany.





# CARGO VESSELS

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Various drive designs are used for merchant ships, with both two-stroke as well as four-stroke diesel or dual fuel engines. Highly flexible couplings not only find application in main drives with diesel-mechanical and diesel-electrical drive units, but also in auxiliary drive configurations for generating electrical power, as well as for PTI, pump drives etc.

Through the RATO family, a comprehensive, standardized range of couplings is available that also meets particular requirements of this sector, such as the safe transmission of very high torques. Here, a broad spectrum with regard to torsional elasticity and dampening properties enables optimum coordination of the rotational vibration behavior. The proportion of elastically mounted engines is also increasing in the merchant ships sector. VULKAN Couplings has taken this into account by also including elastic mounts as part of the product range.



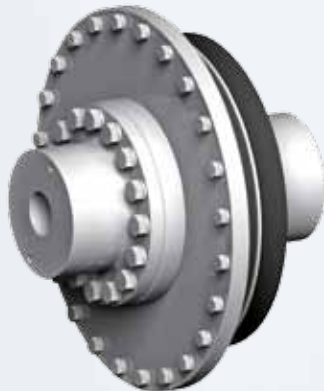
# THE DIESEL-MECHANIC FOUR-STROKE DRIVE

The most frequently used mode of propulsion in not only general cargo ships and bulk cargo ships, but also in tankers and container ships, are medium-sized, single-engine units with high-volume, medium-fast running four-stroke diesel engines, which drive a controllable pitch propeller (CPP) via a reduction gear. The CPP is necessary as most of these units also drive a generator via gearbox PTO from the main gearbox.

This classic drive design requires careful adjustment of rotational vibration by means of a highly flexible coupling in the main drive line, between the diesel engine and the main transmission, as well as in the fast-running PTO line. With their broad spectrum of available

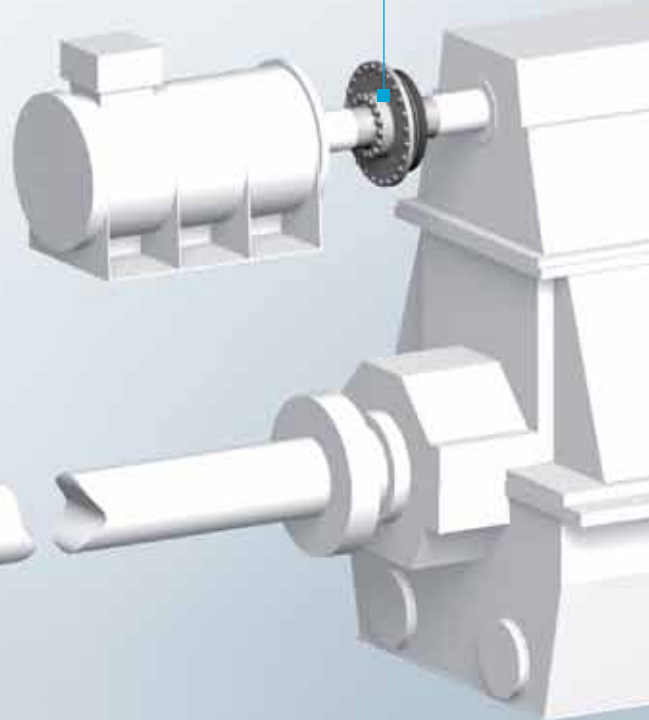
torsional stiffnesses, VULKAN RATO S and RATO R series ensure optimum rotational vibration behavior, as well as low stresses in the main gear and in the PTO unit shaft line. The more and more encountered elastic mounting of the main engine in this shipping sector, for reasons of comfort, requires a main drive coupling that can absorb the axial, radial and angular displacements with the lowest possible reaction forces. These properties are additional strengths of the highly flexible RATO R and RATO S series.

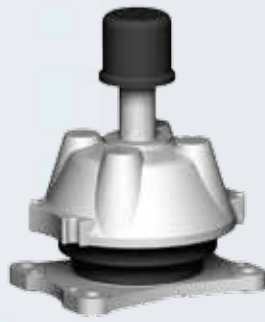
The interaction between the flexible coupling and the elastic engine mounting may be further optimized through the use of elastic mounts from the VULKAN Couplings product range.



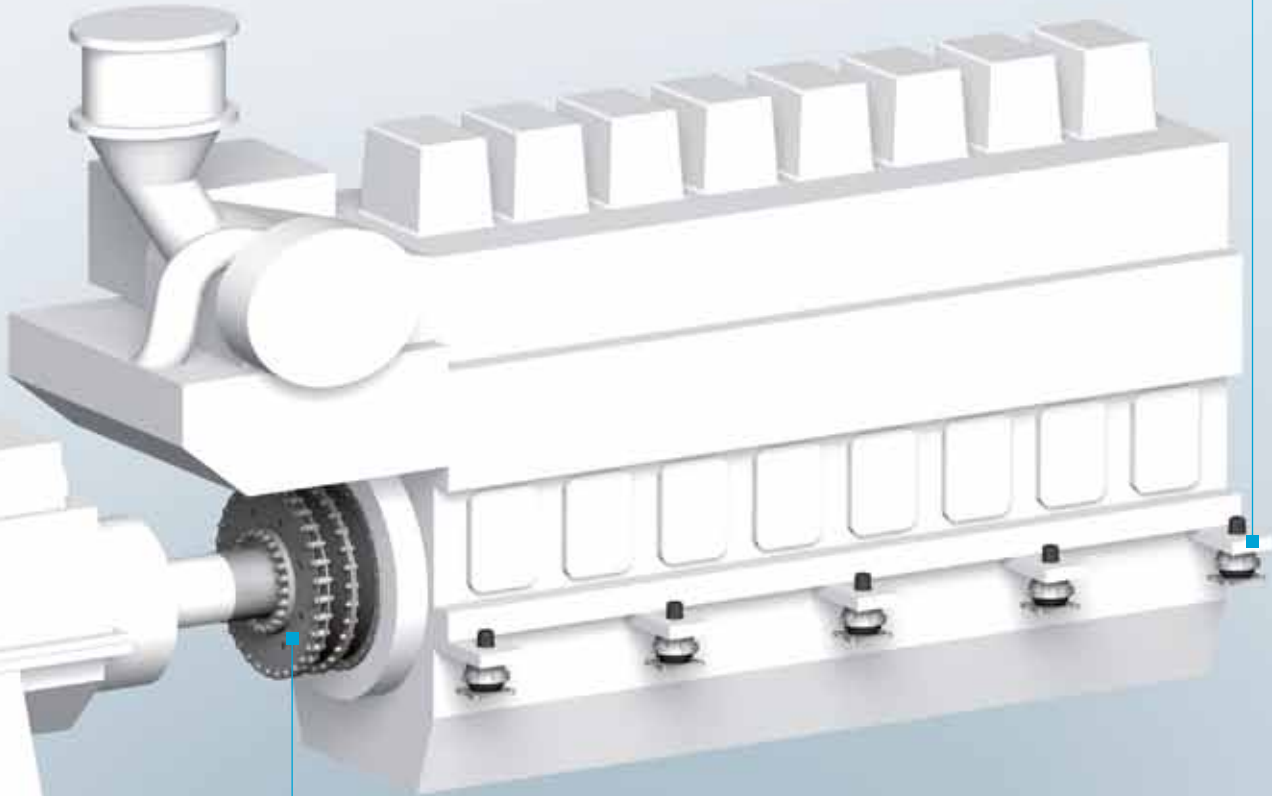
## VULKARDAN E SERIES

**TORQUE RANGE**  
2.50 kNm – 20.00 kNm





**T SERIES**  
LOAD CAPACITY  
3.00 kN – 175.00 kN

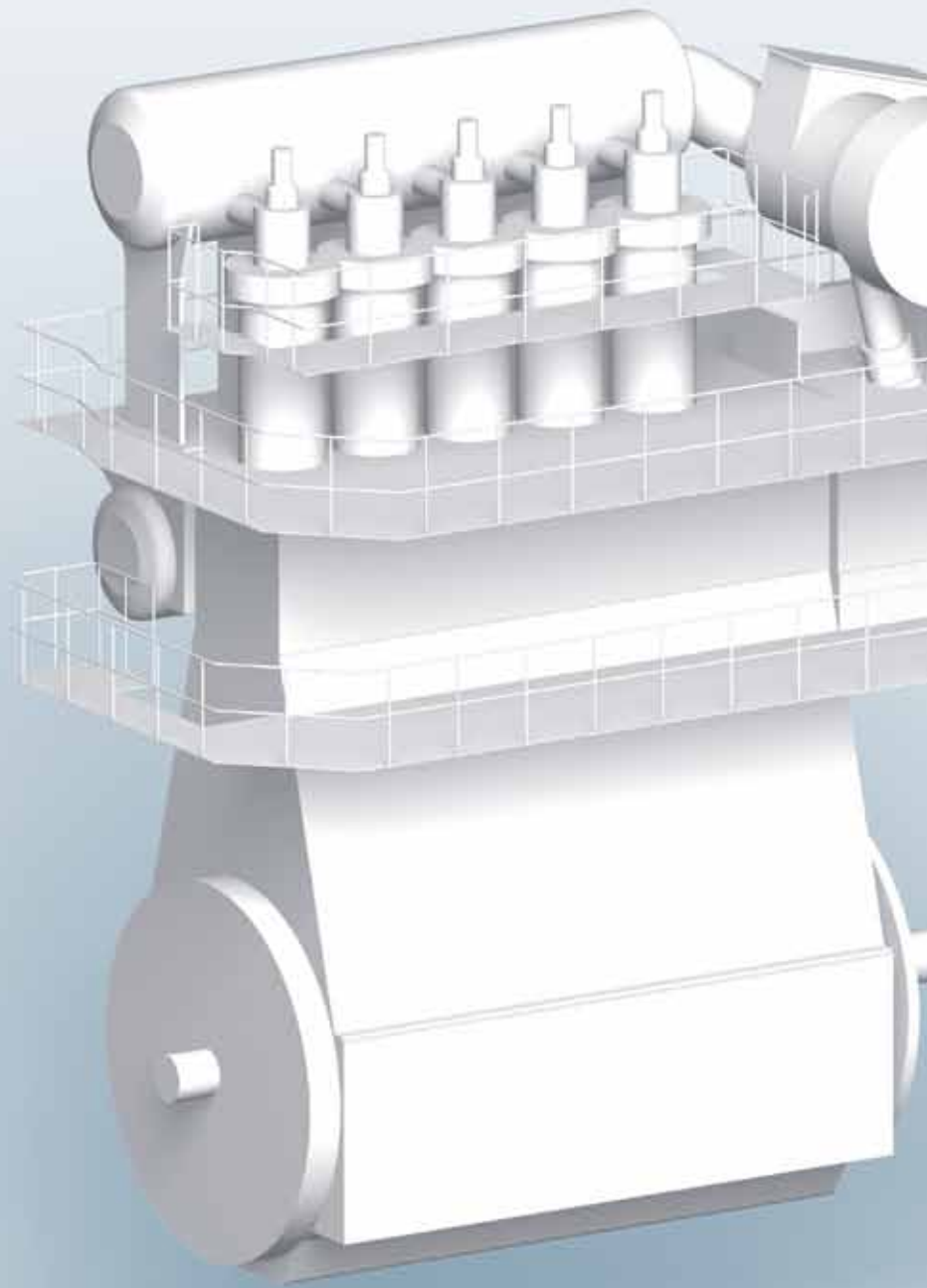


**RATO R SERIES**  
TORQUE RANGE  
12.50 kNm – 270.00 kNm

# GENERATOR DRIVE VIA TUNNEL GEARBOX

The generation of electrical power on ships with two-stroke diesel or dual fuel drives can be achieved in many different ways. The most space-saving solution with regard to axial length is the generator drive through the main engine via a tunnel gearbox, which encloses the closed propeller shaft line. This means that the highly flexible connection from the propeller shaft to the hollow gearbox shaft, necessary for elimination of inadmissible rotational vibrations in the generator drive, can only be achieved through a

segmented coupling. Looking at this in another way, this means that this type of drive could only be realized following development of the RATO S series. At this point, the coupling also protects the gear meshes to the high gear stage from potential vibrations from the direct-coupled propeller shaft. Vibrations and shaft displacements, occurring in the high speed PTO branch between the tunnel gearbox output and the generator, are absorbed by additional, highly flexible VULKAN Couplings.



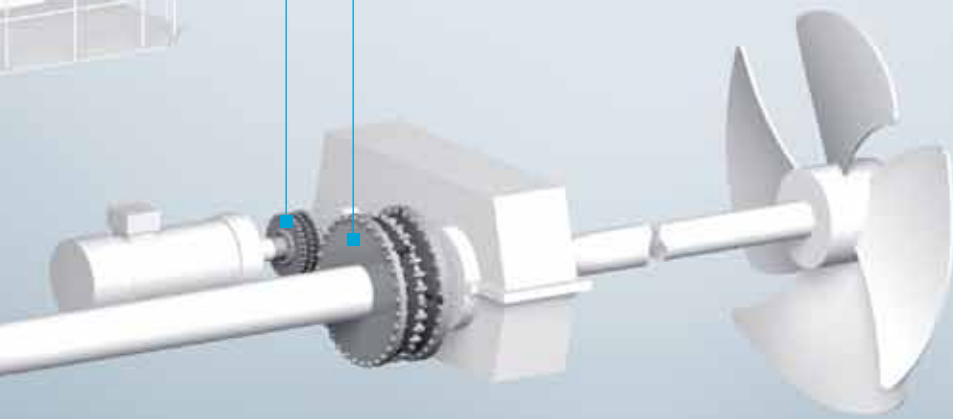
## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm



## RATO S SERIES

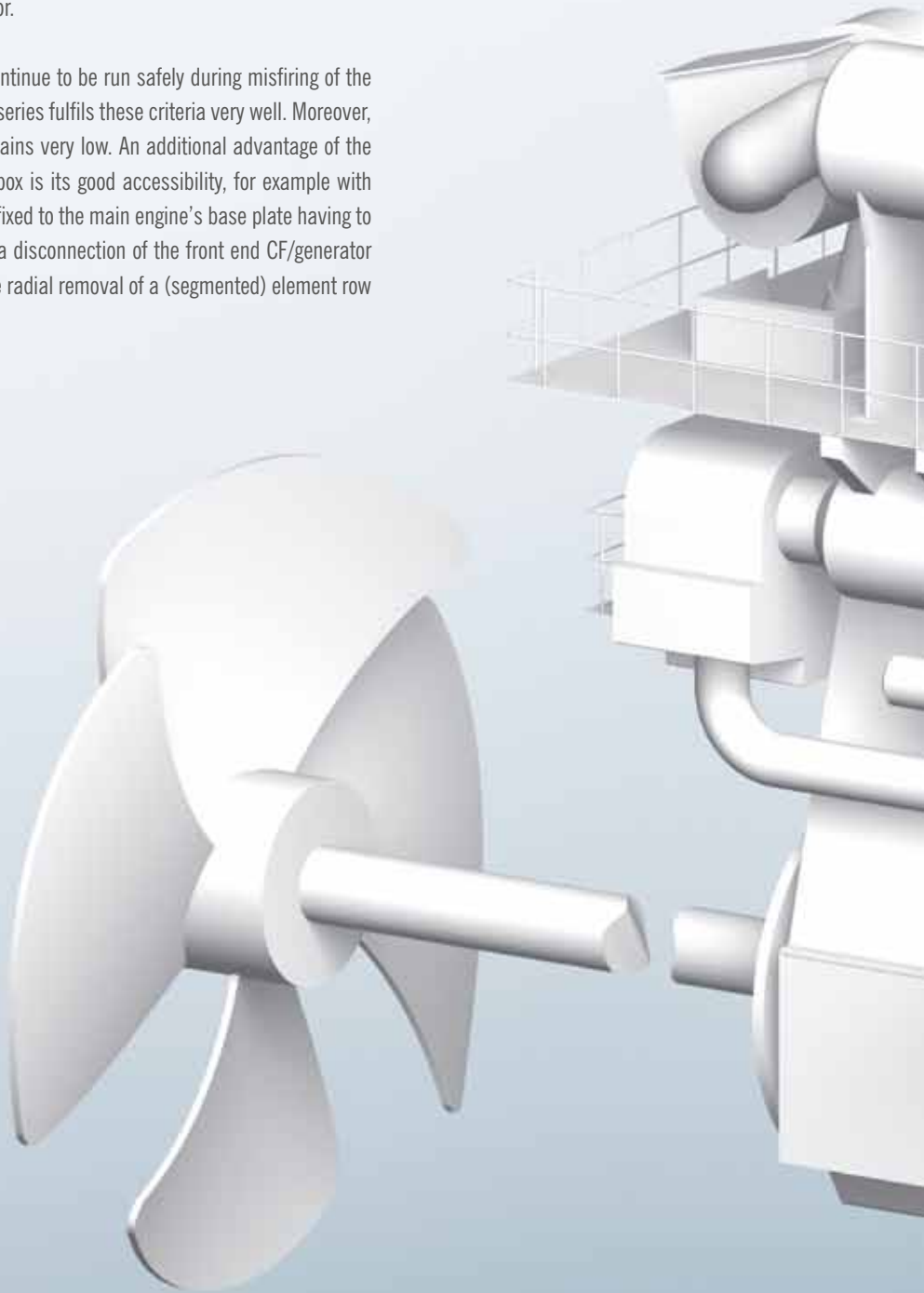
TORQUE RANGE  
12.50 kNm – 800.00 kNm

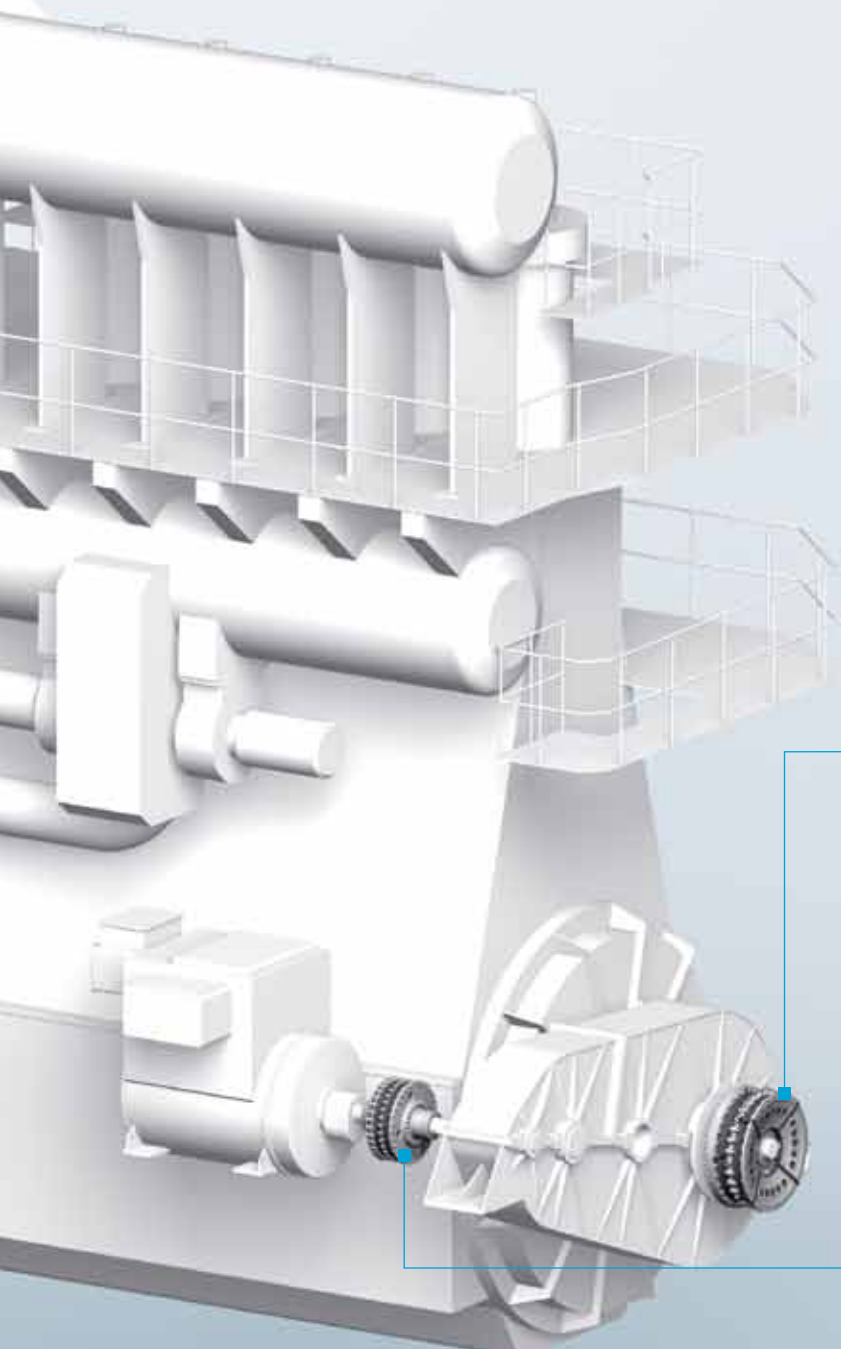


## THE CF DRIVE

Another current solution generating electrical power via a generator driven by a two-stroke diesel or dual fuel engine, is the constant frequency (CF) unit, which is located at the front end of the main engine. This serves to drive an alternator, whereby the generator speed, despite the varying speed of the main engine, is held constant through a planetary, hydrostatic transmission. A torsionally soft connection of the CF generator unit to the main engine is advantageous here in terms of better torsional vibration behavior.

Hereby, it is possible for the generator unit to continue to be run safely during misfiring of the main engine. The highly flexible VULKAN RATO S series fulfils these criteria very well. Moreover, it ensures that the gearbox stress generally remains very low. An additional advantage of the RATO coupling installed at the front of the gearbox is its good accessibility, for example with inspections, without the spur gear transmission fixed to the main engine's base plate having to be removed. This advantage also exists should a disconnection of the front end CF/generator unit become necessary due to failure. The simple radial removal of a (segmented) element row of the RATO S series secures the disconnection.





## RATO S SERIES

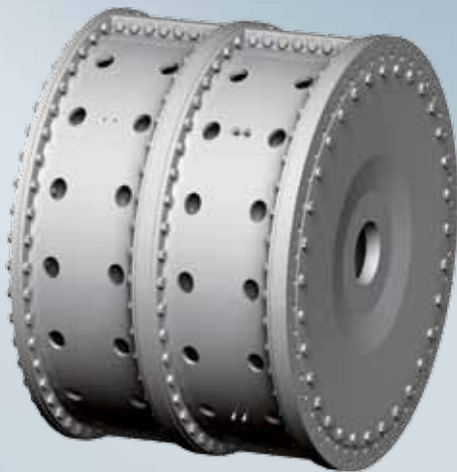
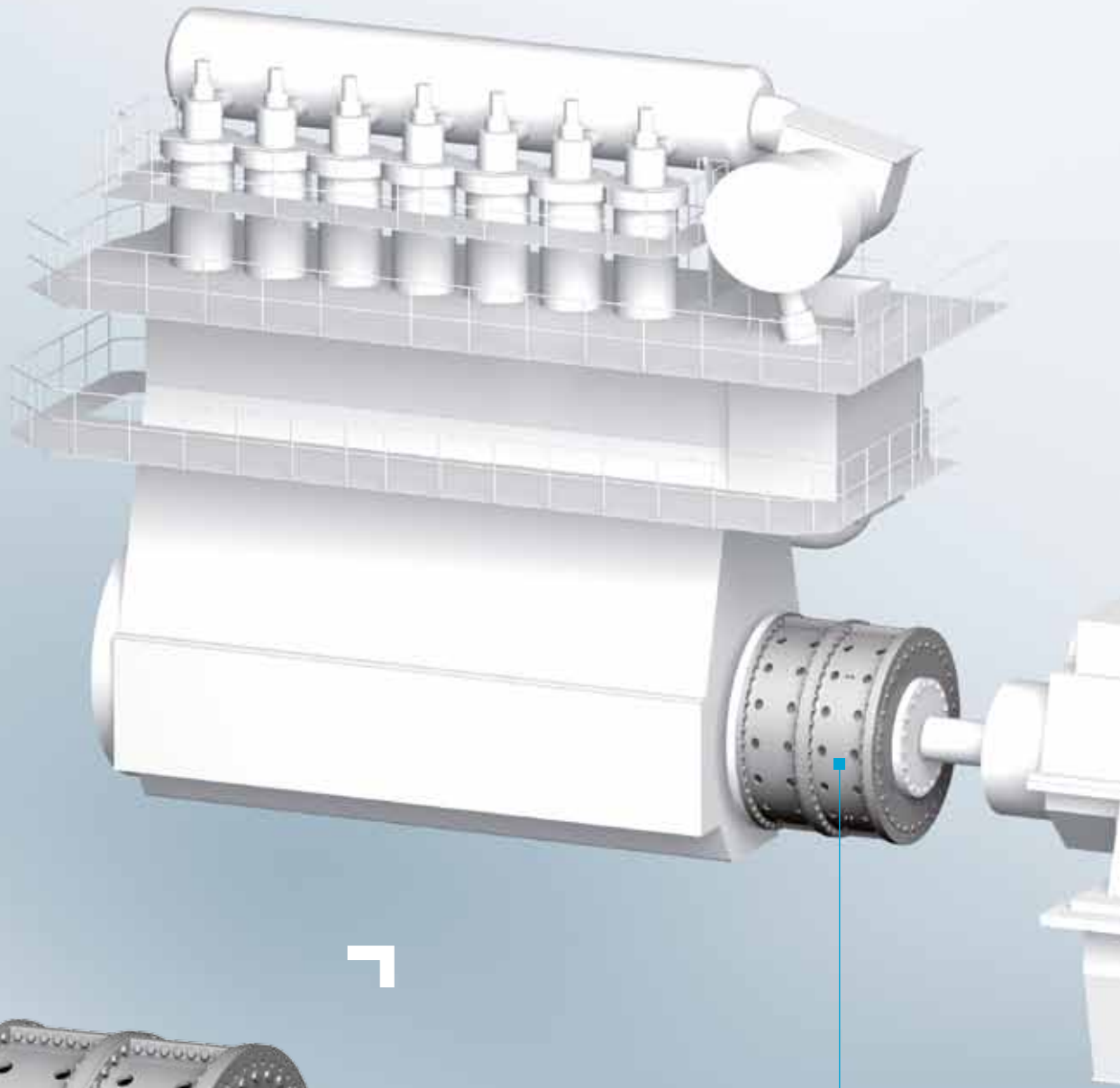
TORQUE RANGE  
12.50 kNm – 800.00 kNm



## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm





**RATO S SERIES**  
(special design)

**TORQUE RANGE**  
up to 2000.00 kNm



# THE TWO-STROKE MAIN PROPULSION DRIVE WITH REDUCTION GEAR

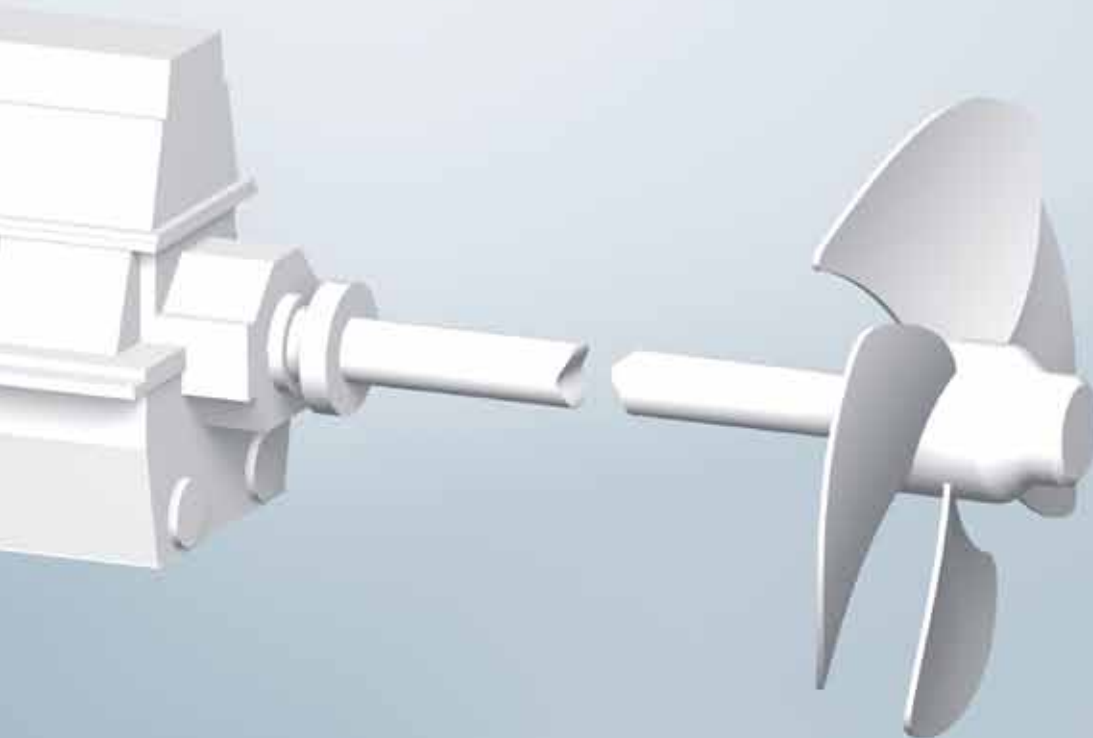
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The trend towards ever larger tankers or container ships for economic reasons places increased demands on the maneuverability of ships, due to increasing shipping traffic on the world's seas and, in particular, due to narrow shipping lanes. Lowest possible propeller speeds are not only good for maneuverability, but also allow the use of bigger propellers, which leads to clear increases in the efficiency of drive units. The use of reduction gears in the two-stroke main propulsion drive lines provide the possibility of reducing the propeller speed.

This concept places particular demands on the flexible couplings to be installed between the main engine and the reduction gears for reasons of torsional vibration and misalignment. Nominal torques to be transmitted of 1,500 kNm are not unusual (such as, for example, in the Vmax tanker "Stena Vision" and "Stena Victory", with two MAN B&W 7S60 MC-C engines with a performance of 15,785 kW each at 105 r.p.m.; propeller speed (FPP) at 66 r.p.m.).

Electronically controlled injection systems of modern two-stroke diesel engines hereby enable long-term operation at extremely low speeds, in order to further improve the maneuverability. However, this requires highly flexible couplings with torque-dependent (progressive) stiffness characteristic to keep the resonance from the main engine order, with a connected propeller, very low.

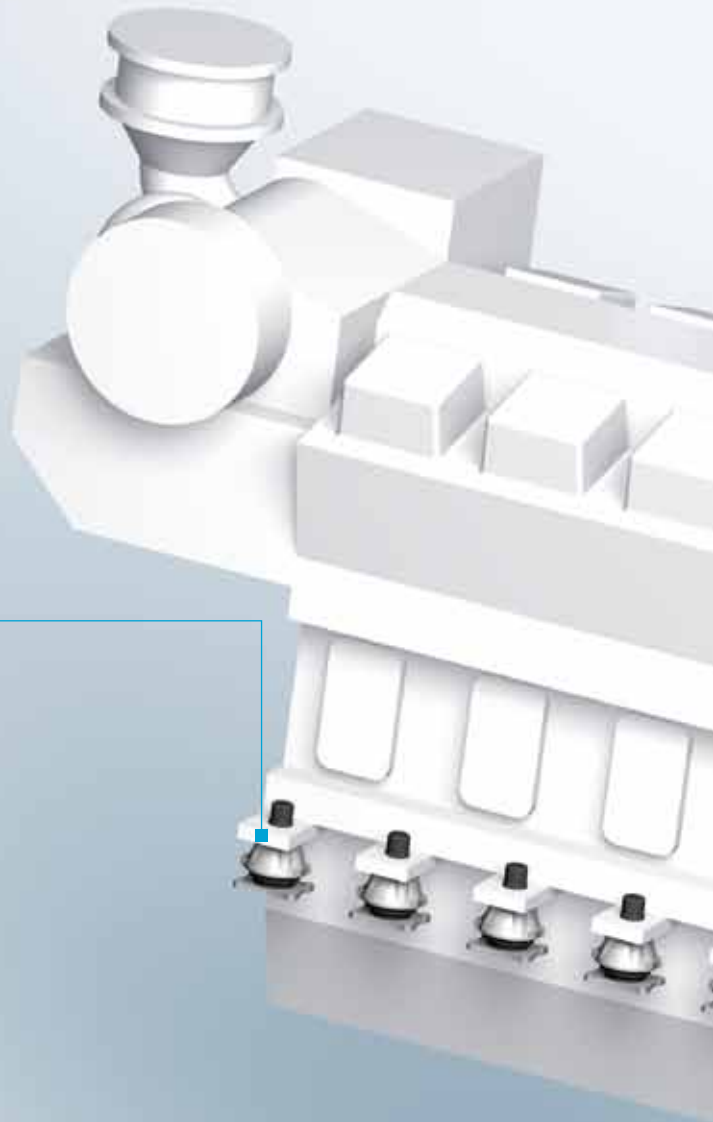
VULKAN Couplings has the competence, the experience and the products to equip such challenging units successfully. Based on the RATO S series range, specialized couplings were developed, which currently can transmit a nominal torque to 2,000 kNm. Through the use of silicon elements the desired progressive torsional stiffness characteristic is achieved. The use of this coupling technology enables the main propulsion drives of the above-mentioned Stena Vmax tanker to achieve propeller speeds of 19 r.p.m. during maneuvering, without producing any gearbox noise.





## T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN



## RATO S SERIES

TORQUE RANGE  
12.50 kNm – 800.00 kNm

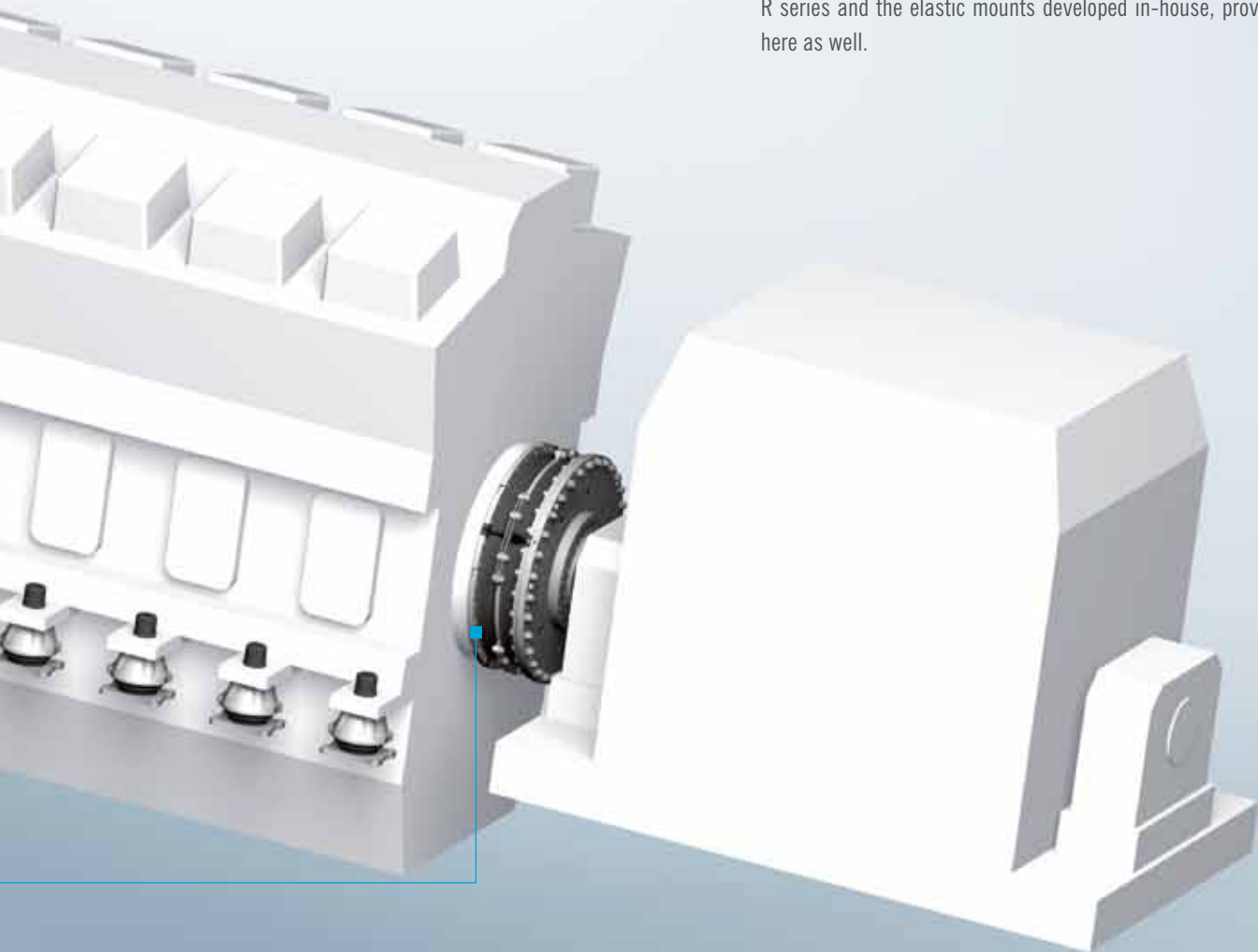
# THE ELECTRIC DRIVE WITH FOUR-STROKE DUAL FUEL ENGINES

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LNG/LPG gas tankers exploit the property of their cargo to expand for their own propulsion. Although in the past mostly steam turbines were used that were suitable for this fuel, in the last few years, particularly due to more stringent laws on emissions, there has been a rethink towards more efficient, cleaner and compact propulsion designs. The most useable, in the meanwhile, is the main propulsion drive using electric motors. The energy required to power them is produced by a power plant.

This unit consists of several gensets and their four-stroke, dual fuel engines are driven by boil-off gas. The gas drive places even higher demands on the highly flexible coupling to keep the vibratory stress in the system to an acceptable level for the connected components. Due to their design, the VULKAN RATO S, RATO R and RATO DG series enable a backlash-free, precisely controllable transmission of torque, which eliminates the risk of shock loads in the system.

These engines are also being increasingly elastically mounted. This means that the tuned system between VULKAN RATO S and RATO R series and the elastic mounts developed in-house, proves itself here as well.





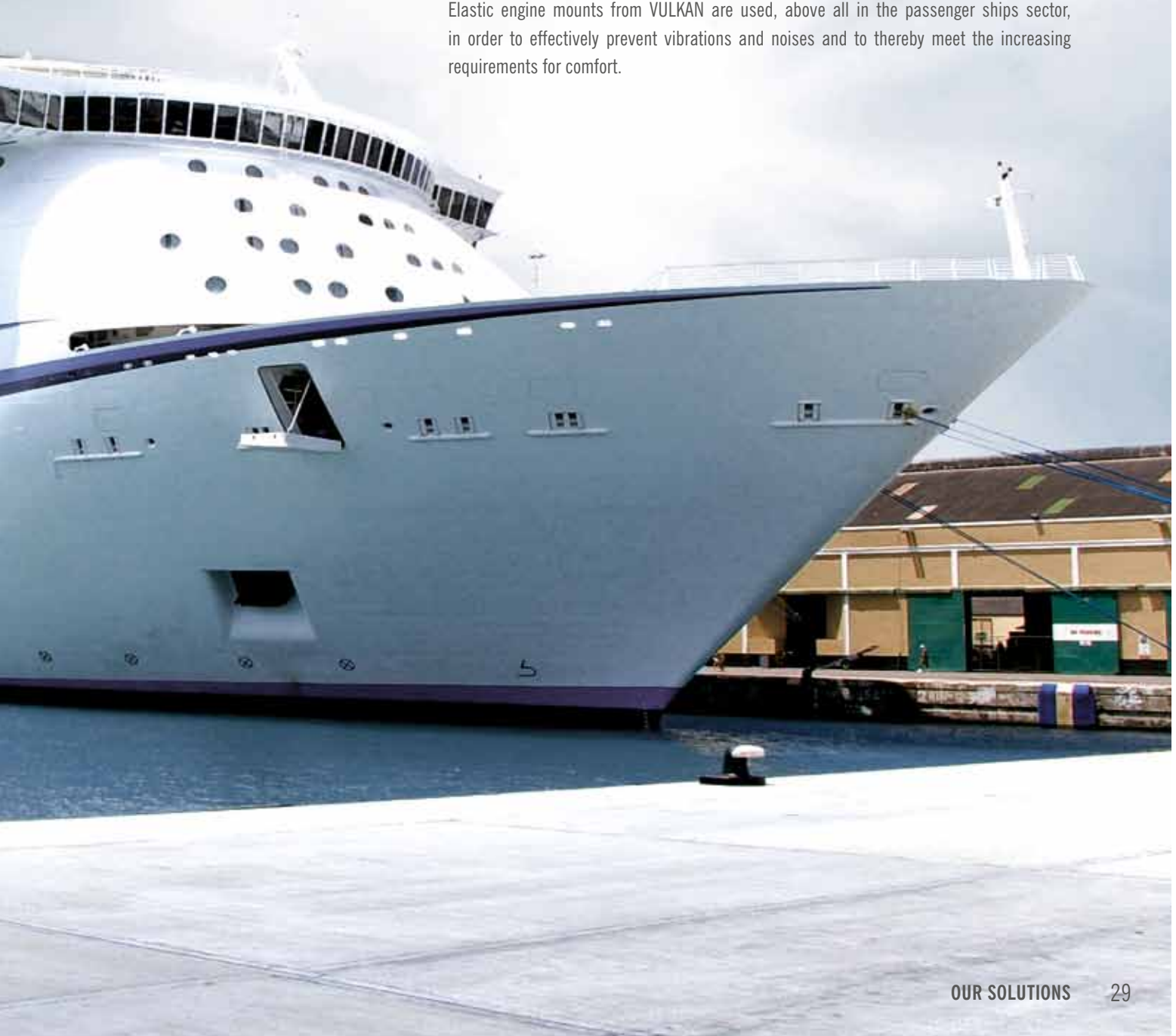
# PASSENGER SHIPS

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Passenger ships are characterized in particular by a comfort-based selection of the propulsion concept. A low vibration and noise level must be guaranteed. Besides the requirements for optimum torsional vibration behavior, multi-engine applications with only elastically mounted four-stroke diesel engines (more and more also dual fuel or gas-driven) make high demands on the misalignment capacity of flexible couplings. Highly flexible RATO S and RATO R couplings meet these requirements; they are characterized by their potential to absorb high axial, angular and radial misalignments.

In fast ferries, the weight optimization of the drive components is also an important consideration. With this in mind VULKAN Couplings delivers solutions involving the use of light weight composite shafts.

Elastic engine mounts from VULKAN are used, above all in the passenger ships sector, in order to effectively prevent vibrations and noises and to thereby meet the increasing requirements for comfort.



# THE MULTI-ENGINE, DIESEL-MECHANIC FOUR-STROKE DRIVE

The large drive units in RoPax ferries are characterized by a high complexity, which permits a high level of variation in the operating profiles, for the greatest possible profitability. Mostly diesel-mechanical, four or more diesel engines drive two or more controllable pitch propellers via one double transmission (twin input/single output) each. In addition, generators are built in through the PTO stage of the main gearbox or at the front end of the engine, to meet the high electricity requirements on board. Thereby the PTO transmission is also set up as a PTI; i.e. the generator works as an electric motor for maneuvering. In terms of torsional

vibration, due to the arrangement of the drive line components, as well as several possible drive variations, high demands are placed on the flexible couplings. In addition, the soft elastic mounting of the engines, as well as the spatially economic arrangement of the drive components, demand a high degree of misalignment capacity from the coupling within smallest dimensions. Here as well a useful combination of VULKAN RATO S and RATO R series, in conjunction with in-house developed elastic mounts and torsionally stiff VULKAN misalignment couplings, represent the universal solution.

## T SERIES

**LOAD CAPACITY**  
3.00 kN – 175.00 kN



## MEMBRANE COUPLING

**TORQUE RANGE**  
12.50 kNm – 500.00 kNm



## RATO R SERIES

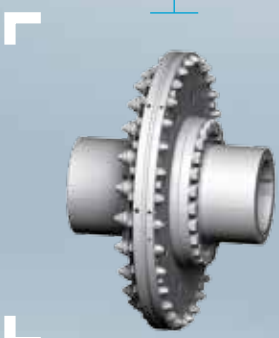
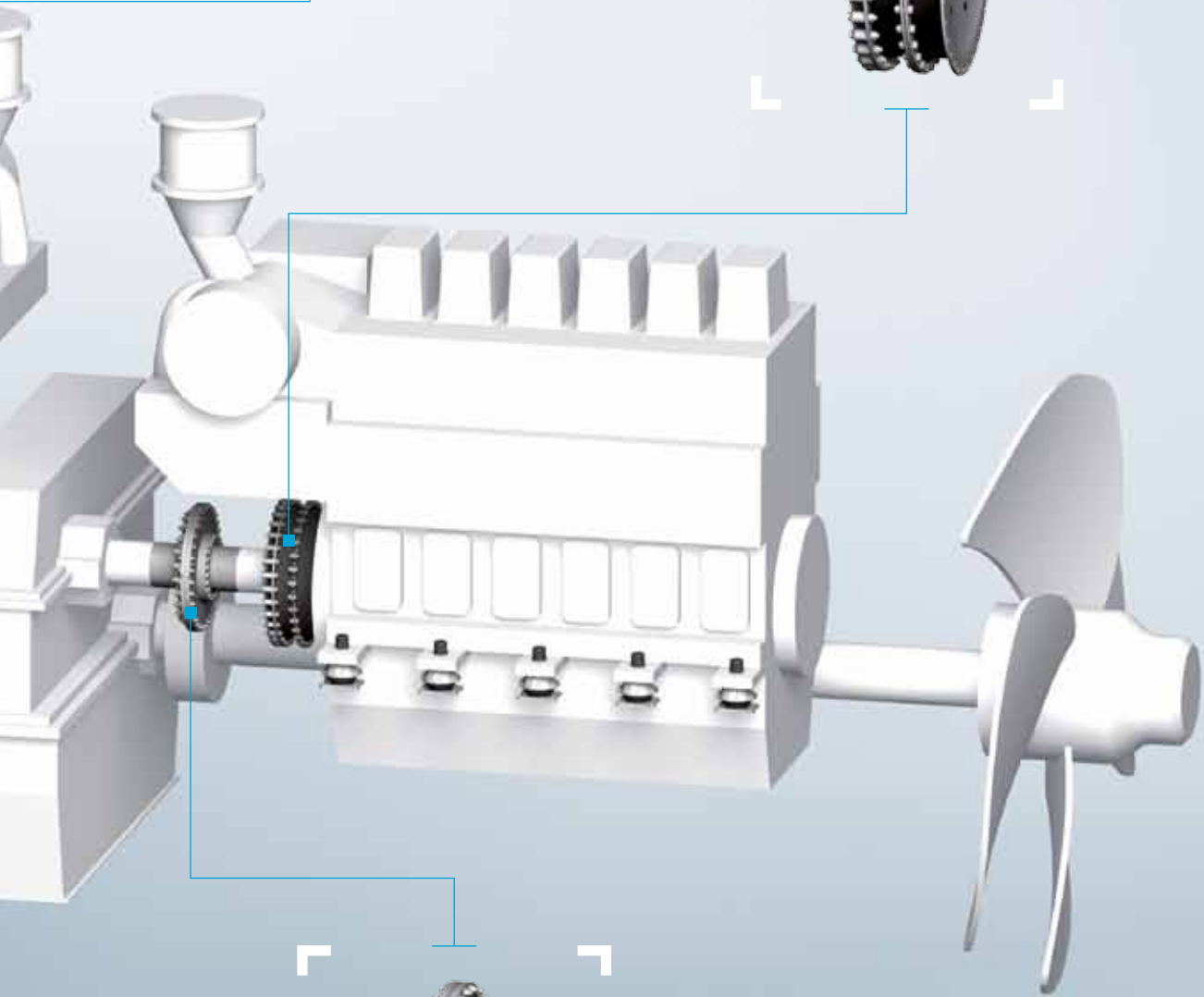
**TORQUE RANGE**  
12.50 kNm – 270.00 kNm



**RATO R SERIES**  
TORQUE RANGE  
12.50 kNm bis 270.00 kNm



**RATO R SERIES**  
TORQUE RANGE  
12.50 kNm bis 270.00 kNm



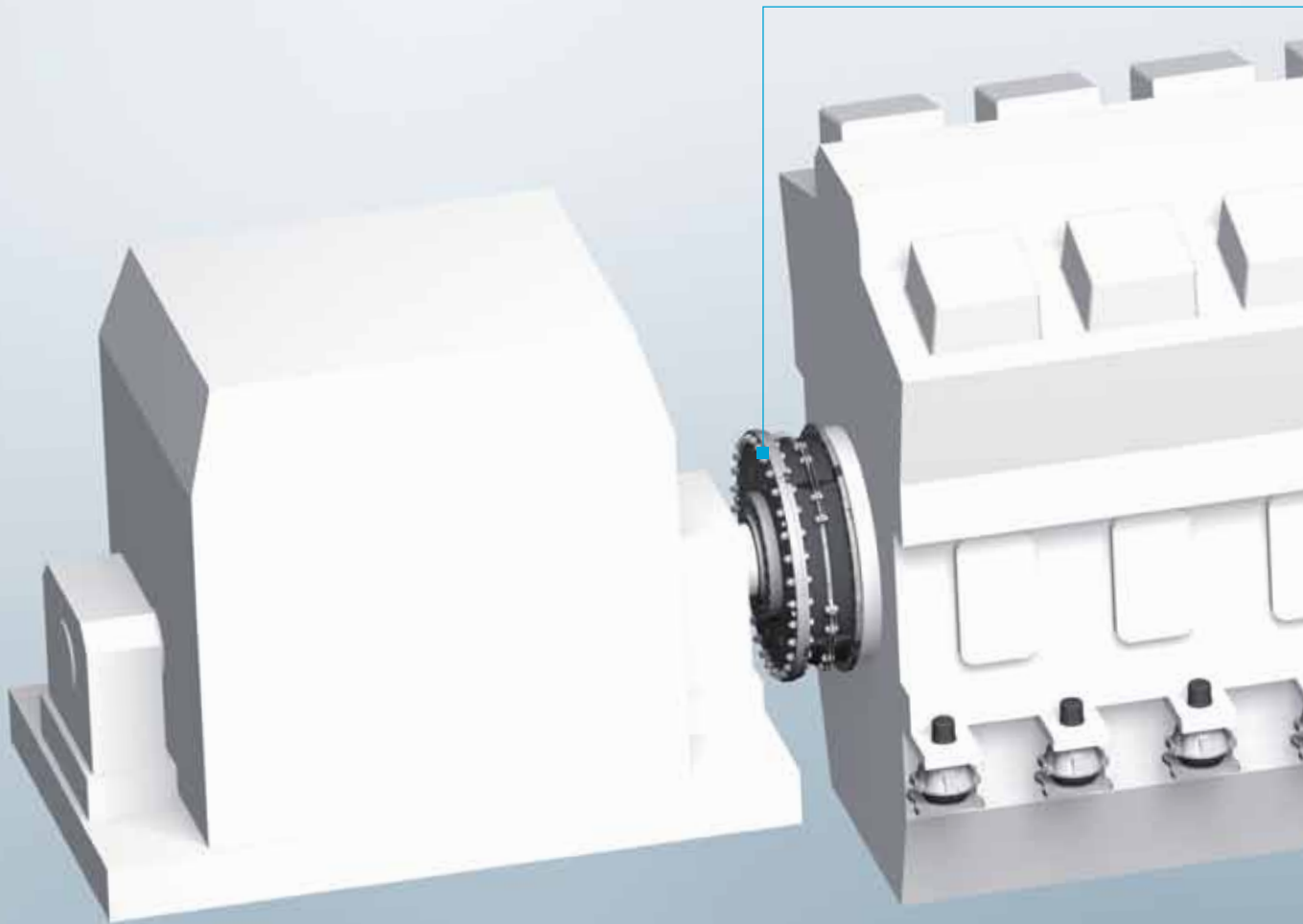
**MEMBRANE COUPLING**  
TORQUE RANGE  
12.50 kNm – 500.00 kNm

# THE COMPACT DIESEL-ELECTRIC DRIVE

Cruise ships are characterized by a particularly high requirement for comfort; this is also valid for the drive unit. Although in the past still more diesel-mechanic drives were used, today diesel-electric drives are found almost exclusively, mostly in combination with the highly maneuverable POD drive. The power supply required for the electric motors is provided by means of high-performance diesel generators.

In order to reduce the noise levels, the almost exclusively built high-volume, four-stroke diesel engines are elastically mounted; the generators, in contrast, are rigidly mounted. The compact design

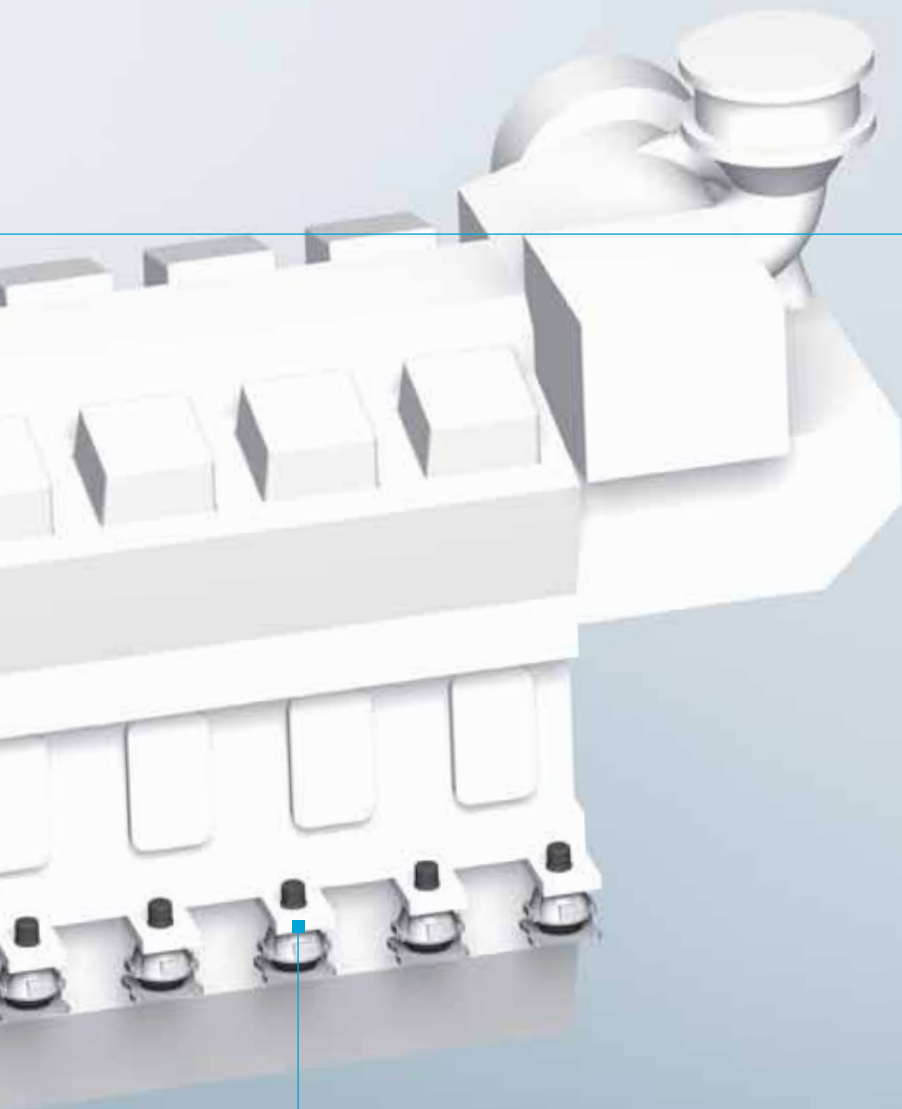
evident here (diesel engine and generator are located in the same compartment) not only demands an optimum torsional stiffness level from the flexible coupling to adjust the torsional vibration state, but also a high misalignment capacity within a compact design. Added to this comes the necessity to reduce the amplitude of the structure-borne noise between the engine and generator. With its highly flexible RATO S and RATO R standard couplings, in combination with elastic mounts made specifically for the particular application, VULKAN Couplings offers a complete solution that fulfils these requirements very well.





## RATO S SERIES

TORQUE RANGE  
12.50 kNm – 800.00 kNm



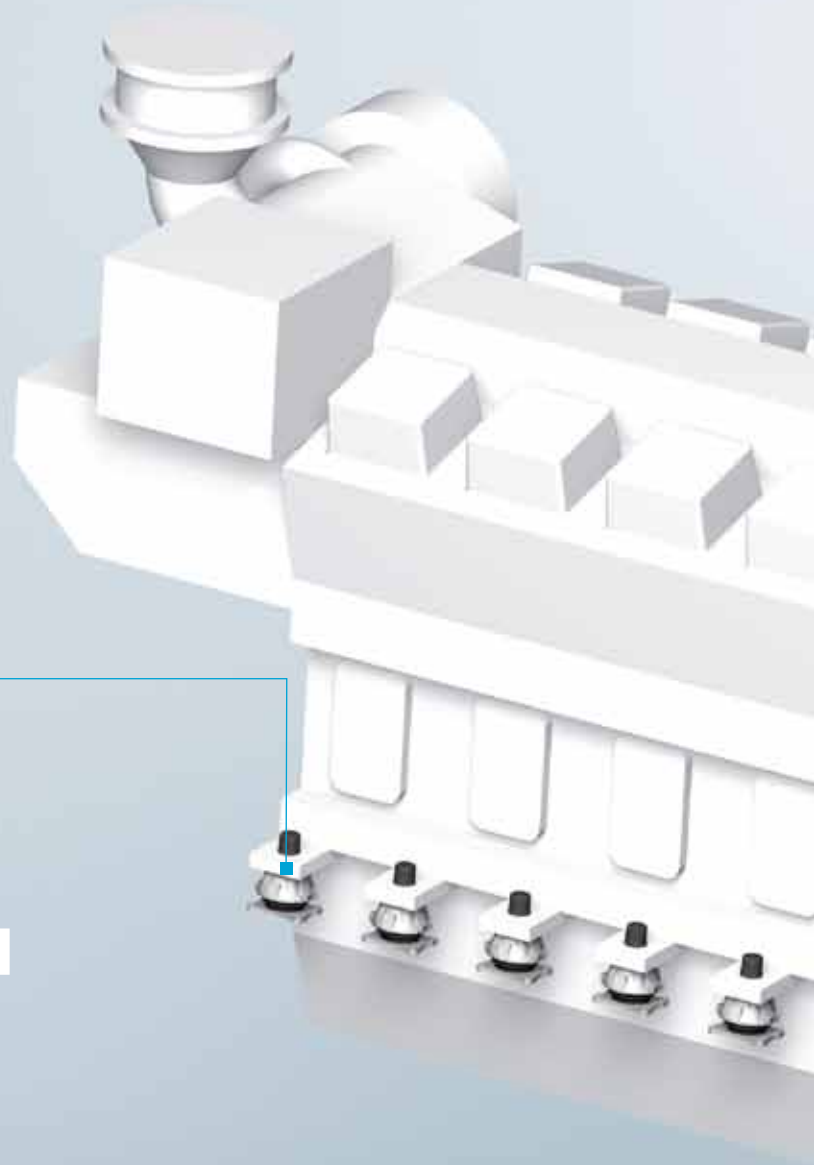
## T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN



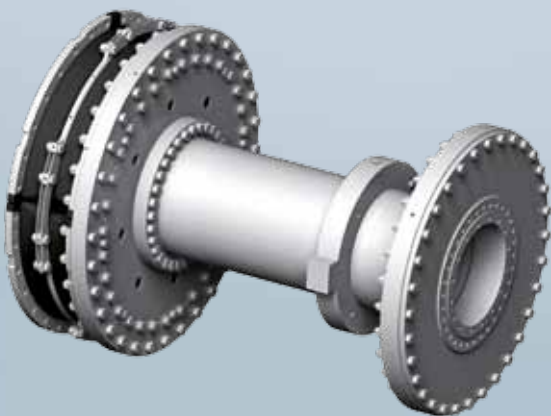
### T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN



### RATO S SERIES

TORQUE RANGE  
12.50 kNm – 800.00 kNm

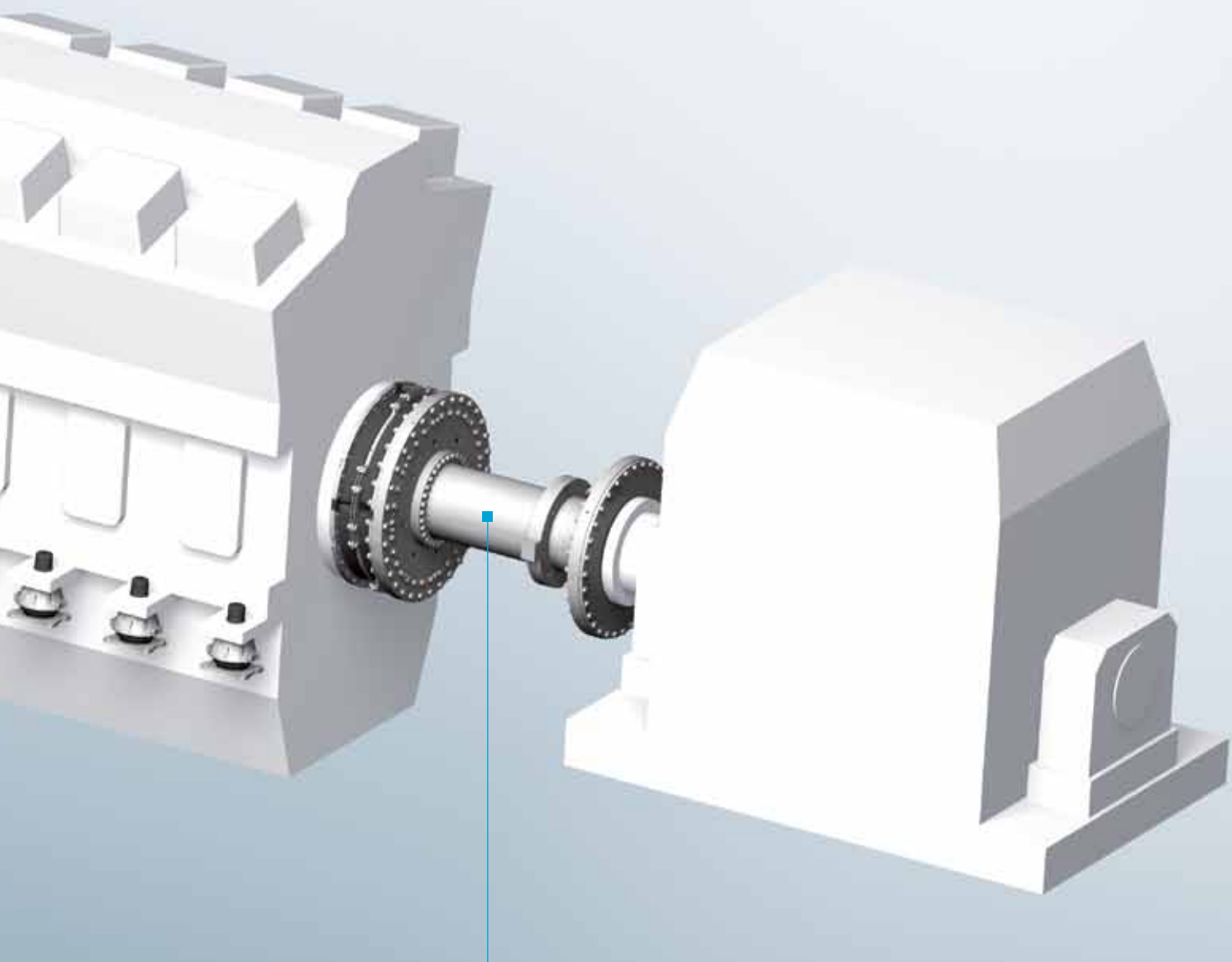


# THE SEPARATED DIESEL-ELECTRIC DRIVE ARRANGEMENT

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For ship design or safety-relevant reasons, the arrangement of compact gensets is not always possible. Often the four-stroke diesel engines are located separately from the generators in different compartments, separated by a bulkhead.

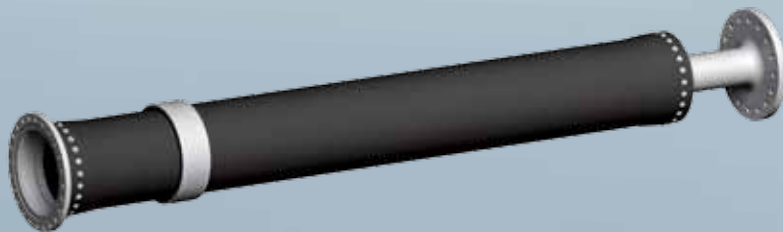
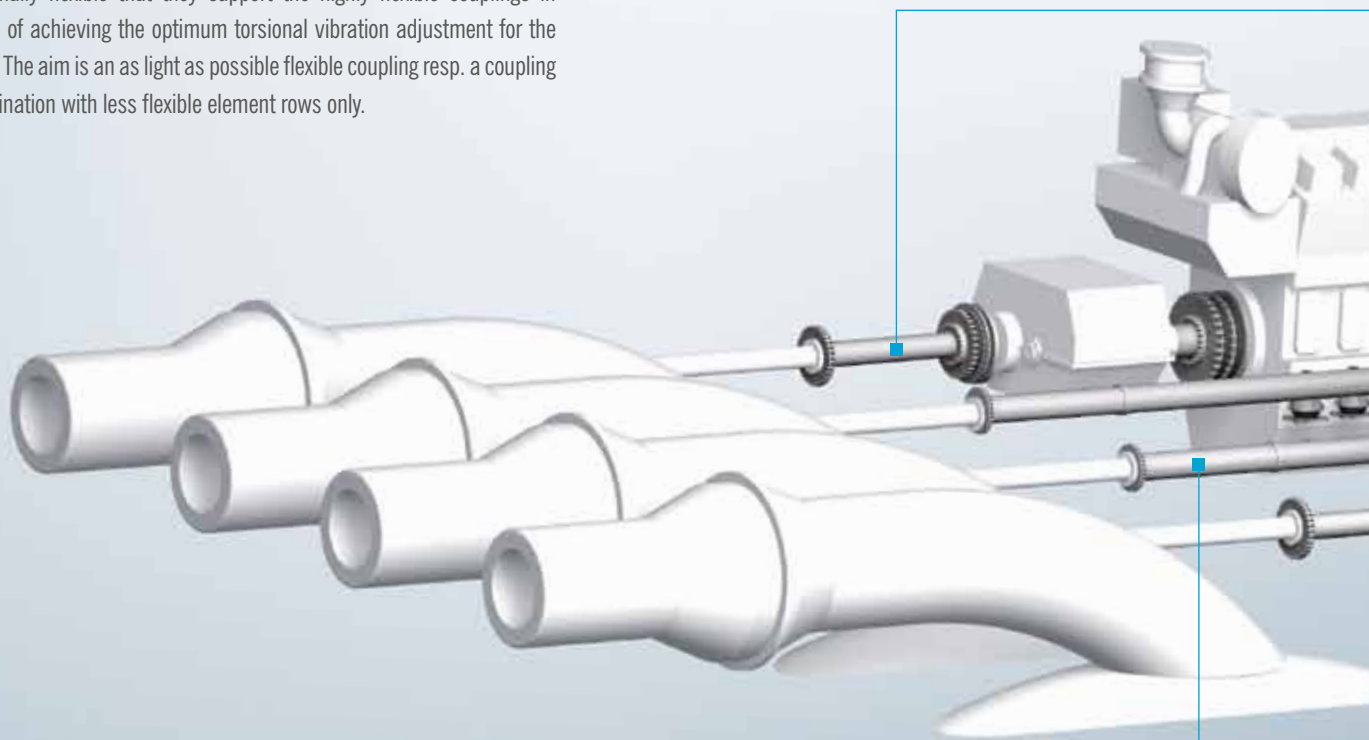
In such cases, tailor-made, highly flexible coupling solutions are required, in order to bridge the distance between engine flywheel and generator, as well as make adjustments for torsional vibrations and absorb large displacements. Here, VULKAN Couplings offers specialized, cardanic solutions based on the standard RATO coupling portfolio, which meet all criteria.



# THE JET DRIVE

Commercial use places high demands on fast ferry drives with regard to high power at high efficiency, which also inevitably leads to the requirement for less weight. Today, for reasons of comfort, one opts mainly for elastically mounted four-stroke diesel engines with high power density, as well as waterjet drives. The requirement for weight optimization is also valid for all other components of these diesel-mechanic drives. Due to their relatively low specific weight, composite shaft lines allow longer distances between the bearings and therefore less bearing points in comparison to heavier steel shaft lines, thereby saving significant weight. This is also true for the shafts themselves. Moreover, composite shafts, through the winding angle of their fibers, can be made so torsionally flexible that they support the highly flexible couplings in terms of achieving the optimum torsional vibration adjustment for the units. The aim is an as light as possible flexible coupling resp. a coupling combination with less flexible element rows only.

With the famous RATO R, VULKAN Couplings offers a compact, power dense, high misalignment coupling with large speed reserves; this coupling was specially developed for these units. Depending on ship-building requirements, it is supplied compact (standard) or cardanic, combined with a composite shaft to bridge larger distances - also available as a complete solution with in-house produced elastic engine mounts. VULKAN Couplings offers the composite shaft line after the transmission as a system inclusive of highly flexible couplings, mounts and bulkhead seals, including the relevant hardware - the complete solution from a single source.

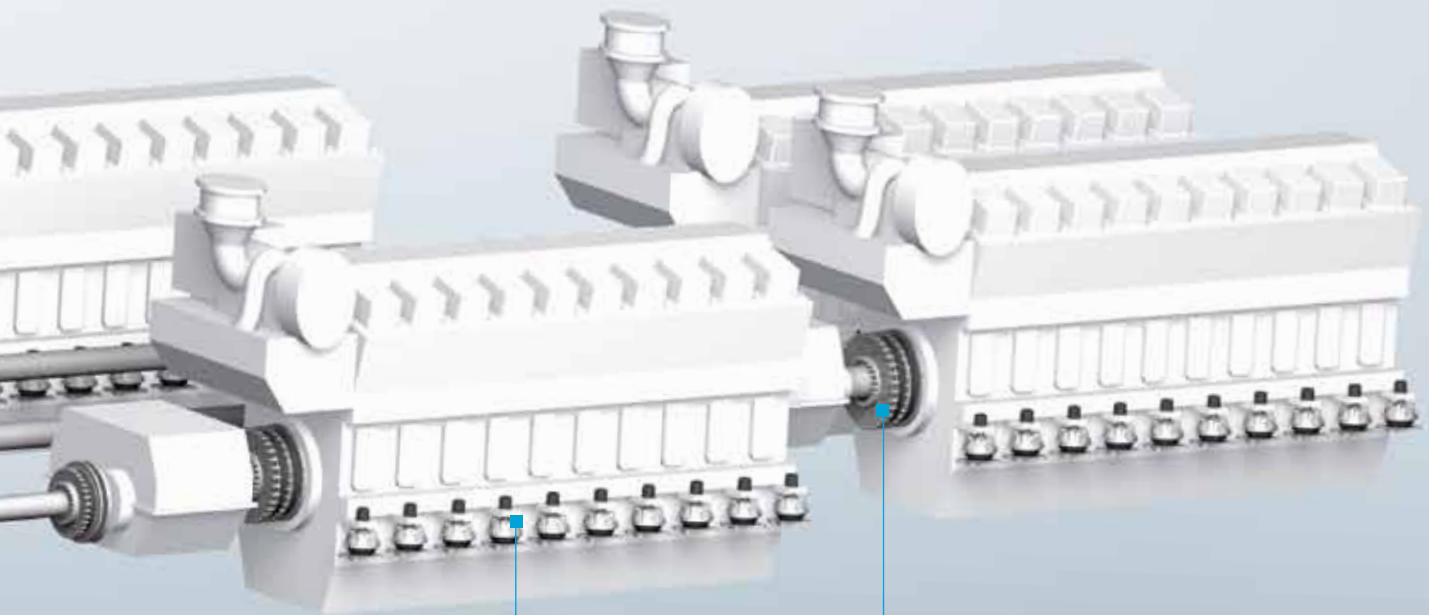


## COMPOSITE SHAFT

TORQUE RANGE  
5.00 kNm – 800.00 kNm

## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm



## T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN

## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm





# PLEASURE BOATS

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Generally speaking, pleasure boats are characterized by drive units optimized particularly for comfort and noise reduction. The drive engines used for these applications are characterized by a high power density combined with low engine weight. In conjunction with this lightweight construction, high demands are placed on optimum torsional vibration behavior, as well as the misalignment capacity of flexible couplings.

VULKAN Couplings provides an optimum product portfolio for these applications, comprising elastic mounts for engines and gearboxes, highly flexible couplings between engine and gearbox, couplings on the propeller shaft optimized for misalignment or noise reduction, together with special mounts for the engine's exhaust pipes.

Mega yachts, predominantly located in the luxury sector, make particularly high demands on the drive unit's running behavior. In most cases, high-performance, fast-running, but lightweight construction four-stroke diesel engines are used to drive propellers or water jets. This and other characteristics of shipbuilding require the use of specially adapted, power dense, high misalignment and structure-borne noise reducing coupling solutions, often combined with weight-optimized shafts.

For this application as well, VULKAN Couplings enable the optimum operation of the drive unit through components adapted to one another, such as highly flexible RATO S, RATO R and VULKARDAN E Couplings, elastic mounts and composite shafts.

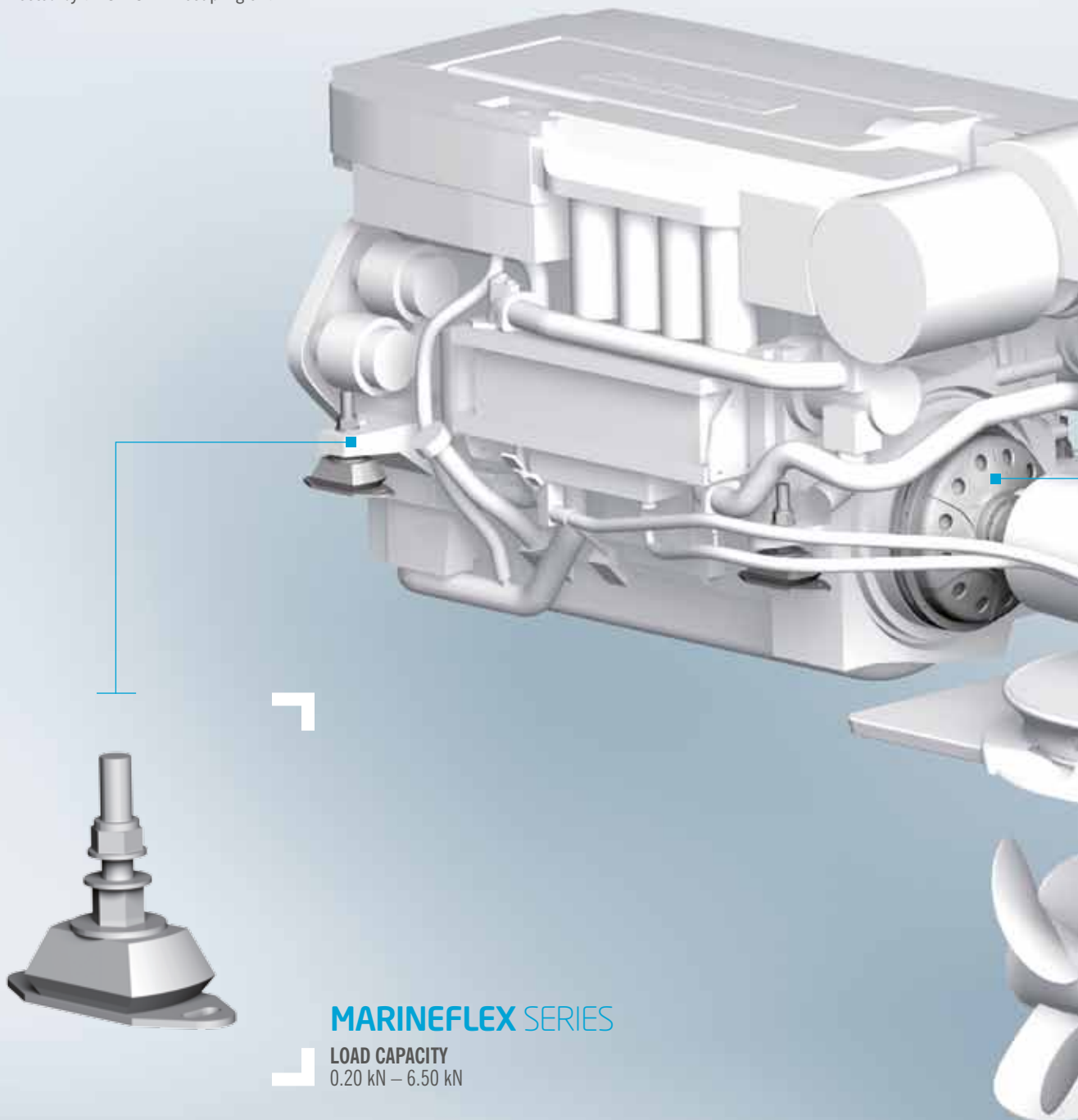


# COMPACT POD DRIVE

This POD drive is a drive system for yachts up to 100 ft and engine ratings up to 1200 hp. This drive system enables an up to 15 % higher cruising speed at the same performance, at up to 30 % reduced fuel consumption compared to standard drive lines. This POD drive system is available in twin or multiple engine configuration. Different products from VULKAN Couplings can also be used in this modern drive system.

If the connection between the engine and POD drive is made by a so called bell housing the diesel engine and the POD drive will either be connected by a VULASTIK L coupling or a

VULKARDAN E coupling. If there is no bell housing connection an elastic coupling in combination with a cardan shaft or similar coupling can be used. Either MEGIFLEX B couplings in double cardanic configuration, or VULKARDAN L couplings in combination with a cardan shaft, or the integral shaft support (with VULKARDAN E or VULASTIK L couplings) combined with a cardan shaft can be used.



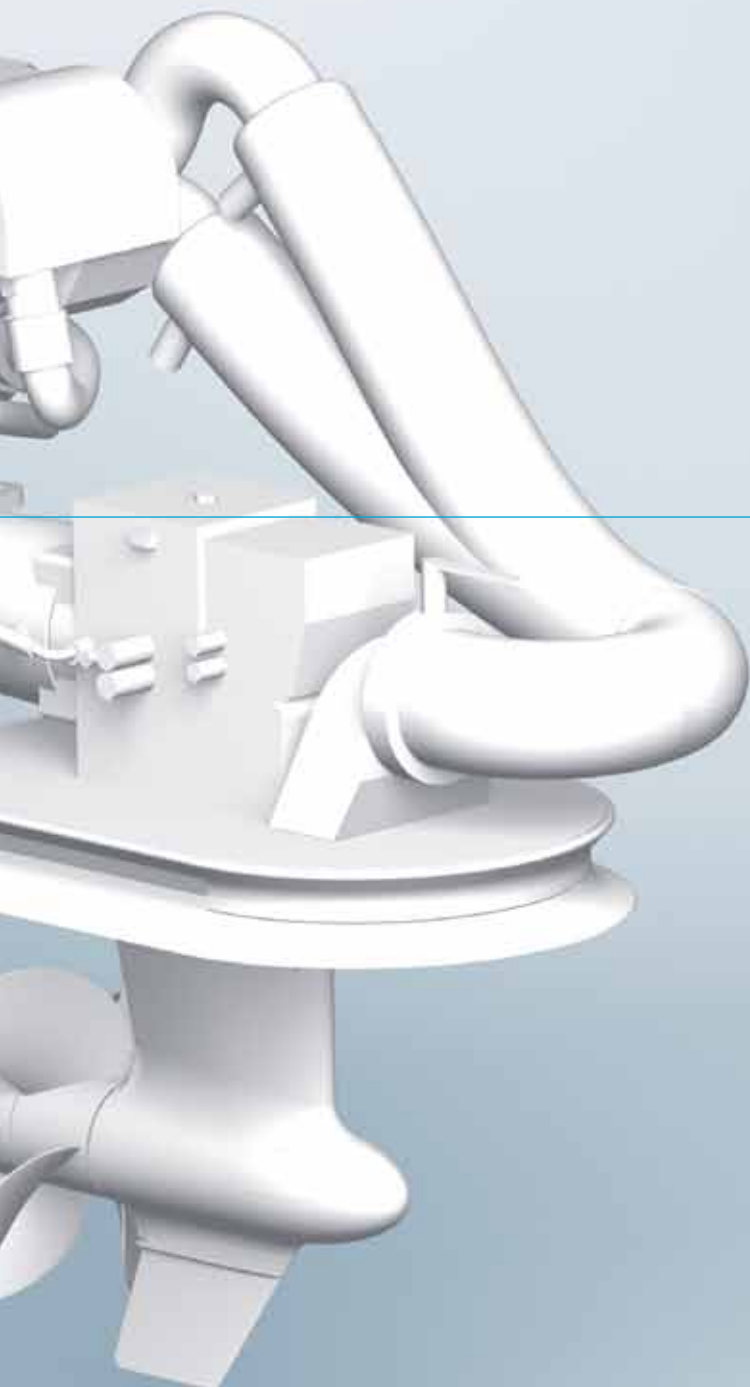
## MARINEFLEX SERIES

LOAD CAPACITY  
0.20 kN – 6.50 kN



## ISS with VULASTIK L SERIES

**TORQUE RANGE**  
2.50 kNm – 20.00 kNm





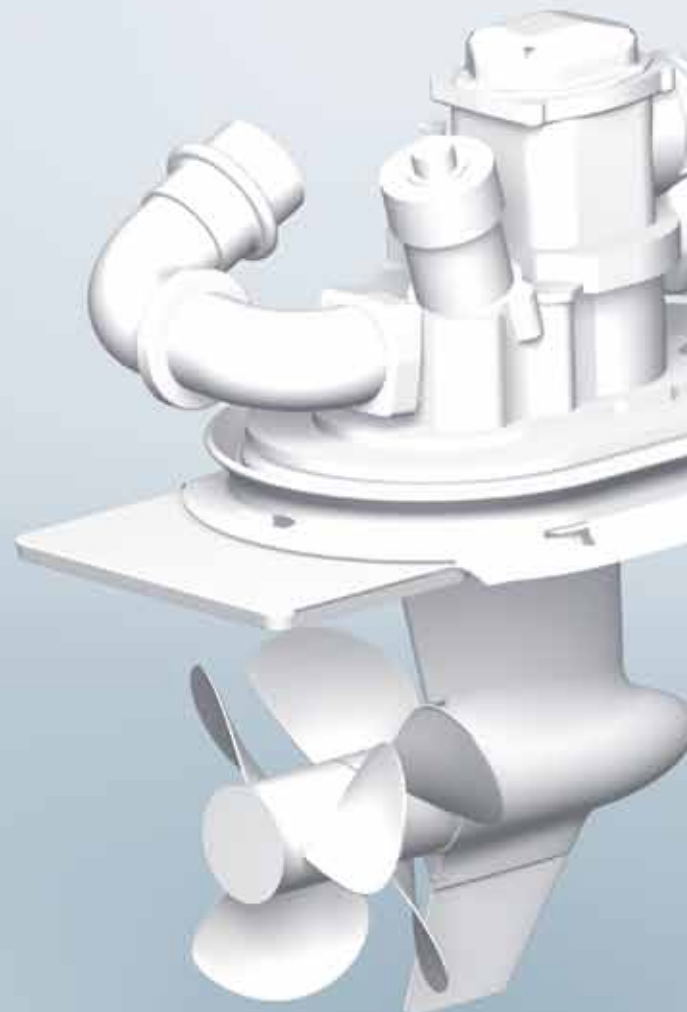
## ISS with VULKARDAN E SERIES

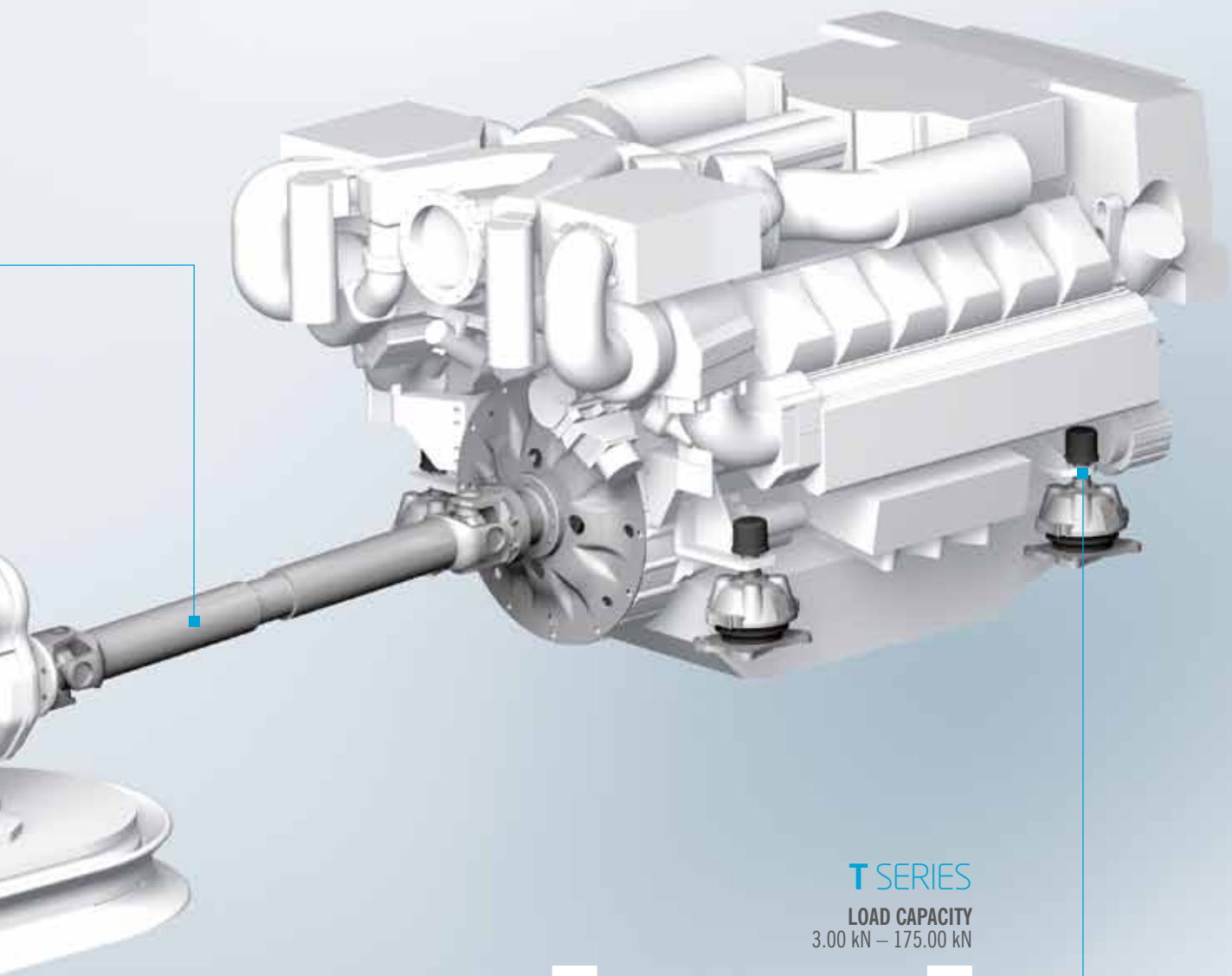
**TORQUE RANGE**  
1.00 kNm – 3.15 kNm

## POD DRIVE

The POD Drive is one of the most efficient propulsion systems, specially made for twin-engined pleasure crafts of 50 to 75 feet length, and in triple or quad configuration suitable for yachts up to 120 feet length, where each pod can be driven by a diesel engine up to 1200 hp. This system offers an increased propulsion efficiency, compared to traditional drive lines, resulting in a speed increase and a significant reduction of fuel consumption at cruising speed. Products from VULKAN Couplings also find application in these modern drive systems.

The connection between the diesel engine and the actual POD drive is made through an flexible coupling in combination with a cardan shaft or similar flexible coupling. Either MEGIFLEX B couplings in double-cardanic configuration, or VULKARDAN L couplings in combination with a cardan shaft, or the integral shaft support (with VULKARDAN E or VULASTIK L coupling) combined with a cardan shaft, are used.





## T SERIES

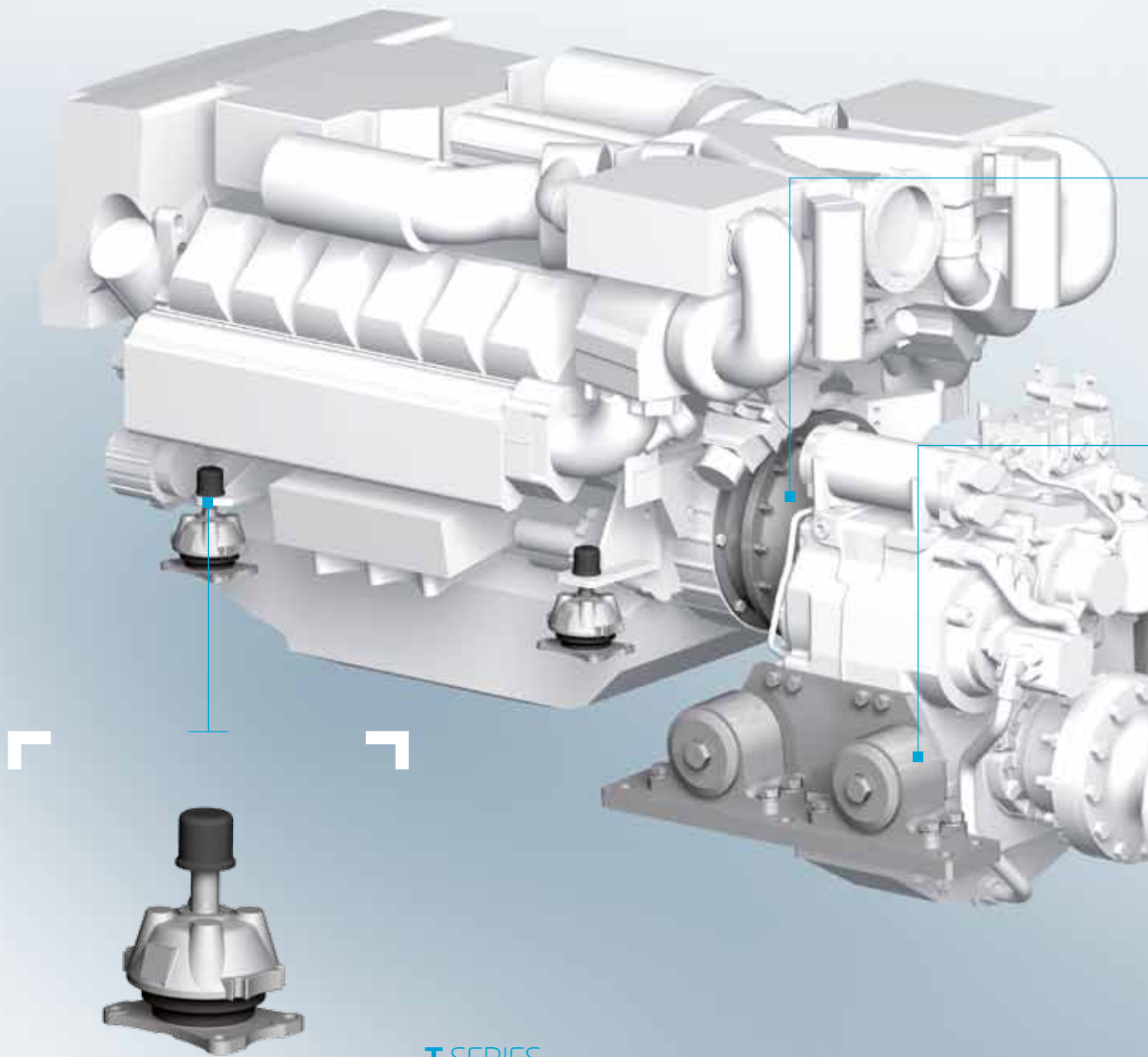
LOAD CAPACITY  
3.00 kN – 175.00 kN



# DOUBLE-ENGINE DIESEL DRIVE FOR YACHTS

Yachts, ships larger than 10 m in length, are normally driven by two—diesel engine units, whereby the gear box is directly coupled to the diesel engine (closed-coupled) or the connection between engine and gear box is made by a coupling and a cardan shaft (V-drive). The diesel engines used in such applications are characterized by their high power density combined with low weight, and make high demands on the couplings used in terms of optimization of torsional vibrations as well as the required displacement values.

Products from VULKAN Couplings are the ideal solution for these types of applications. The use of VULASTIK L series in silicone for closed coupled drives, VULKARDAN E series for freestanding applications, as well as integral shaft supports with VULASTIK L for V-drives, offers exceeding running smoothness for the drive units, specially in the lower speed range, combined with an excellent protection of the drive unit from unwanted reaction forces that are generated by the angular deflection of the cardan shafts in V-drives.



## T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN



### VULKARDAN E SERIES

(freestanding)

**TORQUE RANGE**  
2.50 kNm – 20.00 kNm



### VULASTIK L SERIES

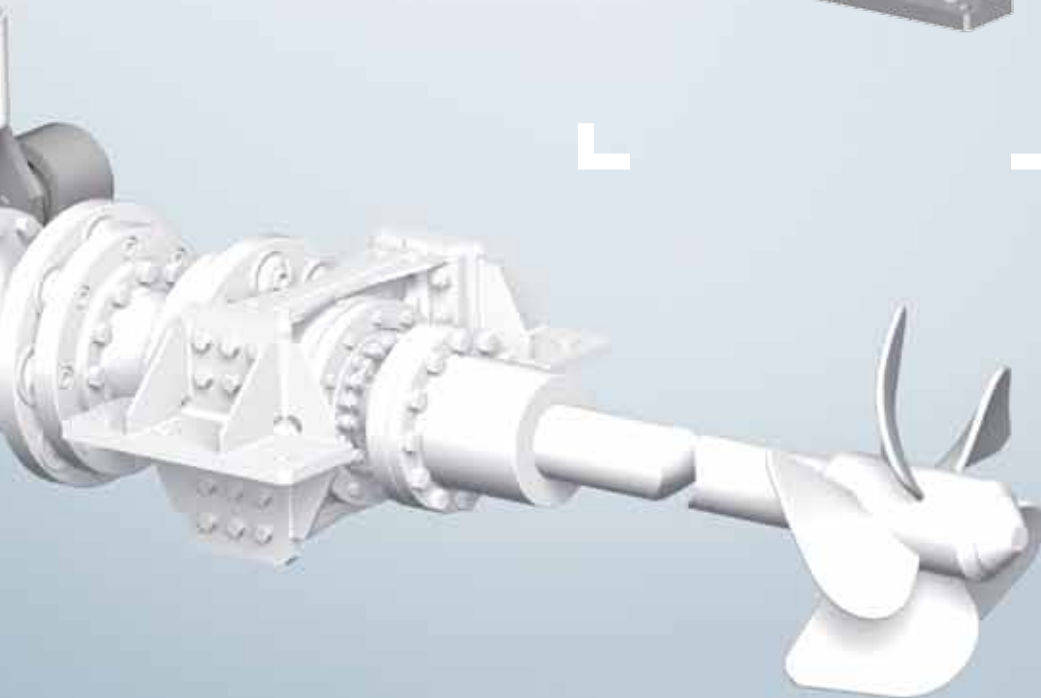
(bellhousing)

**TORQUE RANGE**  
0.40 kNm – 20.00 kNm



### AVR SERIES

**LOAD CAPACITY**  
5.00 kN – 93.00 kN

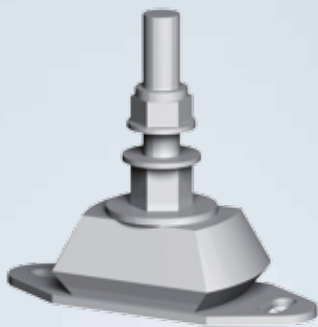
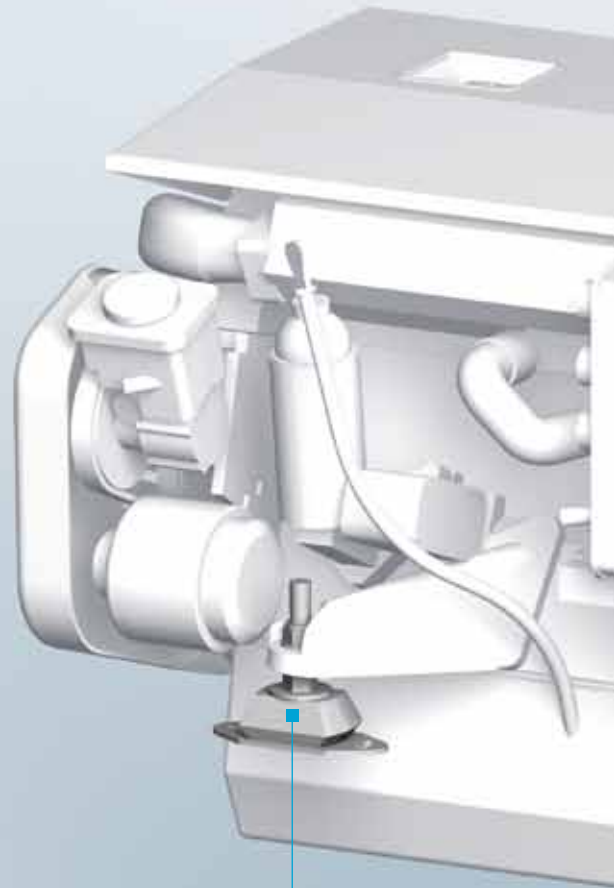


# STERN-DRIVE

On fast sport boats with a length under 10 m (33 ft) the so-called Stern-Drive is frequently the mode of propulsion, which is meant to combine the advantages of inboard motors with those of outboard motors - low noise levels in combination with high maneuverability. The real drive (propeller and transmission) is located outside the boat. Generally, the connection between the engine and the transmission is made through an flexible coupling in association with a cardan shaft.

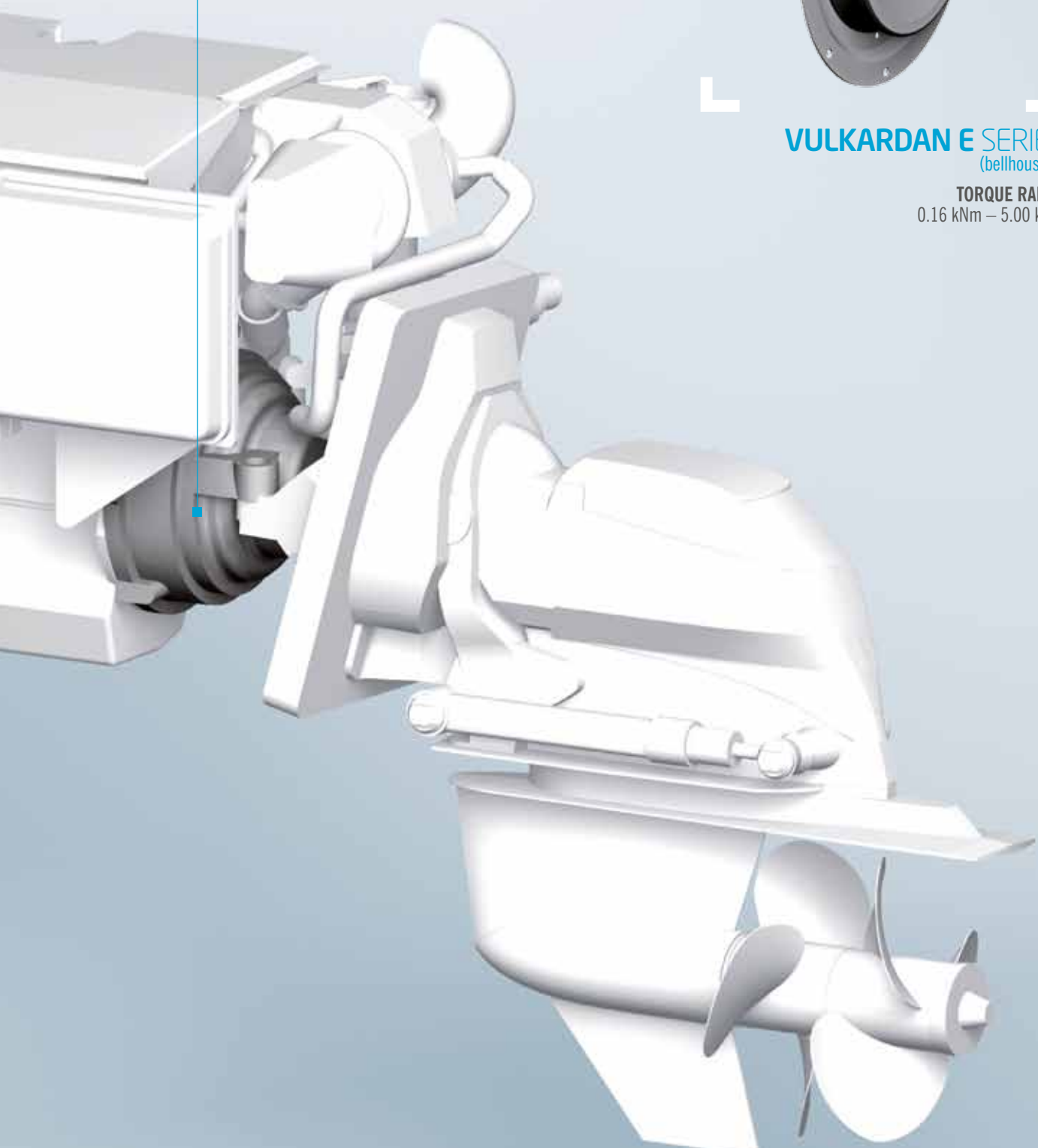
Products from VULKAN Couplings that find application here include: MEGIFLEX B series in double-cardanic configuration, VULKARDAN L series in combination with a cardan shaft or VULKARDAN E / TORFLEX series for bellhousing applications.

These products enable optimum adjustment of the drive unit to ensure the greatest possible running smoothness over the entire speed range.



## MARINEFLEX SERIES

**LOAD CAPACITY**  
0.20 kN – 6.50 kN



**VULKARDAN E SERIES**  
(bellhousing)

**TORQUE RANGE**  
0.16 kNm – 5.00 kNm

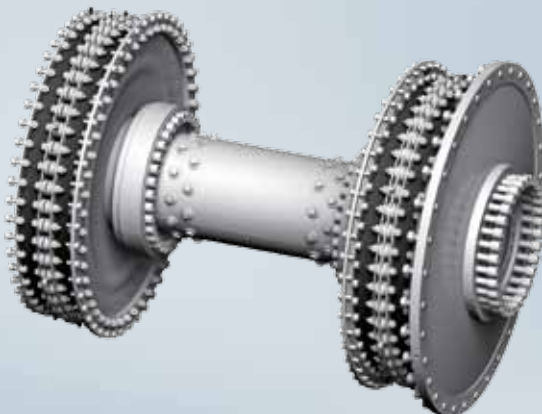
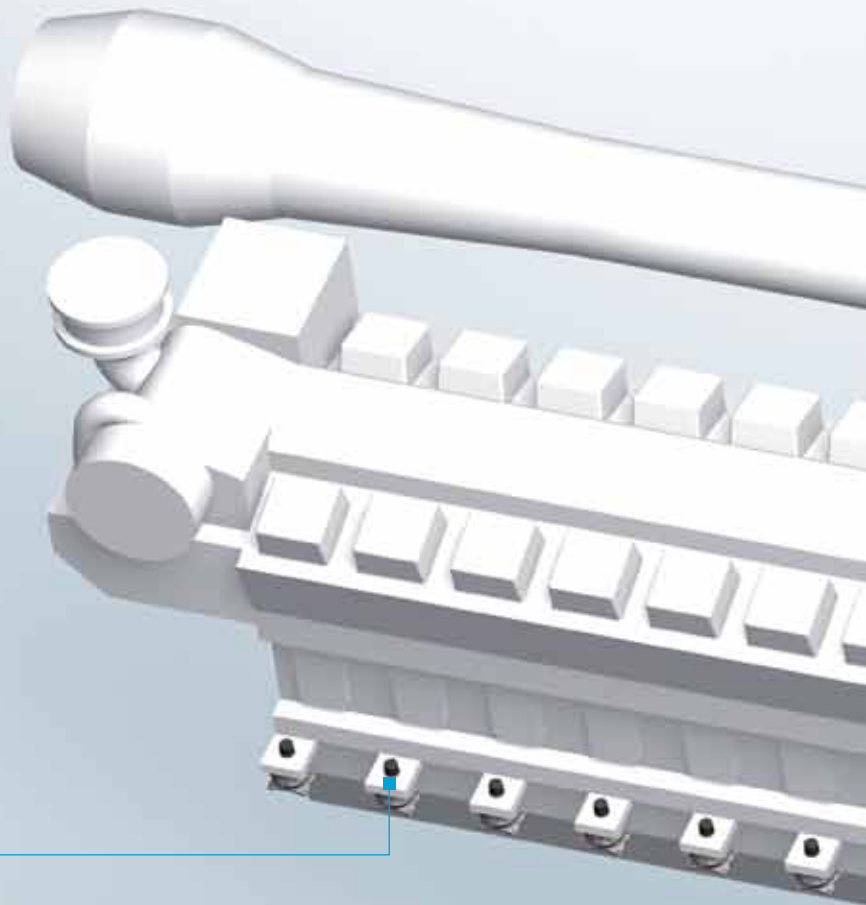
# THE COMFORT DRIVE

With regard to the drive units, the mega yachts may be most closely compared to fast ferries. For the most part, fast-running, highly powered, but lightweight diesel engines are employed. The drives, usually diesel-mechanic, drive jets or propellers via lightweight reduction gears. The requirements for comfort are even higher; a special elastic mounting system (e.g. elastic engine as well as gear box mounting) ensures maximum noise attenuation. This and certain specifics of ship-building require the use of specially adapted, high misalignment and

structure-borne noise reducing couplings between the main engine and gearbox, as well as at the gearbox output to the propeller shaft. Here too VULKAN Couplings offers intelligent coupling solutions based on the RATO S and RATO R portfolio, combined with short-building resp. cardanic composite shafts, both without a noise transmission path for maximum structure-borne noise reduction, and of course also combined with elastic engine mounts adapted for the unit – the complete solution from a single source.

## T SERIES

**LOAD CAPACITY**  
3.00 kN – 175.00 kN



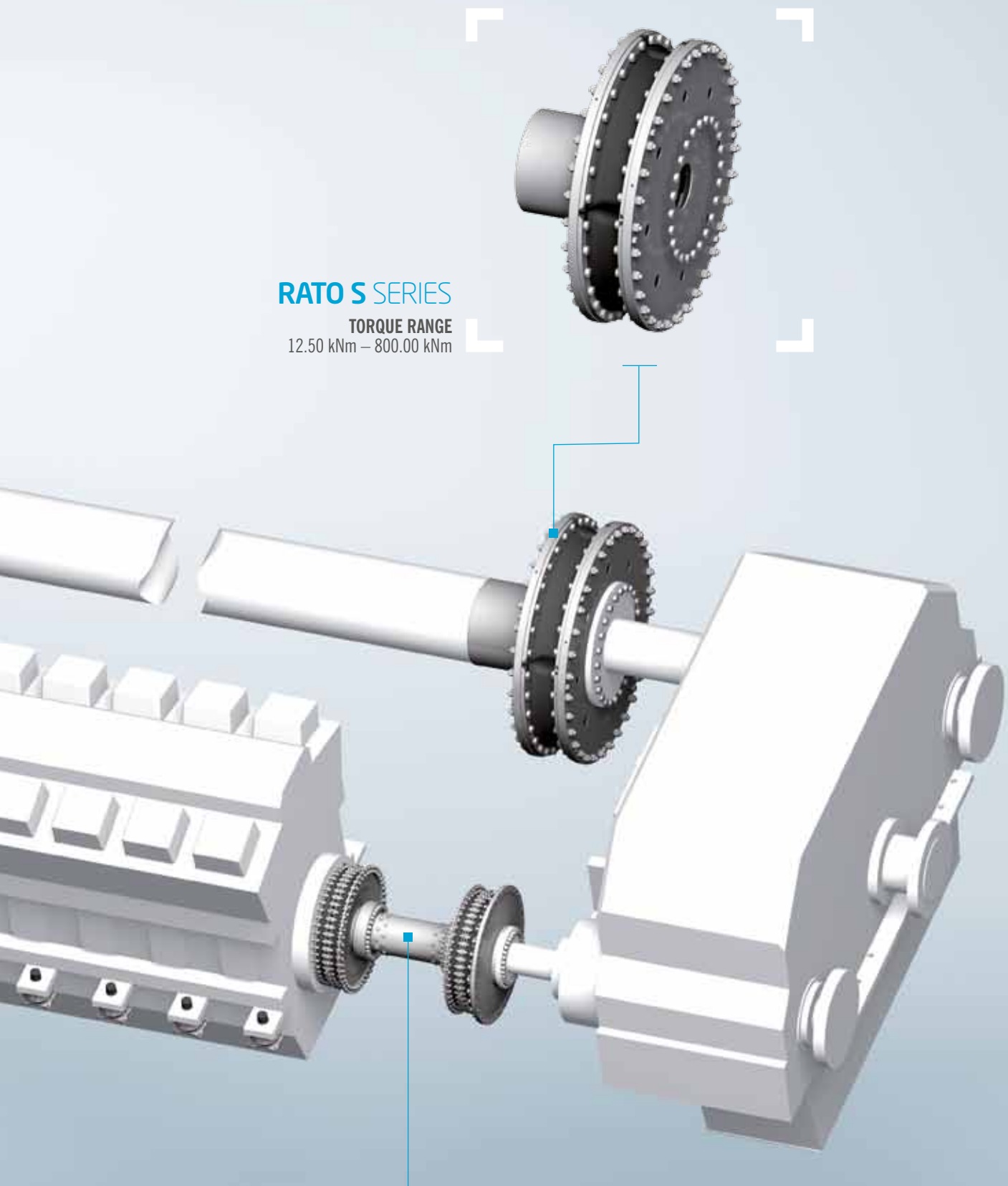
## RATO R SERIES

**TORQUE RANGE**  
12.50 kNm – 270.00 kNm



## RATO S SERIES

TORQUE RANGE  
12.50 kNm – 800.00 kNm





# WORK BOATS

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Under the generic term 'work boats', diverse types of boat are found starting with trawlers, tugboats, offshore supply vessels, inland navigation vessels, crew boats, fire fighting boats through to icebreakers and dredgers.

The common denominator among all these ship types is an all-out continuous operation at unrestricted continuous output; i.e. the drive units are subjected to the greatest levels of stress and demand total reliability.

VULKAN Couplings provides the ideal solution for all of these demanding drive units: integral shaft support with VULKASTIK L series, the VULKARDAN E series for elastically-mounted engines, as well as the well-proven RATO R and RATO S series for higher powered engines. The range is complemented by suitable engine mounts, and where saving weight is an additional criterion, composite shafts may be installed to bridge greater distances.



# THE DIESEL-ELECTRIC DRIVE FOR WORK BOATS

Up to 7,000 operating hours per year, high performance requirements and the greatest possible maneuverability - these are the demands made of work boats. In order to meet these demands, diesel-electric drive systems, in conjunction with steering propeller drives, are more and more frequently being used with these kinds of ships. Diesel engines drive generators, the generated energy is used to drive electric motors that in turn drive the corresponding rotatable steering propeller drive.

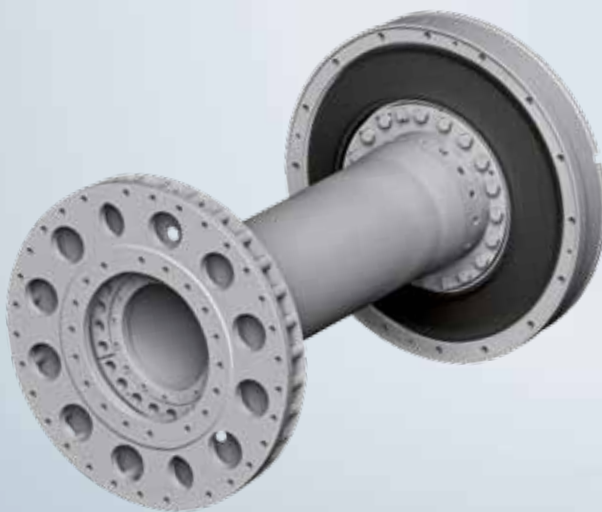
Couplings from VULKAN Couplings are the ideal products for these drive systems. RATO S, RATO DS, RATO R, or ISC series serve for optimum torsional vibration reduction and dampen the existing propeller excitation.

The double-cardan membrane couplings, used in conjunction with the RATO couplings, compensate for the displacements arising during operation between drive and the drive side.



## RATO S SERIES

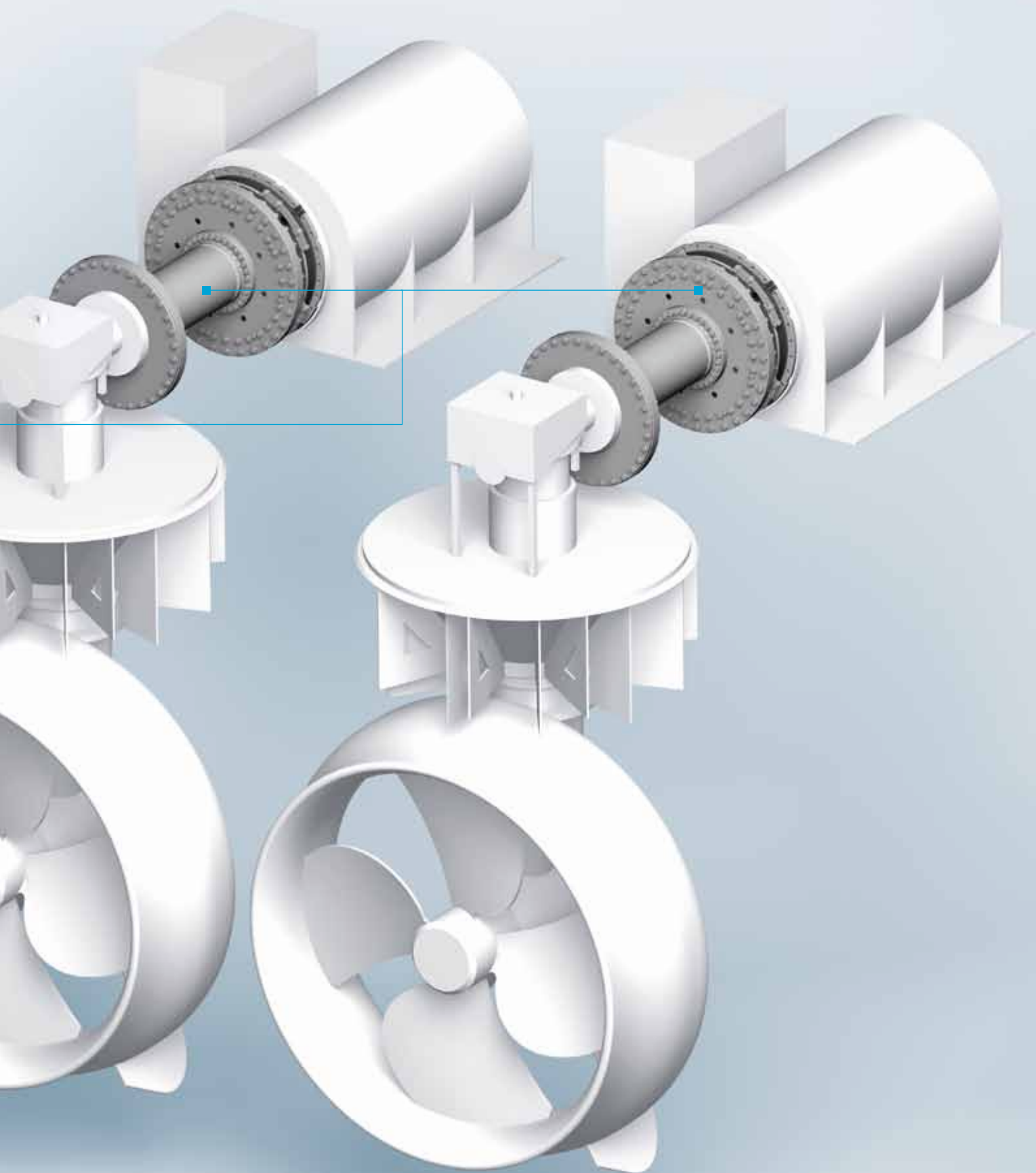
**TORQUE RANGE**  
12.50 kNm – 800.00 kNm



## ISC SERIES INTEGRATED SHAFT COUPLING

**TORQUE RANGE**  
10.00 kNm – 160.00 kNm





# DIESEL-MECHANIC DRIVE WITH INTEGRAL SHAFT SUPPORT

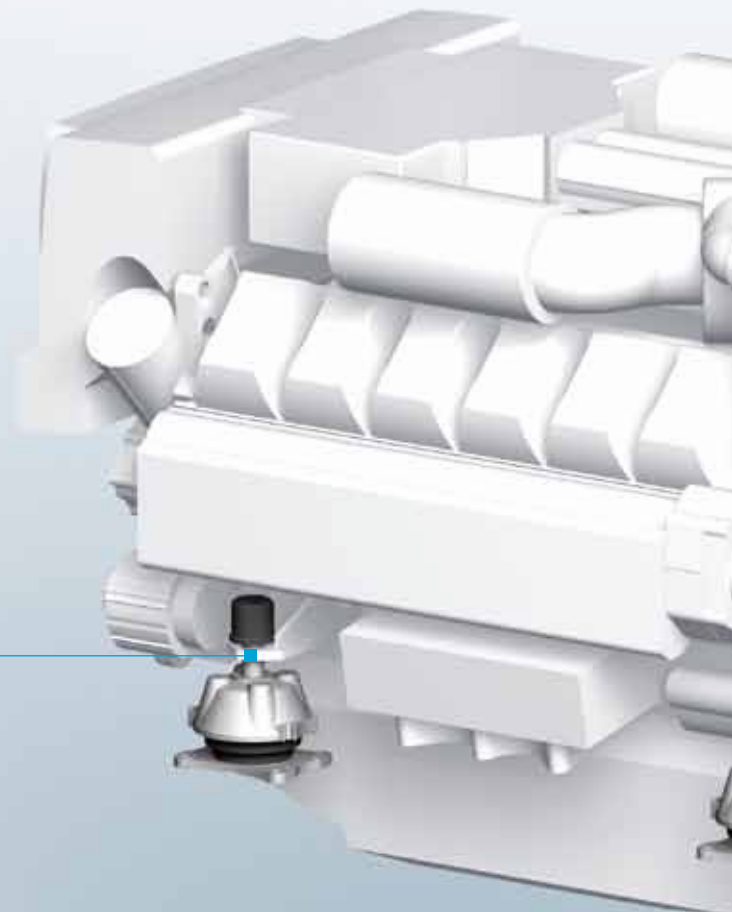
With diesel-mechanic drive units, where there is an angular displacement between the diesel engine and the gear box (so called V-drive or remote drive), cardan shafts are normally used between the diesel engine and the gear box, which compensates this angular shaft displacement.

The diesel engine has to be protected from the reaction forces generated by the angular displacements of the cardan shafts. The integral shaft support from VULKAN Couplings provides optimum drive protection, due to its design principle.

Through the internal bearings of the ISS, the reaction forces created from the angular displacement of the cardan shaft are transmitted through the coupling housing into the engine block, the engine's crankshaft bearings remain unaffected by these forces, which in turn means an optimum protection for the engine. The whole drive system is completed with suitable engine and gear box mounts from VULKAN Couplings. The result is a drive unit that fulfils all demands related to heaviest duty in combination with an optimal running smoothness and comfort.



**T SERIES**  
LOAD CAPACITY  
3.00 kN – 175.00 kN



## ISS WITH VULASTIK L SERIES

**TORQUE RANGE**  
2.50 kNm – 20.00 kNm



## AVR SERIES

**LOAD CAPACITY**  
5.00 kN – 93.00 kN



# THE MULTI-ENGINE DIESEL-MECHANIC DRIVE IN ICEBREAKERS

The breaking of ice of up to one meter in thickness during continuous sailing, the ramming of large blocks of ice – these are the highest requirements that are placed on the drive unit. This is particularly valid for the engines, transmissions, as well as the highly flexible couplings. Here, VULKAN Couplings provides the ideal products with the RATO S or RATO R series, which are able to cope with these high requirements. The RATO R series used in this particular arrangement not only protect the drive unit from harmful vibrations,

but also protect the diesel engine's crankshafts from impact shock loads, which are unavoidable during hard operation. A great part of the impact energy is hereby absorbed by the couplings.

Such units are completed with highly flexible RATO R respectively VULKARDAN E series, which are located in the PTO drive to the electricity-producing generators, as well as with VULKAN engine mounts.



## RATO R SERIES

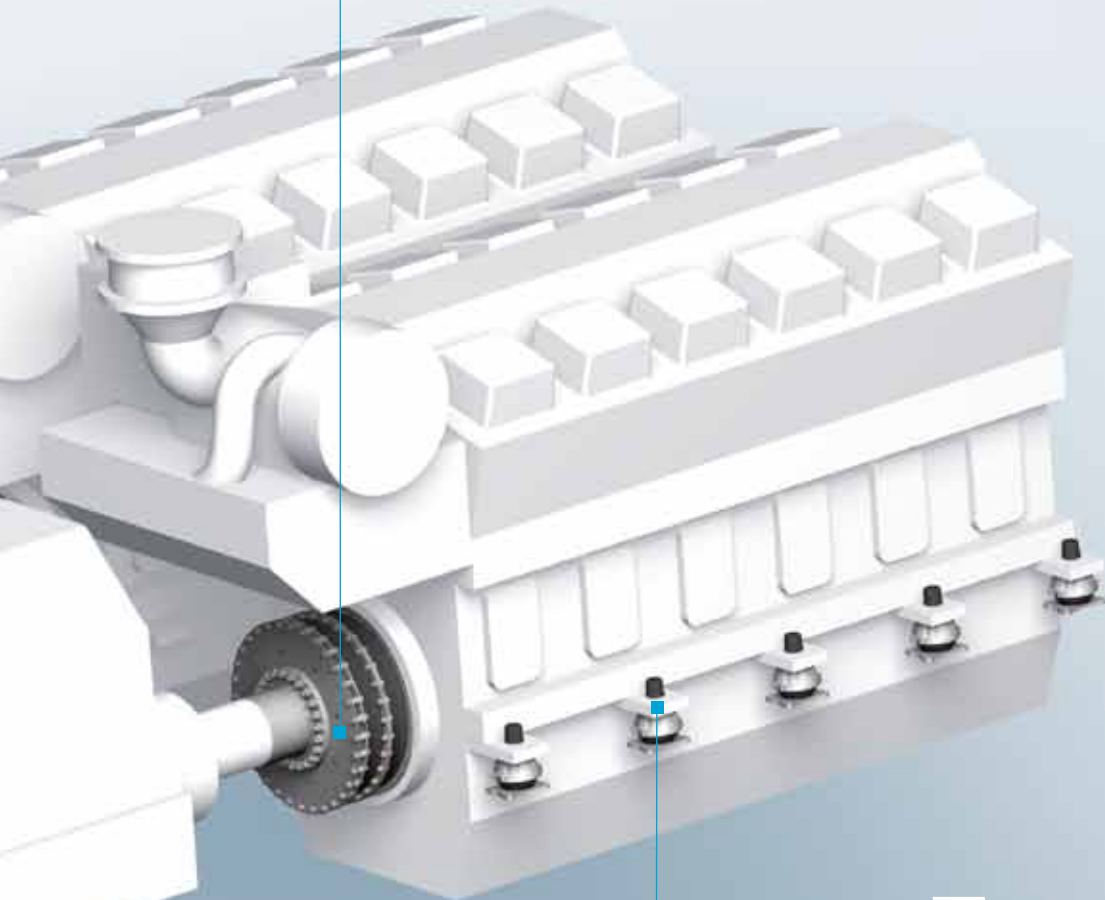
**TORQUE RANGE**  
12.50 kNm – 270.00 kNm





**RATO R SERIES**

**TORQUE RANGE**  
12.50 kNm – 270.00 kNm



**T SERIES**

**LOAD CAPACITY**  
3.00 kN – 175.00 kN

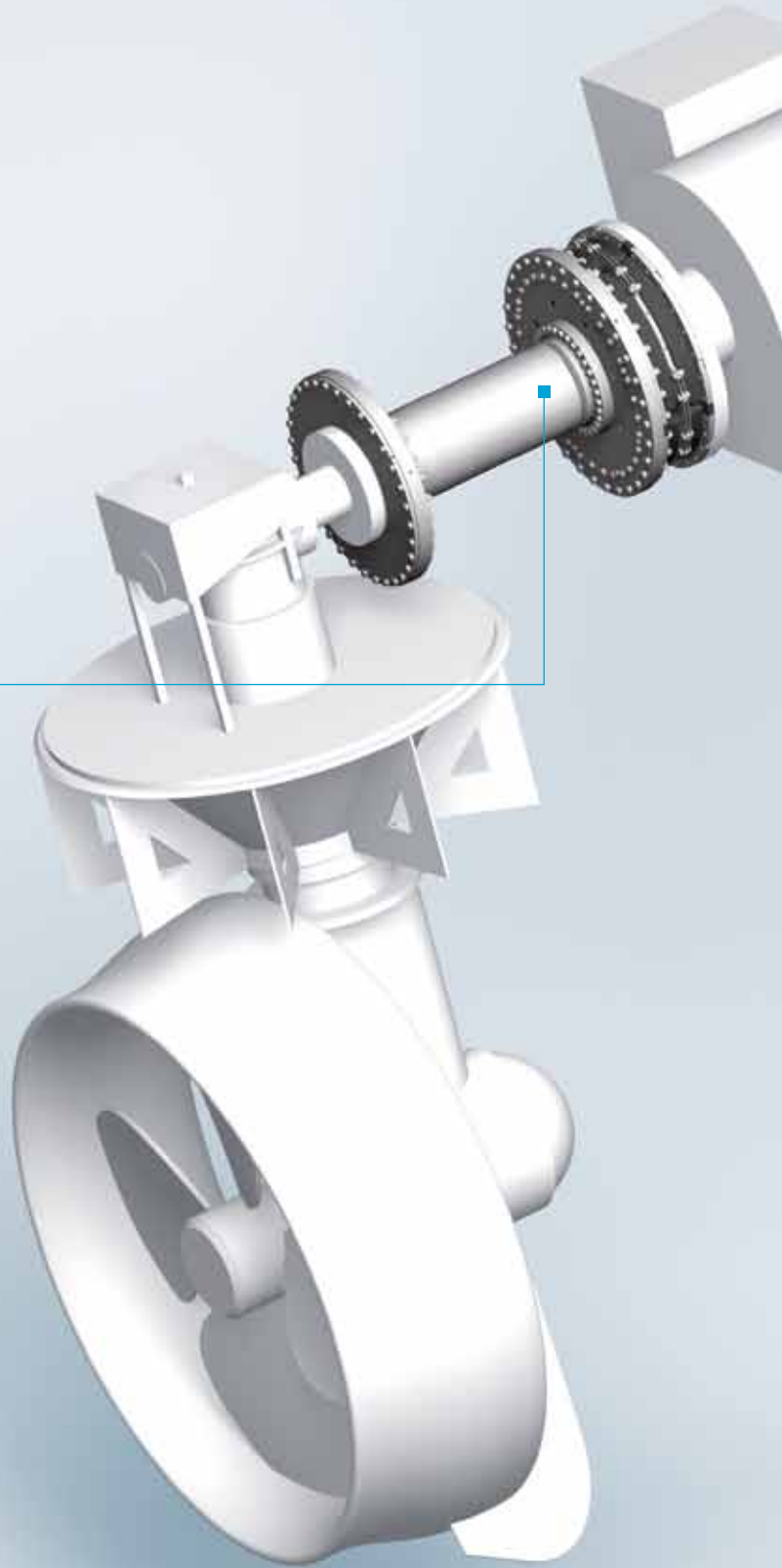
## RATO S SERIES

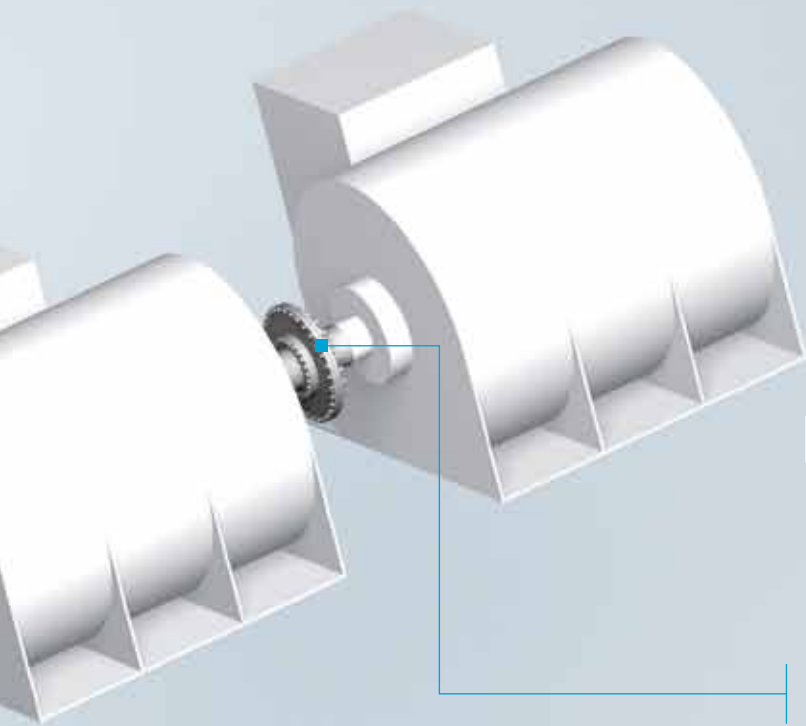
**TORQUE RANGE**  
12.50 kNm – 800.00 kNm



## RATO DS SERIES

**TORQUE RANGE**  
6.30 kNm – 160.00 kNm





## MEMBRANE COUPLING

TORQUE RANGE  
12.50 kNm – 270.00 kNm

# THE DIESEL-ELECTRIC DRIVE IN ICEBREAKERS

As an alternative to the diesel-mechanic drive in icebreakers, the diesel-electric drive is also used to meet the high performance requirements during operation.

The diesel-electric power transmission is a drive system where by generator sets the mechanical energy of the diesel engines is converted into electrical energy. This electrical energy is used for electric motors driving POD drives, steering propellers, etc. In this case the diesel engine drives a generator and between the diesel engine and the generator various VULKAN products can be used. Depending on the performance and setup of the diesel engine (fixed or elastic), either VULASTIK L series or products from the RATO range are employed. For mounting the motor and the generator, suitable VULKAN mounts are used.

The energy produced from the generators is used to drive two electric motors quite often in a so-called tandem design, which are connected to

each other with a torsionally rigid VULKAN flexible coupling. This results in a high power output with an attendant compact layout. The flexible coupling is located between the electric motors serves to compensate for displacements arising from thermal distortion of components or deformation of the ship's hull during operation.

The electric motors in turn drive large, rotatable POD drives through corresponding transmissions. Between the electric motor and the transmission, the well-proven RATO S, RATO DS and RATO R series are located, combined with an additional membrane coupling. On the one hand, their role is to protect the drive system through torsional vibration reduction from all harmful vibrations (caused by propeller excitation) and to safely compensate the displacements occurring during operation. On the other hand, it is to dampen impact stresses arising during rough operation, and thereby protect the electric motors.

# DIESEL-ELECTRIC DREDGER DRIVE

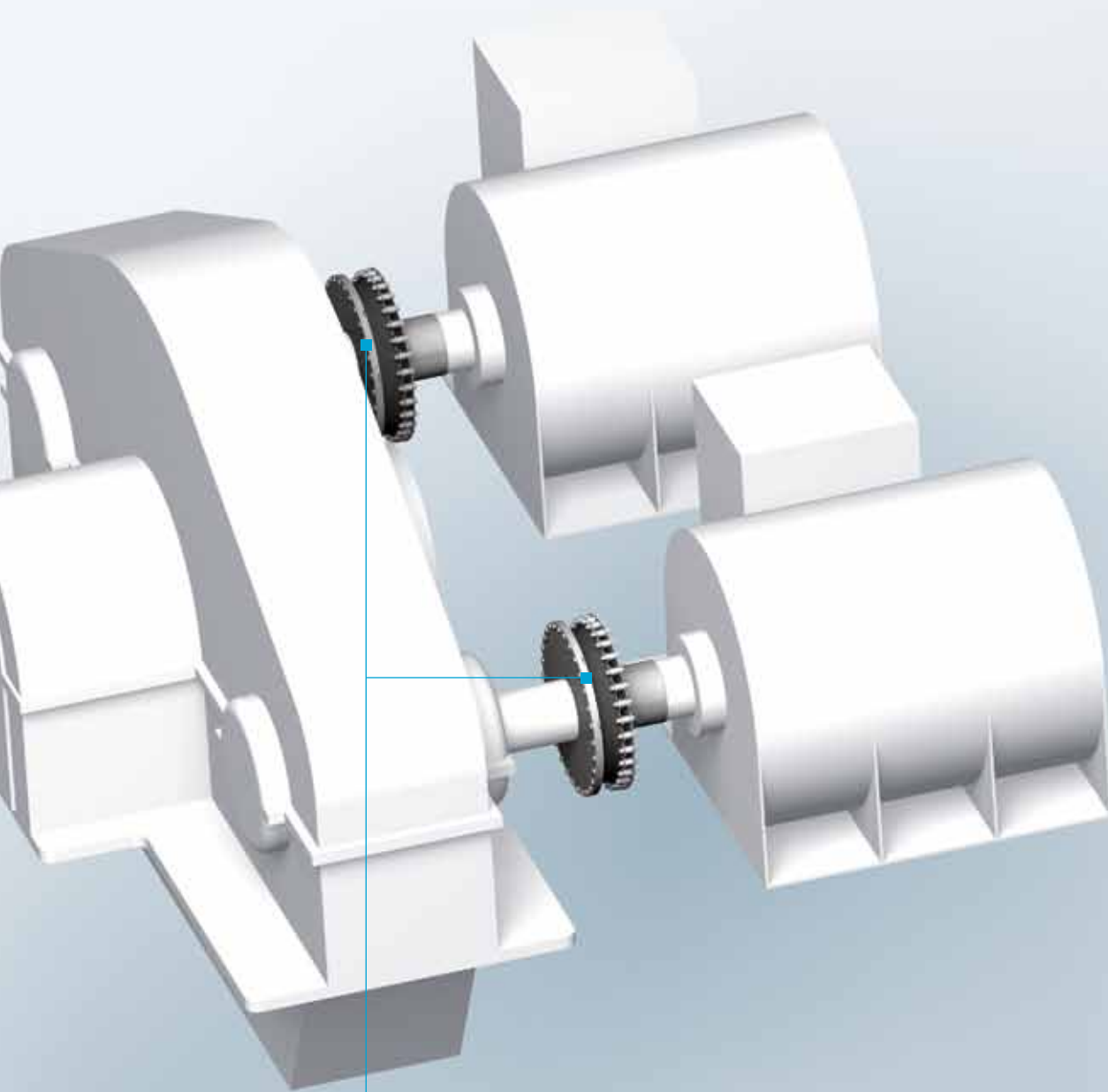
Several highly powered generators, driven by medium-speed four-stroke diesel engines running at mid-speed, provide the electricity that is used for the electric motors of the main and auxiliary drives. The main generators (not shown in this picture) are driven directly or through a gearbox. The generators are rigidly, the diesel engines are rigidly or elastically mounted. The main propulsion drive, as well as the auxiliary drives, such as the dredger pump, jet pump and other various machines, are driven by electric motors.

For this type of unit, VULKAN Couplings offers a wide range of couplings with RATO S, RATO R, and RATO DS series. A good tuning of the drive unit's torsional behavior is achieved by a large range of dynamic torsional stiffness and damping values available for the RATO couplings. In the field of clutches also, which are used for example in the dredger pump drive, with the MESLU-RATO combinations VULKAN Couplings provides optimum solutions.



## RATO DS SERIES

**TORQUE RANGE**  
6.30 kNm – 160.00 kNm



## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm

# DIESEL-MECHANIC DREDGER DRIVE

Dredgers are mainly driven by two medium-speed four-stroke diesel engines. On the flywheel side of the engine the dredger's propulsion drive usually takes place, on the front side a dredger pump is driven mechanically, or a large generator produces the electricity for the dredger pump units.

The direct pump drive at the front side of the engine or the propulsion drive can each be engaged or disengaged via clutches in combination with flexible couplings.

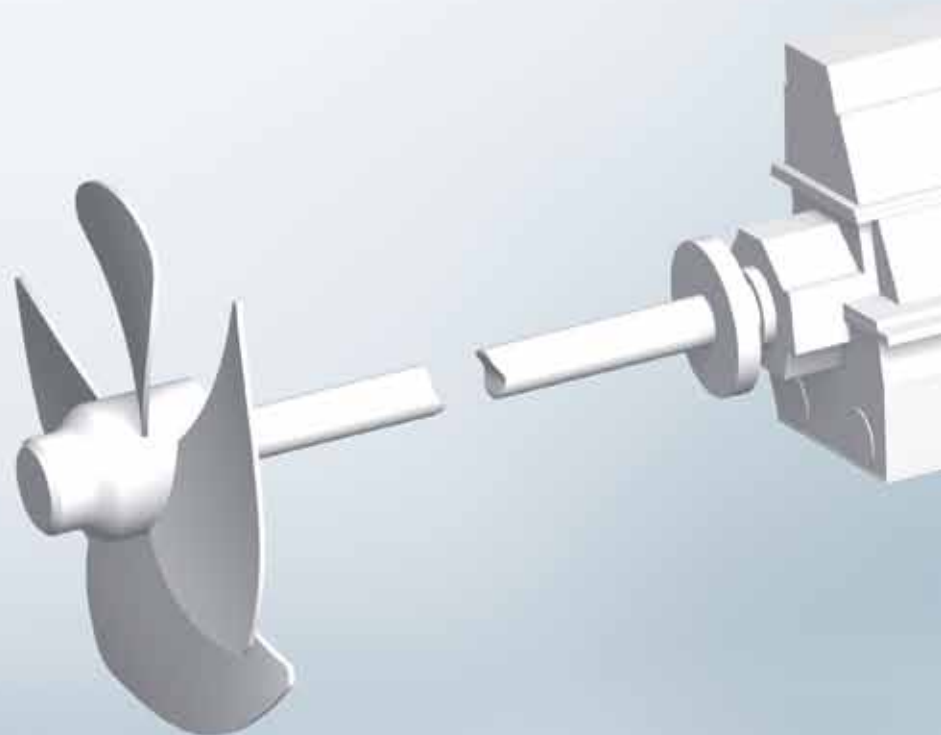
For this application the VULKAN MESLU series, a torsionally-rigid double cone friction clutch, and an elastic RATO series can be combined. For the MESLU clutch, the outer part is supported by the inner part via bearings. This means that the heat generated during clutch operation is lower than with a bearingless clutch, as the MESLU clutch does not have to center itself over the friction liners. This also leads to less and equal wear of the friction liners. Heat dissipation takes place through the outer part of the clutch. An additional advantage of the MESLU-RATO clutch series combination is that the generated heat does not affect the highly flexible coupling due to its location outside the clutch.

A slip control fitted to the clutch controls the speed difference between the primary and the secondary side of the clutch. Should an overload occur in the drive train during dredging (e.g. through large stones in the dredger pump), this leads to slipping of the clutch, which causes a speed difference between the outer and inner parts. This speed difference is recognized by the slip control, which immediately disengages the clutch, ensuring that the pump is separated from the engine. Damage to the drive train is thereby prevented.

A good tuning of the system in terms of torsional vibration will also be achieved by the combination of a MESLU clutch with the highly flexible RATO S and RATO R series.

If a generator is driven by the front drive, this runs without load during propulsion drive of the dredger. During dredging operations the propulsion drive is disengaged via the clutch.

With its broad spectrum of products, consisting of clutches and highly flexible couplings, VULKAN Couplings can provide for all drives on dredgers.





**RATO S SERIES**

**TORQUE RANGE**  
12.50 kNm – 800.00 kNm

**MESLU RATO SERIES**

**TORQUE RANGE**  
8.00 kNm – 270.00 kNm

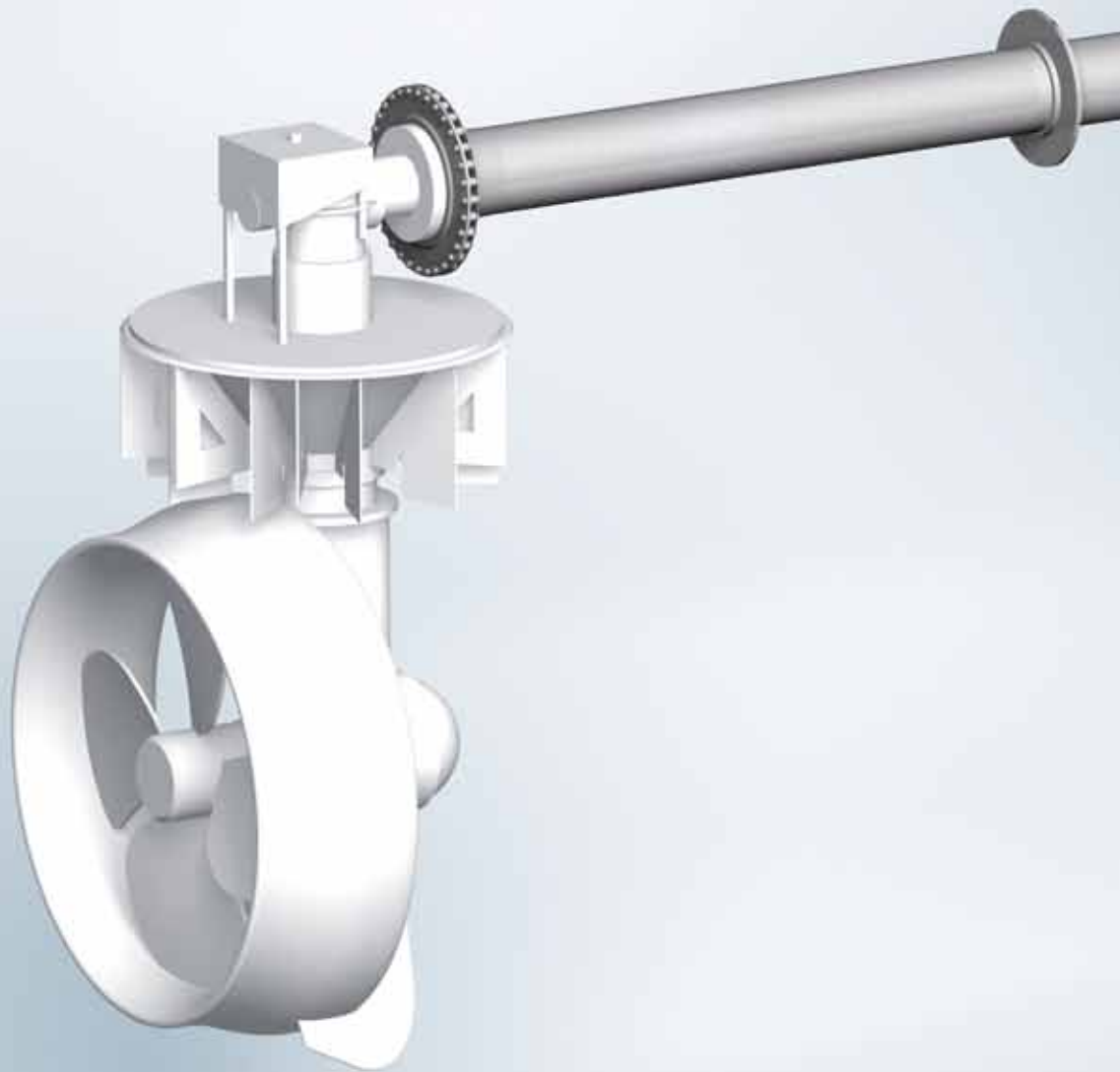
# THE DIESEL-MECHANIC DRIVE IN TUGBOATS

In order to achieve good maneuverability, tugboats are mostly fitted with steering propellers. There are various steering propeller systems on the market such as steering propellers in Z configuration or vertically-arranged steering propellers. What these drive systems have in common is that the engine power and motor speed may be transmitted over a distance of several meters from the motor to the rudder-propeller's gearbox.

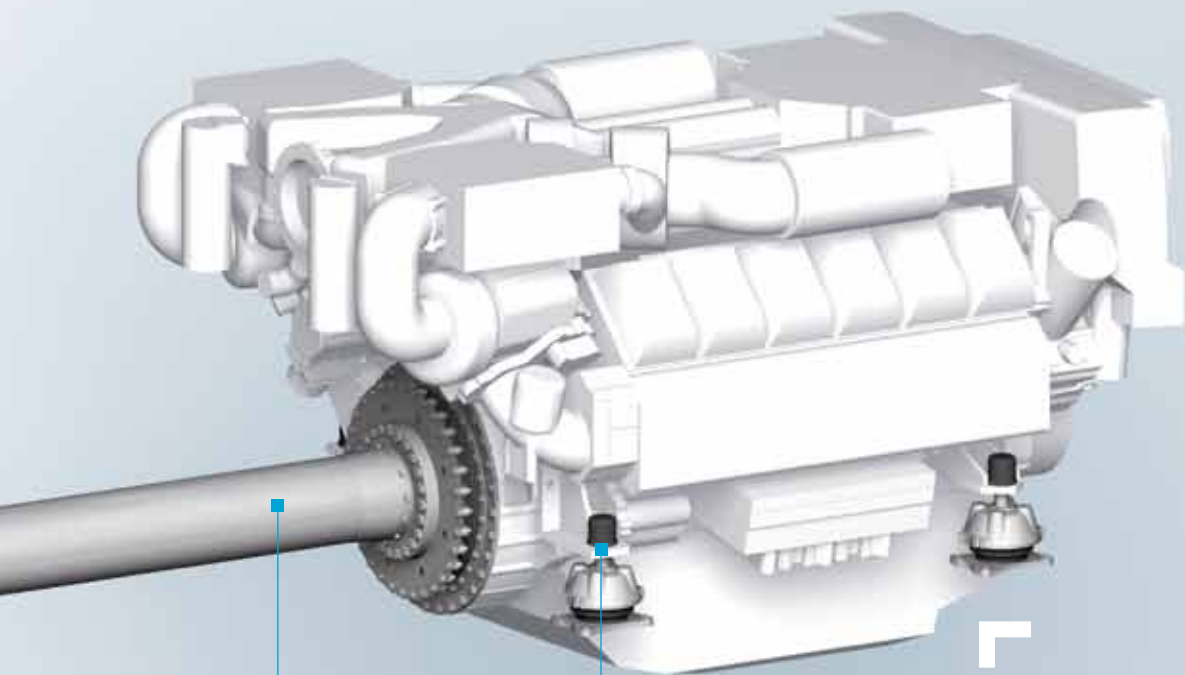
VULKAN Couplings provides the torsionally flexible coupling for the engine (mostly a highly flexible VULKARDAN E or RATO R series), as well as the shaft system. When the engine (usually elastically mounted) and the rudder-propeller's input shaft are arranged co-

axially to one another, a bearingless connection between the highly flexible VULKARDAN E, RATO R, RATO DS and ISC series installed at the engine side and the steering propeller can be achieved using a VULKAN composite shaft of several meters in length. The weight of the shaft against the coupling's elastic element is supported by a specially designed radial bearing.

This combination of a torsionally flexible VULKAN Coupling with a VULKAN composite shaft represents a technically high-quality and low-priced system solution, which compensates for engine displacements and where, in addition, the additional work of adjusting intermediate bearings is not needed.







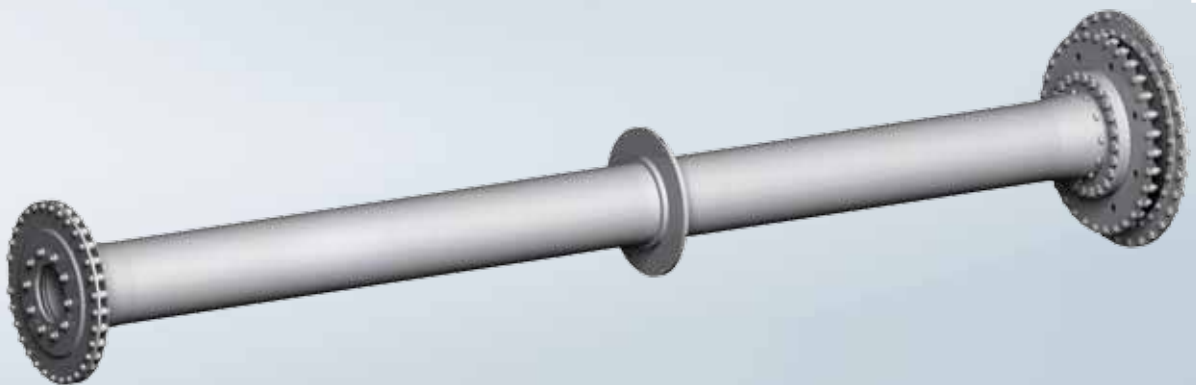
### T SERIES

LOAD CAPACITY  
3.00 kN – 175.00 kN



### COMPOSITE SHAFT SERIES

TORQUE RANGE  
5.00 kNm – 800.00 kNm







## SPECIAL VESSELS

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Specialized ships are used in diverse demands. This is also true for the drive units installed. While heavy lift ships follow the drive concept of cargo ships, in electric motor positioning drives for FPSOs or drilling platforms (mostly vertical drives), the required radial and axial guiding of the drive train is ensured by the construction-based stiffer setup of the standard RATO DG.

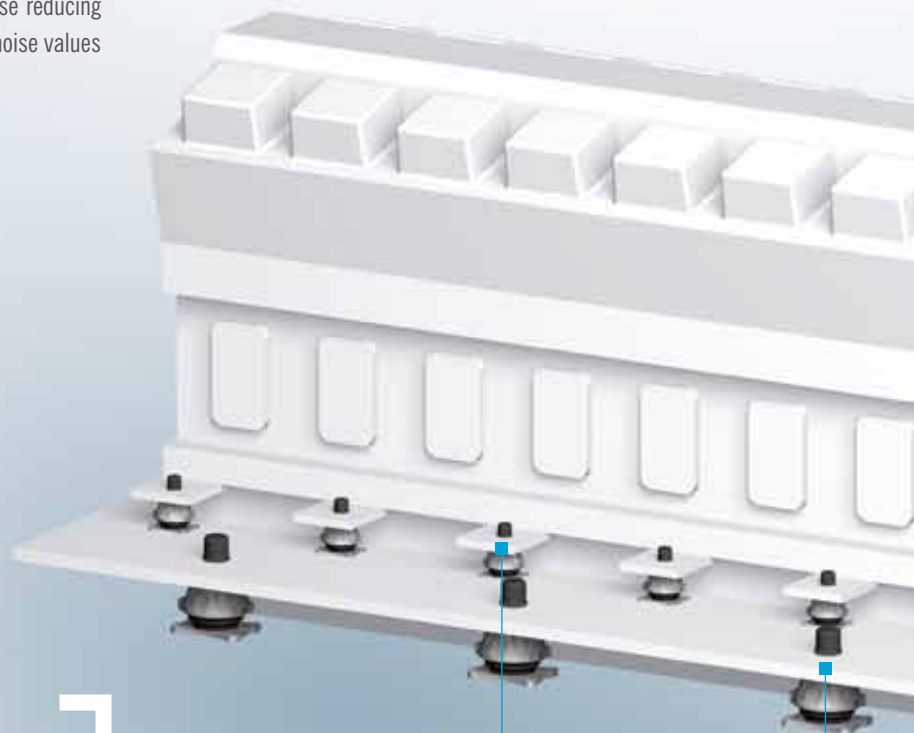
Navy applications also place very special demands on the drive components. In particular, properties such as structure-borne noise attenuation and shock resistance at high displacement capacities are demanded. Often the specifications need lightweight coupling solutions, but also non-magnetic designs. For optimum tuning of the units, VULKAN Couplings offers special solutions based on the standard couplings range, in part by using non-magnetic materials, and in part with lightweight-construction composite shafts, as well as noise-reducing and large-displacement-absorbing shock mounts.

# THE SHOCK- AND NOISE-SENSITIVE DIESEL-MECHANIC DRIVE

Navy applications of this type like for example mine hunting boats place such a heavy demand on the shock resistance as well as the noise behavior of the drive unit that the use of elastic mounting from commercial ships is not suitable. Therefore, often so-called double elastically mounted drive units are used here, whereby the elastically mounted, four-stroke diesel engine and the rigidly mounted reduction gear are fitted on a common base frame that is in turn elastically mounted to the ship's hull. This drive configuration requires a further coupling behind the gearbox, in addition to the highly flexible coupling between the main engine and the gearbox, which absorbs the relative movements between the elastically mounted common base frame and the fix mounted propeller shaft line in the event of shock. Furthermore, the coupling must be designed in such a way that it causes no noise path; i.e. it must also perform structure-borne noise reducing functions, in order to be able to achieve the water-borne noise values specified for this type of ship.

For this kind of unit, VULKAN Couplings offers a wide range of couplings based on the well-known RATO S and RATO R as well as VULKARDAN E series, often modified with specially adjusted membrane couplings to accept high displacement values. Making use of the dampening properties of natural rubber, in double row configuration, these couplings can achieve a structure-borne noise reduction of ca. 30 dB.

There is also the possibility of being able to optimally tune couplings with elastic mounts to one another, as VULKAN Couplings carry special shock mounts as part of its portfolio.



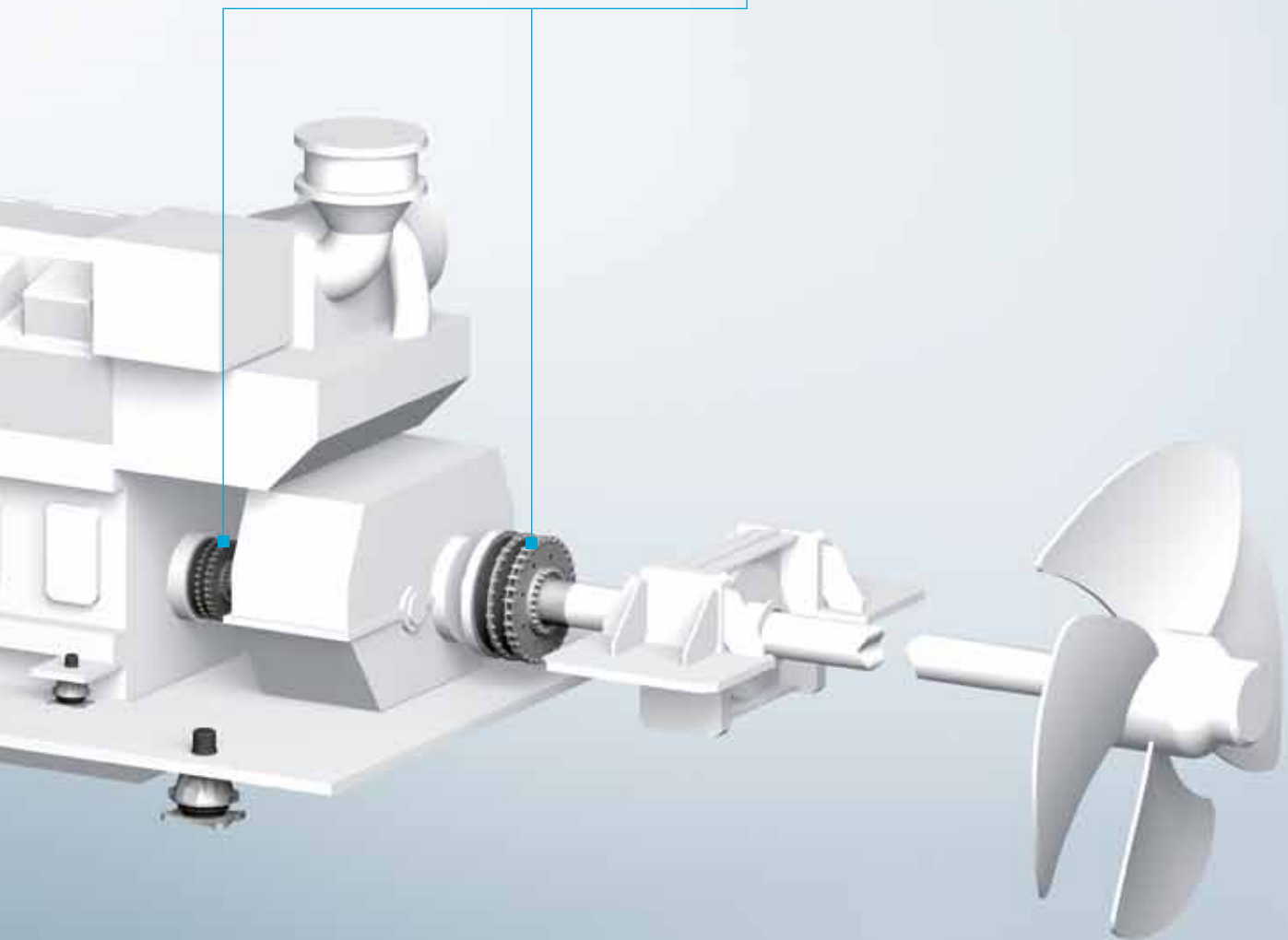
## T SERIES

**LOAD CAPACITY**  
3.00 kN – 175.00 kN



## RATO R SERIES

TORQUE RANGE  
12.50 kNm – 270.00 kNm



# THE SHOCK- AND NOISE-SENSITIVE DIESEL-ELECTRIC DRIVE

The classic submarine drive consists of diesel generator units that either transmit the electricity generated directly to the electric drive motors or store it in batteries, in order to also ensure drive during submersed (silent) operation. As well as shock resistance, requirements for very low noise levels are placed on the drive units; in part the use of materials is specified that influence the positioning behavior.

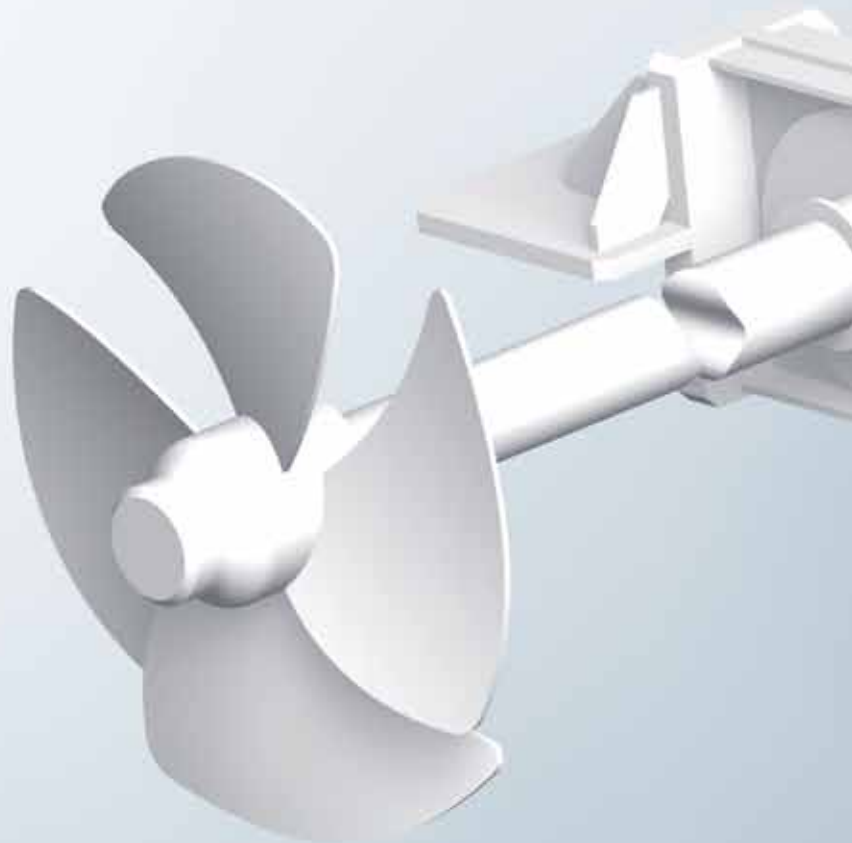
In submarines, space conditions are often very narrow and therefore the drive units must be kept very compact. This is also true of highly flexible couplings that are built into the electric-motor-driven fixed pitch propeller drive for technical reasons of displacement and noise. For emergency reasons these are fitted with a fail-safe device.

For these drives, VULKAN Couplings offers high displacement and compactly designed, specialized couplings that have been optimized over many years, based on the segmented RATO S series, which also meet the requirements for low noise levels. These couplings are also available in a non-magnetic version. For optimum adjustment of the flexible coupling/elastic mount system, the noise-reducing and large-displacement-absorbing shock mounts from VULKAN Couplings supply range are also used.

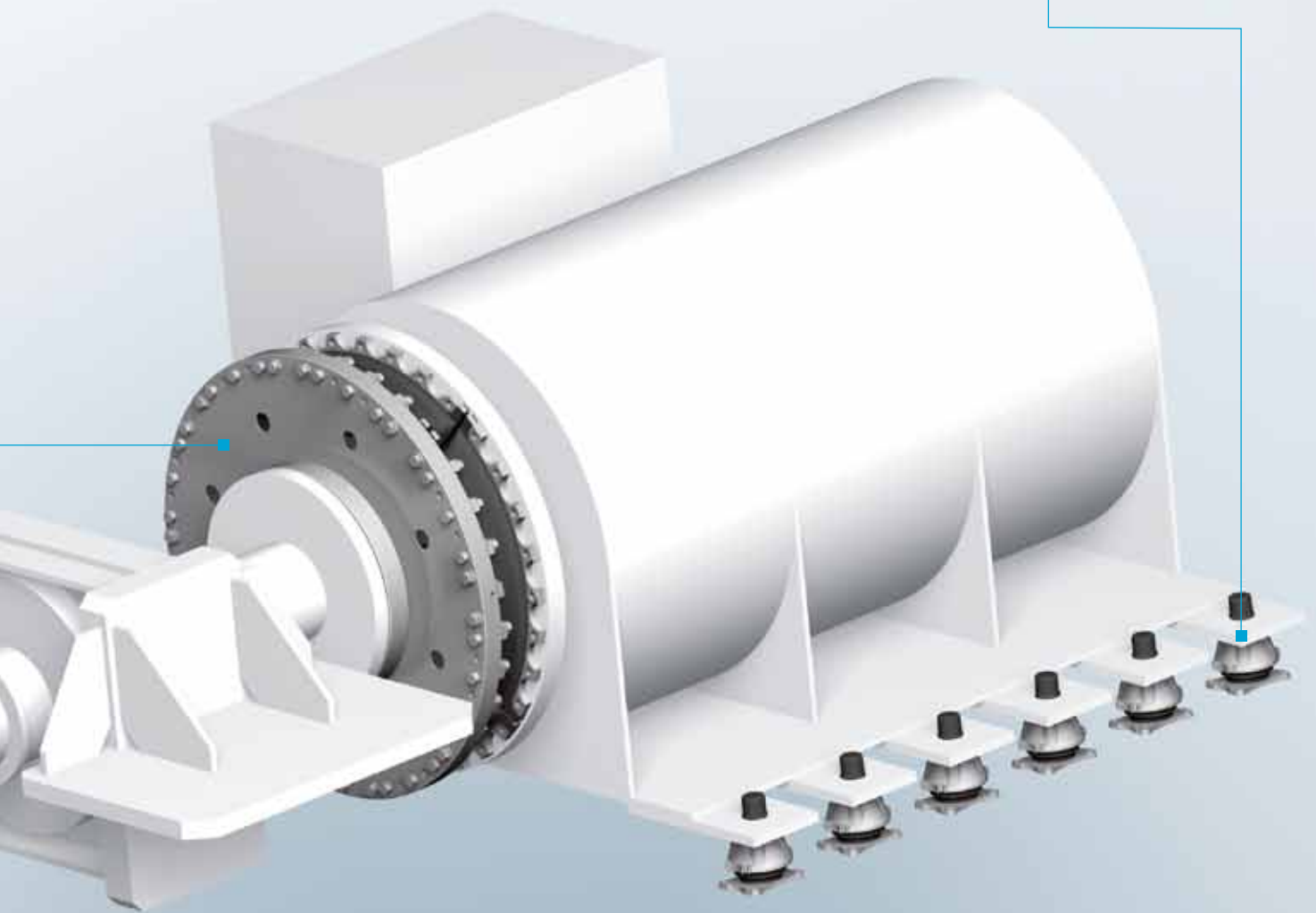


## RATO S SERIES

TORQUE RANGE  
12.50 kNm – 800.00 kNm



**T SERIES**  
LOAD CAPACITY  
3.00 kN – 175.00 kN



# THE DYNAMIC POSITIONING DRIVE

Since the development of satellite navigation, it is possible to keep drilling platforms and ships in position dynamically using their own drive units. The steering propeller units driven by electric motor are most often designed as vertical drives, meaning the electric motor, as well as the shaft line (telescopic shaft) are mounted in a vertical position. The flexible coupling required to tune the drive line in terms

of torsional vibration (propeller excitation) must, in addition, also ensure the radial and axial guiding of the drive train.

The VULKAN RATO DG series meet these requirements perfectly. In terms of construction, no significant modifications of the standard design are necessary, which makes this solution commercially very attractive.

## RATO DG SERIES

**TORQUE RANGE**  
8.00 kNm – 160.00 kNm







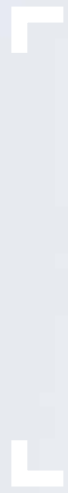
# THE DIESEL-MECHANIC FOUR-STROKE DRIVE

As well as general cargo ships and bulk cargo ships, tankers and container ships, heavy-lift vessels also use medium-sized, single-engine units with high-volume, medium-fast running four-stroke diesel engines, which drive a controllable pitch propeller (CPP) via a reduction gear. The CPP is necessary as most of these units also drive a generator via gearbox PTO from the main gearbox.

This classic drive design requires careful adjustment of rotational vibration by means of a highly flexible coupling in the main drive line, between the diesel engine and the main transmission, as well as in the fast-running PTO line. With their broad spectrum of available torsional stiffnesses, VULKAN RATO S and RATO R series ensure

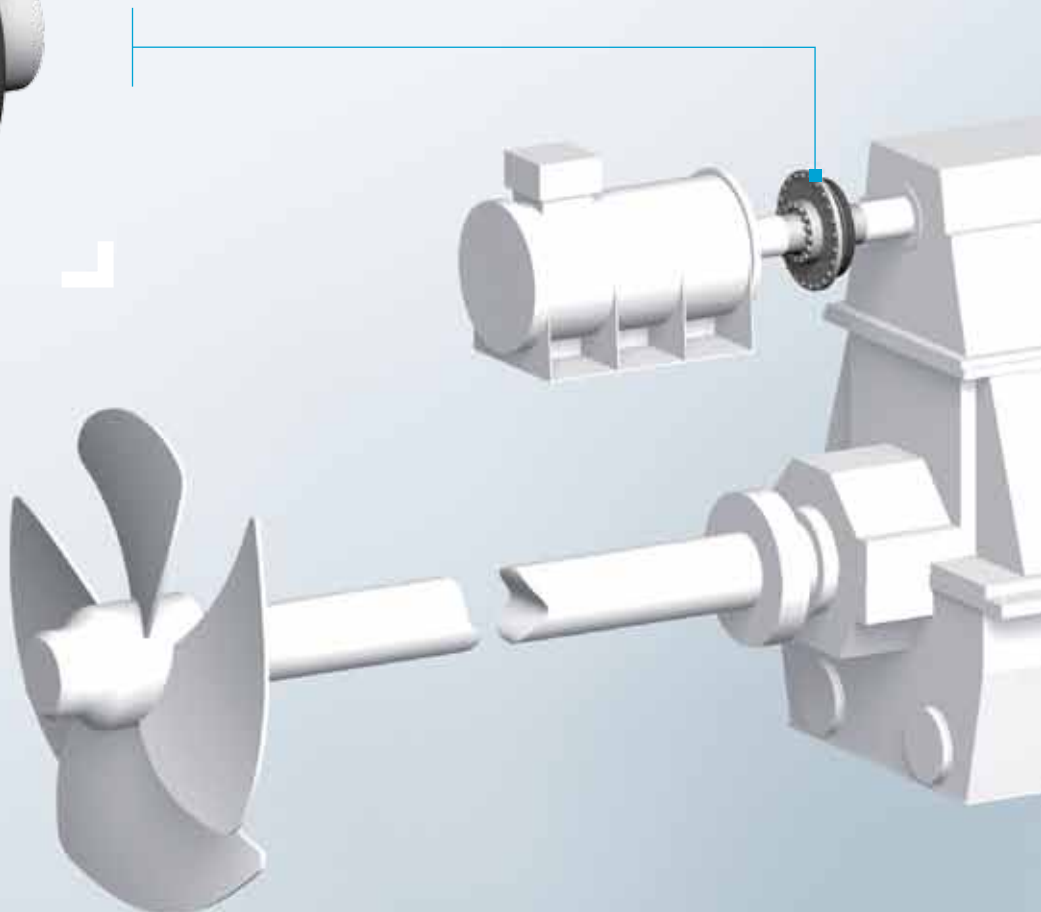
optimum rotational vibration behavior, as well as low stresses in the main gear and in the PTO unit shaft line.

The more and more encountered elastic mounting of the main engine in this shipping sector, for reasons of comfort, requires a main drive coupling that can absorb the axial, radial and angular displacements with the lowest possible restoring forces. These properties are additional strengths of the highly flexible RATO R and RATO S series. The interaction between the flexible coupling and the elastic engine mounting may be further optimized through the use of elastic mounts from the VULKAN Couplings product range.



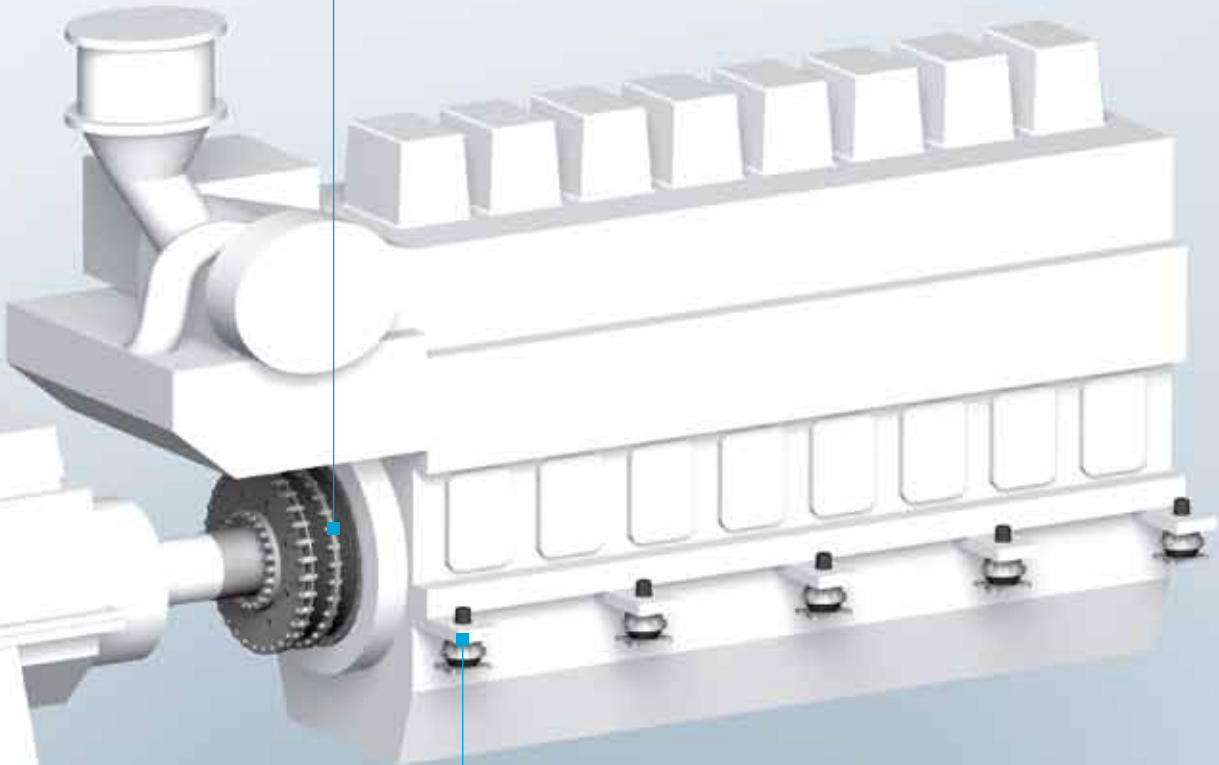
## VULKARDAN E SERIES

**TORQUE RANGE**  
2.50 kNm – 20.00 kNm



**RATO R SERIES**

**TORQUE RANGE**  
12.50 kNm – 270.00 kNm



**T SERIES**

**LOAD CAPACITY**  
3.00 kN – 175.00 kN





# AUXILIARY DRIVES

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**In the maritime sector, auxiliary units such as generators, pumps and winches were either driven by the main engine via engine front end or gearbox PTOs or by separate engines (diesel, dual fuel, gas engines or electric motors).**

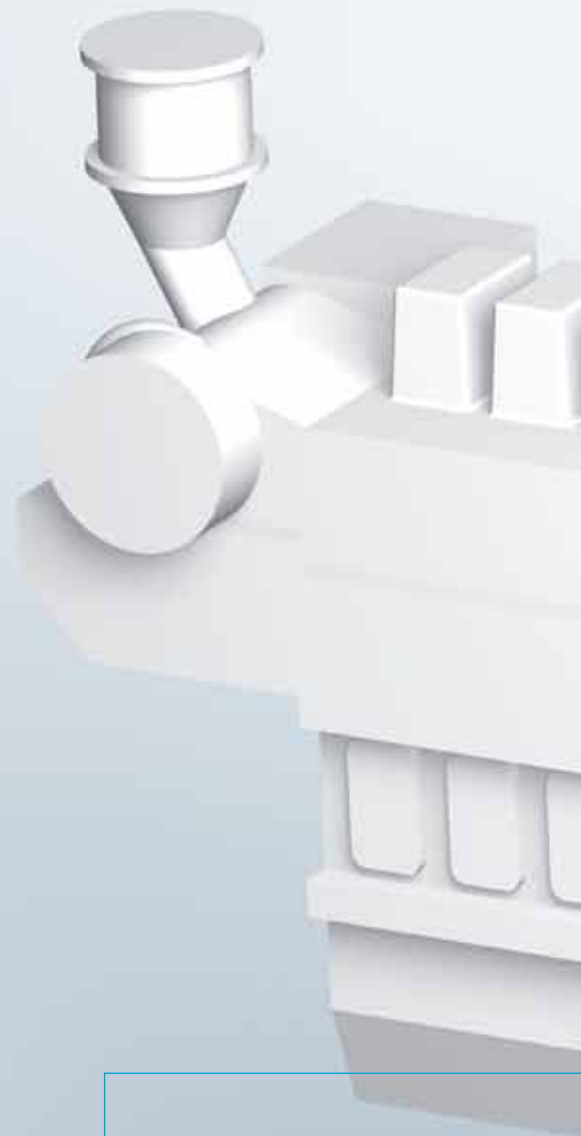
The various configurations require couplings with very different torsional stiffness levels. If, for example, the gearbox PTO often requires torsionally soft tuning, a FIFI drive requires a torsionally stiffer coupling set-up. For all named applications, VULKAN Couplings provides the optimum solution as far as torsional vibration is concerned, either from the standard couplings range (VULASTIK L, VULKARDAN E, RATO series) or with tailor-made solutions based on the standard portfolio.

# THE AUXILIARY UNIT

In the maritime sector, auxiliary units such as generators and pumps were either driven by the main engine via engine front end or gearbox PTOs or by separate motors. The four-stroke diesel-driven auxiliary units belong to the latter category, which are particularly found in cargo ships with two-stroke FPP drives, in order to cover the partly considerable energy requirement of these ships.

Depending on the consuming power of the generators, and thereby the size of the four-stroke diesel engines, for comfort reasons either only the diesel engines are elastically mounted, or the engine and generator are rigidly mounted on a common frame, which is elastically mounted to the ship's hull above. If highly flexible couplings are generally used for the first category, for the last configuration it depends whether single- or double-bearing generators are being used. While single-bearing generators are rigidly coupled, for genset applications with double-bearing generators, highly flexible couplings are necessary.

With not only the RATO series, but also with VULASTIK L, VULKARDAN E and VULKARDAN G, VULKAN Couplings has available a broad spectrum of flexible couplings that cover a large torque and torsional stiffness range, so that the possibility of a favorable tuning exists, with regard to stationary and transient torsional vibration behavior of the system. Above all, VULKAN Couplings places value on backlash-free torque transmission. This leads to good transmission behavior, with respect to governor stability, during loading and unloading of the coupling. Particularly for shock load (short-circuit, missynchronisation etc) the VULKAN Couplings design offers very effective protection for the attached machinery against overloading. Together with in-house produced elastic mounts, VULKAN Couplings delivers the complete solution for optimum tuning of auxiliary units.



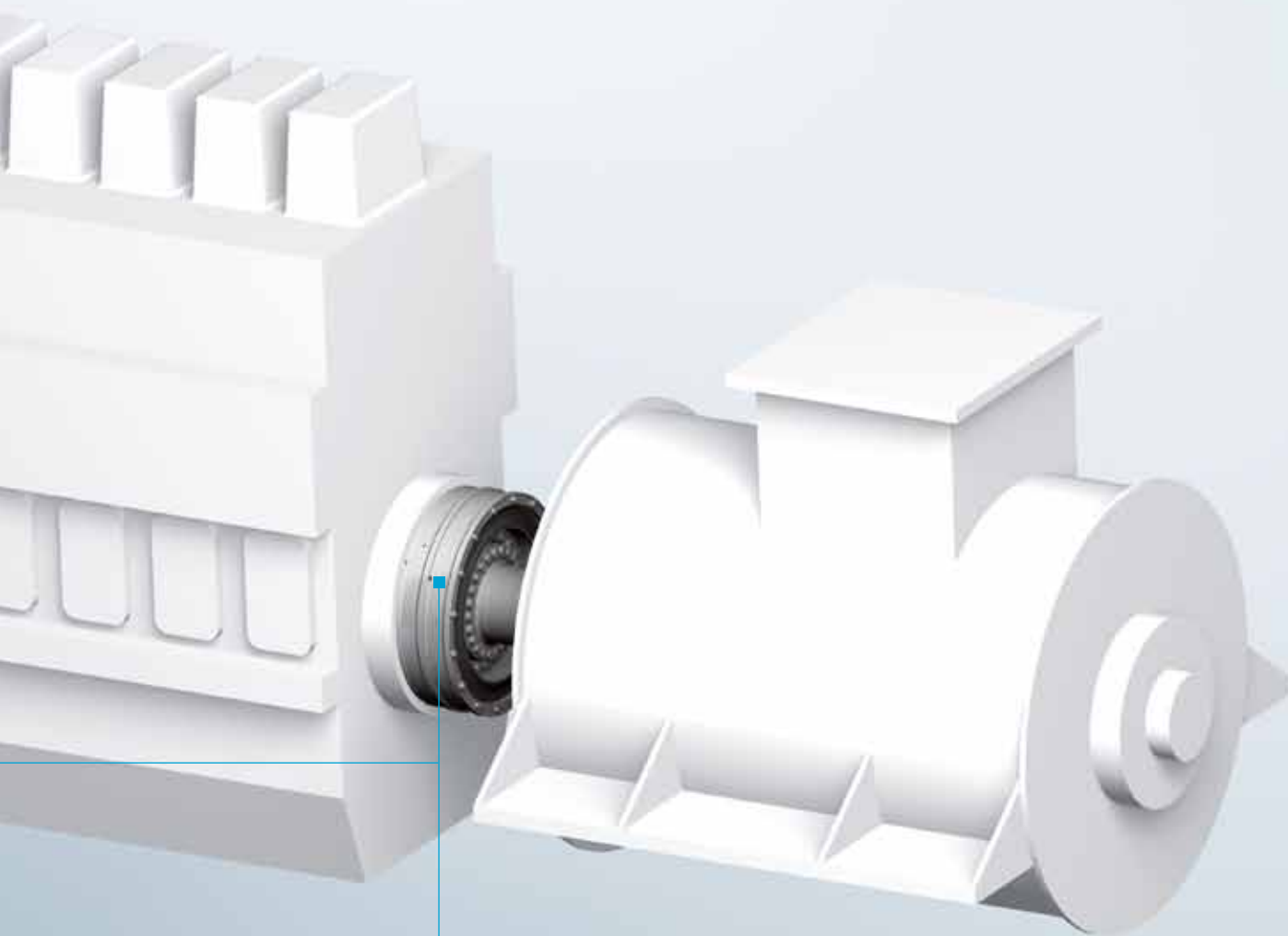
**VULASTIK L SERIES**

**TORQUE RANGE**  
0.40 kNm – 40.00 kNm



**VULKARDAN G SERIES**

**TORQUE RANGE**  
8.00 kNm – 63.00 kNm



**RATO DG SERIES**

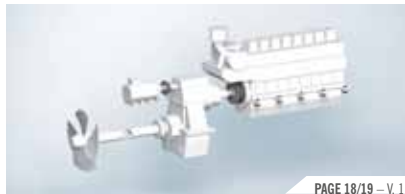
**TORQUE RANGE**  
8.00 kNm – 160.00 kNm

# OVERVIEW

## VULKAN SYSTEM SOLUTIONS

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**CARGO VESSELS**  
THE DIESEL-MECHANIC FOUR-STROKE DRIVE



PAGE 18/19 – V. 1

**PASSENGER SHIPS**  
THE MULTI-ENGINE, DIESEL-MECHANIC FOUR-STROKE DRIVE



PAGE 30/31 – V. 1

**PLEASURE BOATS**  
COMPACT POD DRIVE



PAGE 40/41 – V. 1

**CARGO VESSELS**  
GENERATOR DRIVE VIA TUNNEL GEARBOX



PAGE 20/21 – V. 1

**PASSENGER SHIPS**  
THE COMPACT DIESEL-ELECTRIC DRIVE



PAGE 32/33 – V. 1

**PLEASURE BOATS**  
POD DRIVE



PAGE 42/43 – V. 1

**CARGO VESSELS**  
THE CF DRIVE



PAGE 22/23 – V. 1

**PASSENGER SHIPS**  
THE SEPARATED DIESEL-ELECTRIC DRIVE ARRANGEMENT



PAGE 34/35 – V. 1

**PLEASURE BOATS**  
DOUBLE-ENGINE DIESEL DRIVE FOR YACHTS



PAGE 44/45 – V. 1

**CARGO VESSELS**  
THE TWO-STROKE MAIN PROPULSION DRIVE WITH REDUCTION GEAR



PAGE 24/25 – V. 1

**PASSENGER SHIPS**  
THE JET DRIVE



PAGE 36/37 – V. 1

**PLEASURE BOATS**  
STERN-DRIVE



PAGE 46/47 – V. 1

**CARGO VESSELS**  
THE ELECTRIC DRIVE WITH FOUR-STROKE DUAL FUEL ENGINES



PAGE 26/27 – V. 1

**PLEASURE BOATS**  
THE COMFORT DRIVE



PAGE 48/49 – V. 1



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**WORK BOATS**  
THE DIESEL-ELECTRIC DRIVE  
FOR WORK BOATS



PAGE 52/53 – V.1

**WORK BOATS**  
DIESEL-MECHANIC DREDGER DRIVE



PAGE 62/63 – V.1

**SPECIAL VESSELS**  
THE SHOCK- AND NOISE-SENSITIVE  
DIESEL-MECHANIC DRIVE



PAGE 68/69 – V.1

**WORK BOATS**  
DIESEL-MECHANIC DRIVE  
WITH INTEGRAL SHAFT SUPPORT



PAGE 54/55 – V.1

**WORK BOATS**  
THE DIESEL-MECHANIC  
DRIVE IN TUGBOATS



PAGE 64/65 – V.1

**SPECIAL VESSELS**  
THE SHOCK- AND NOISE-SENSITIVE  
DIESEL-ELECTRIC DRIVE



PAGE 70/71 – V.1

**WORK BOATS**  
THE MULTI-ENGINE DIESEL-MECHANIC  
DRIVE IN ICEBREAKERS



PAGE 56/57 – V.1

**SPECIAL VESSELS**  
THE DYNAMIC POSITIONING DRIVE



PAGE 72/73 – V.1

**WORK BOATS**  
THE DIESEL-ELECTRIC DRIVE  
IN ICEBREAKERS



PAGE 58/59 – V.1

**SPECIAL VESSELS**  
THE DIESEL-MECHANIC FOUR-STROKE DRIVE



PAGE 74/75 – V.1

**WORK BOATS**  
DIESEL-ELECTRIC DREDGER DRIVE



PAGE 60/61 – V.1

**AUXILIARY DRIVES**  
THE AUXILIARY UNIT



PAGE 78/79 – V.1

# IMPRINT

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Please find here the contact details of our global service locations.





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