FLENDER GEAR UNITS

SAFE FAIRWAY
FOR YOUR PROPULSION PROJECTS.

NAVILUS marine gear units: quality and reliability,
from support to product.

flender.com

FLENDER

RORO ferry Kronprins Frederik, which first entered service in 1981, still keeps Germany and Denmark connected to this day – thanks in part to proven propulsion technology from Flender.

Putting a ship into service requires close coordination across an extremely wide range of trades. So much the better when you have a partner that knows how to be a team player.

WITH THE CUSTOMER FOR THE CUSTOMER.

We have been supplying our NAVILUS® gear units to the shipping industry for many decades. That long experience enables us to offer high-quality, industry-specific drive components. Along with reliable products, perfect project management is no less of a key factor in the successful fulfillment of a charter. That's why we put all of our expertise and skill to work for our customers.

High-end engineering

Our drives are optimized for many different types of ships and transmit the engine power to the propeller without unnecessary losses. Extremely high efficiencies, optimum power-to-weight ratios, and minimal vibration and noise levels characterize our products. As a customer, you can always be sure of top reliability, durability, optimum efficiency and minimum maintenance costs. Furthermore, our smooth-running drives reduce static loading and ensure stable operation over the long term, even at full load.

Our gear unit line comprises many different designs, ranging from generator gear units with up to 8 MW and SISO gear units starting from 1 MW to the TWISO gear unit with 50 MW. The propulsion gear units are available as single- or two-speed variants and can be equipped with versatile PTO, PTH and PTI options. That puts all the alternatives of energy production, redundancy and hybrid capability onboard.

Your project in the best of hands

Our broad range of systems and products can satisfy an extremely wide range of requirements. Depending on the task, we can apply elements from our standard tool-kit or work together with the customer to implement designs with unique specifications.

Along with global customer support and service, the main factors behind successful collaboration include high availability and, above all, punctual delivery.

Our familiarity with process, product and system levels helps us better serve our customers. We develop more than just the gear units, we also develop the auxiliary equipment and the schematics. Digitalization in project management and in the design process make our processes fast and flexible. Proposals are issued rapidly and 3-D design drawings can be shared electronically.

One face to the customer

We achieve extremely high reliability and loss-free information channels through the integration of the key account managers within the project team. Always up to date with all essential project details, they can support the customer as their competent partners throughout the project straight through to the after-sales phase.

So expect the best consulting services, backed up by industry knowledge, practical focus and expertise covering the entire drive train, together with open communication to ensure the success of your project.

HYBRID DRIVE AND **ENERGY** SUPPLY **EFFECTIVELY** COMBINED.

SALAMANCA	
Type of ship	ROPAX ferry
Shipyard	Avic Weihai Shipyard Co. Ltd., CN
Owner	Brittany Ferries
Year	2020
Class	DNV 1C
Propulsion	Dual fuel
Output	2 x 13,740 kW
Flender	2 x NAVILUS GHCK 1120

SUCCESSFUL PROJECT
TOP QUALITY
SISO PROPULSION
HYBRID

MISSION

Development of state-of-the-art propulsion gear units for the unique energy management system that will drive the world's largest hybrid ship.

FLENDER SOLUTION

Two powerful SISO gear units with a horizontal shaft offset and an integrated multi-disk clutch. On the PTO shaft, there is a disengaging coupling, with a manually operated coupling to separate the gear unit from the generator.

WHAT ALL FLENDER PRODUCTS HAVE IN COMMON

Flender's gearwheel geometry achieves overlap factors of at least three to ensure reduced noise levels. The reinforcement ribs of the housing and the adaptation of the wall thickness combine with a low-resonance design using low-noise bearings to enable quiet operation.

COOPERATION
PROVEN TECHNOLOGY
SECONDARY PTO
SAFETY

FAR FROM SHORE **EVERYTHING** MUST **WORK CORRECTLY.**

EGBERT WAGENBORG

Type of ship	Multi-purpose vessel – EasyMax
Shipyard	Shipyard Royal Niestern Sander B.V., NL
Owner	Royal Wagenborg
Year	2016
Class	BV
Propulsion	Diesel
Output	3,000 kW
Flender	NAVILUS GMCP 850

MISSION

Flender has already supplied the gear units that drive various generations of Royal Wagenborg multi-purpose vessels. Having long since proven itself under hash operating conditions, the technology has been further developed for today's requirements.

FLENDER SOLUTION

Rapid and straightforward project implementation using a NAVILUS gear unit with optimized design from the existing product portfolio.

WHAT ALL FLENDER PRODUCTS HAVE IN COMMON

To optimize gearwheel contact under load, tooth geometry is continuously monitored and analyzed during production and the grinding process is adapted accordingly.

SISO TECHNOLOGY – RELIABLE AND RAPIDLY AVAILABLE.

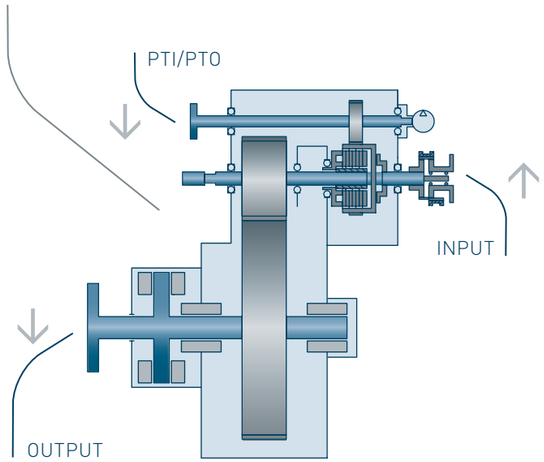
NAVILUS single-input/single-output gear unit solutions cover a power range from 1 to 20 MW. The gear units can be optionally supplied with or without multi-disk couplings.

The yacht Venus combines Philippe Starck's exquisite design with Flender's engineering excellence.

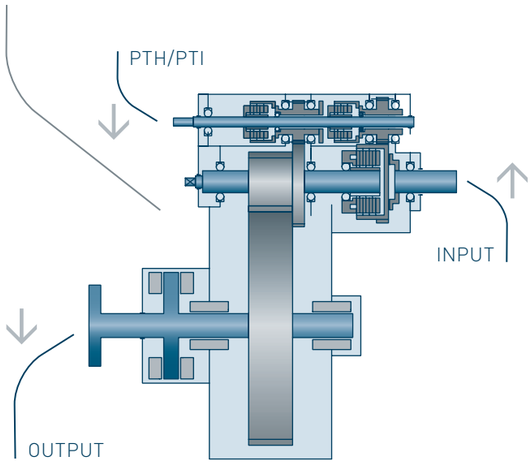
APPLICATIONS

- ROPAX and RORO ferries
- Product tankers
- Chemical tankers
- LNG tankers
- Container ships
- Offshore tugs
- Dredgers
- Research vessels
- Fishing vessels
- Government vessels
- Offshore multi-purpose vessels
- Offshore supply vessels
- Megayachts

NAVILUS GCK
Single reduction gear unit with primary PTO/PTI and hydraulically operated clutch



NAVILUS GMBK/GNBK
Single reduction gear unit with primary PTI and secondary PTH



Our single-input/single-output marine gear units largely comprise high-quality components from our proven modular system.

These single-input/single-output marine gear units are found from coastal vesto ocean going vessels. Depending on the requirements of the ship, they can be built with vertically, horizontally or diagonally offset shafts. A PTO to generate low-cost onboard electricity is almost considered as standard equipment now, whereby generators can be driven as primary or secondary units.

We also carry solutions to ensure PTH operation. This is becoming increasingly important, for example, for ships that transport hazardous goods. All gear units include a directly mounted oil supply system and monitoring as standard equipment.

Because the propeller thrust bearings are integrated in the gear unit, the housings feature a torsionally rigid design. This also ensures that the gears mesh perfectly under all conditions – even when underway in heavy seas, for example.

YOUR BENEFITS

- 1,000 to 20,000 kW
- Available as twin-/multiple-drive and single-drive reduction gear units
- Single-stage and multi-stage solutions
- Transmission ratios ranging from 2 to 10:1, two-stage gear units up to 14:1
- Vertical, horizontal or diagonal shaft offset
- Cast iron or welded housing
- Low-vibration and noise-optimized
- Compact design
- Extremely high efficiency
- Optimum power-to-weight ratio
- Complete with auxiliary equipment
- Easy to install
- Versatile PTI/PTO configurations
- 1-speed or 2-speed gear units
- Integrated thrust bearings

FLEXIBLE POWER FOR PROPULSION AND AUXILIARY EQUIPMENT.

LANEY CHOUEST

Type of ship	AHTS, Anchor Handling Tug Supply
Shipyard	NAS, USA
Owner	EOC
Year	2003
Class	ABS
Propulsion	Diesel
Output	2 x 5,940 kW
Flender	NAVILUS GVL 1750

MISSION

We have already equipped many ships with gear unit technology for EOC. The objective here was to transmit the output of two powerful engines to a propeller shaft and use proven technology to withstand the harsh operating conditions.

FLENDER SOLUTION

Our TWISO gear unit is robust and durable and always ensures extremely economical operation. The secondary PTO also makes it possible to generate enough onboard electricity to drive auxiliary equipment such as a bow thruster.

WHAT ALL FLENDER PRODUCTS HAVE IN COMMON

The design and gear tooth geometry calculations comply with the latest rules of the ship classification societies. State-of-the-art software is used to calculate the geometry and the deflections under various load conditions.

TWISO EXPERTISE
VERSATILITY
PROVEN
PARTNERSHIP

WIND, ELECTRICITY AND DIESEL – A **COMPLEX TASK.**

COPENHAGEN	
Type of ship	RORO ferry
Shipyard	P+S Werften GmbH, DE
Owner	Scandlines
Year	2016
Class	LR 1C
Propulsion	Diesel
Output	3 x 4,500 kW
Flender	NAVILUS GVLS 1600

MISSION

Coordinating three engines and the necessary onboard electricity with one gear unit required a complex solution.

FLENDER SOLUTION

A tailor-made NAVILUS three-engine propulsion gear unit with backlash-free multi-disk clutches satisfies the demands of this innovative application – a challenge that only an experienced project team can handle.

WHAT ALL FLENDER PRODUCTS HAVE IN COMMON

Reliable and robust designs ensure long service life and have low maintenance requirements. Intelligent designs operate with minimum losses and reduce fuel consumption. Our NAVILUS gear units combine both.

MISSION
MULTI-STAGE GEAR UNITS
EXPERTISE – SOLUTION
INDIVIDUAL

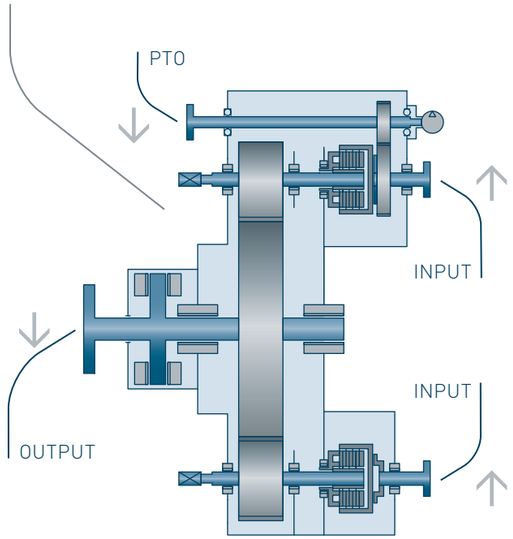
TWISO GEAR UNITS OFFER OPEN VERSATILITY.

APPLICATIONS

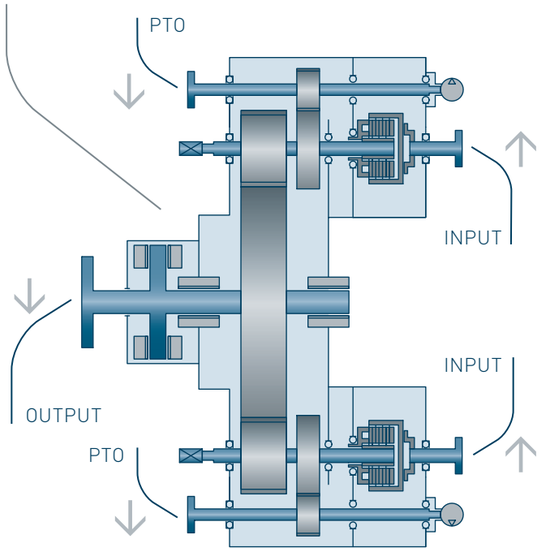
- ROPAX and RORO ferries
- Product tankers
- LNG tankers
- Container ships
- Dredgers
- Research vessels
- Government vessels
- Offshore supply vessels
- Megayachts

Many additional options are available for our NAVILUS gear units: holding brakes, rotor turning gear, oil supply systems and sensors for condition monitoring.

NAVILUS GVL
TWISO gear unit with primary PTO



NAVILUS GVL
TWISO gear unit with two secondary PTOs



Multi-engine ships often require an extremely wide range of propulsion concepts. We help transform specific requirements into a functional product.

Our NAVILUS gear units for ships with two or more engines can intelligently combine the output from multiple diesel engines, electric motors and generators. Through the use of disengaging clutches, the gear units can be operated in single-engine or twin-engine mode or an electric motor can be added. Passenger ships and ferries often take advantage of the flexibility such redundancy provides.

The arrangement of multi-disk clutches used to engage and disengage the gear units permit PTO operation while the engine is running and the propeller is idle. This also enables maintenance operation on twin-screw vessels with four engines.

YOUR BENEFITS

- Up to 50,000 kW
- Implementation of different propulsion concepts
- Project-oriented design according to customer specifications
- Single-stage and multi-stage solutions
- Transmission ratios ranging from 2 to 10:1
- Horizontal or diagonal shaft offset
- Hollow shaft design
- Welded housing design
- Low-vibration and noise-optimized
- Compact design
- Extremely high efficiency
- Optimum power-to-weight ratio
- Complete with auxiliary equipment
- Easy to install
- Versatile PTI/PTO configurations
- 1-speed or 2-speed gear units

PRECISION
2-SPEED
LOW-EMISSION
CUSTOMER-SPECIFIC

INDIVIDUALLY PLANNED **EFFICIENCY.**

POLAR DUCHESS

Type of ship	Seismic vessel
Shipyard	Vulcano Shipyard SRL, Spain
Owner	Rieber Shipping
Year	2014
Class	DNV
Propulsion	Diesel
Output	2 x 4,500 kW
Flender	NAVILUS GVLQ 1250

MISSION

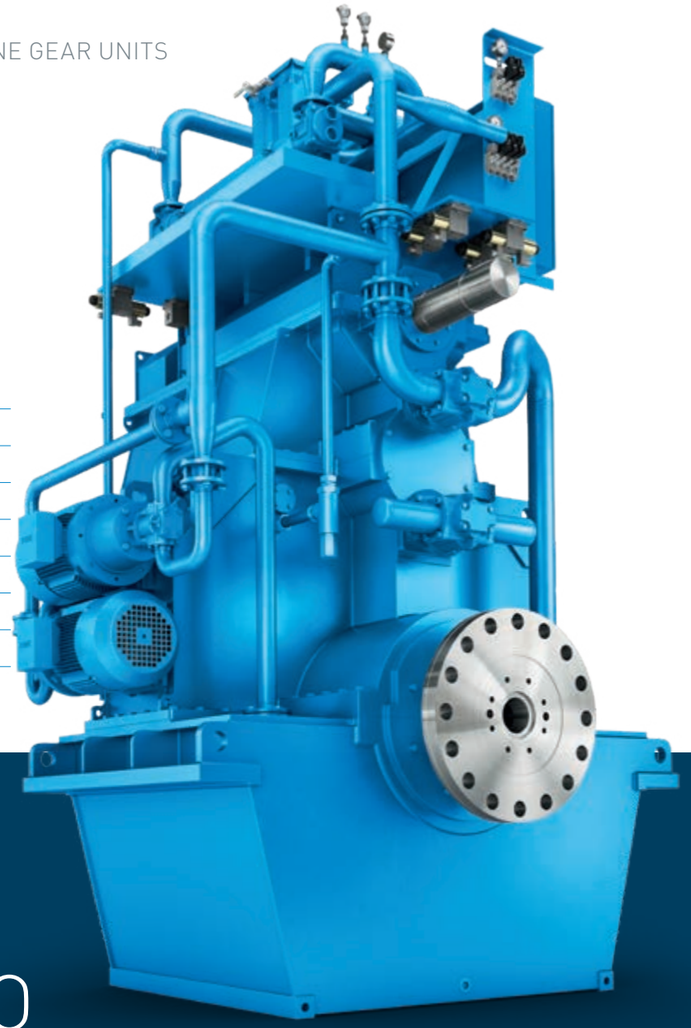
Proceed rapidly to the deployment location and then take seismological measurements at low speed. Two extremely different operating modes – and both of them must always be as economical as possible.

FLENDER SOLUTION

Specially developed for this application, a TWISO 2-speed gear unit with hollow shaft design enables the ship to remain extremely fuel-efficient at all times while moving at various speeds. Just like many other research vessels that study the world's oceans efficiently with 2-speed gear units from Flender.

WHAT ALL FLENDER PRODUCTS HAVE IN COMMON

Our gear units are fully tested on our test stands before delivery. As a result, you receive not only high-torque gear units, but also the assurance that they will withstand harsh conditions on the high seas.



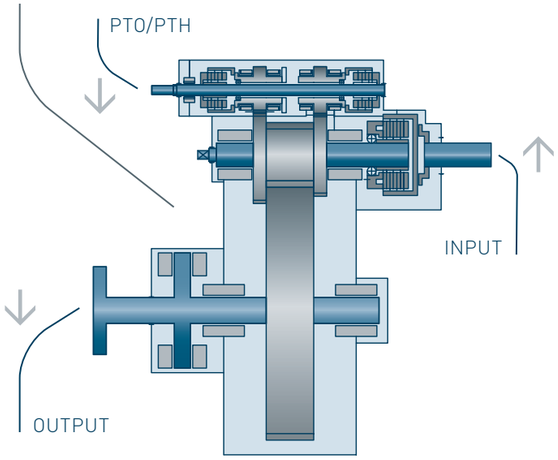
APPLICATIONS

- Product tankers with APS notation
- Research vessels
- Seismic vessels
- Chemical tankers
- Rescue vessels
- Fishing vessels
- Patrol boats
- Megayachts

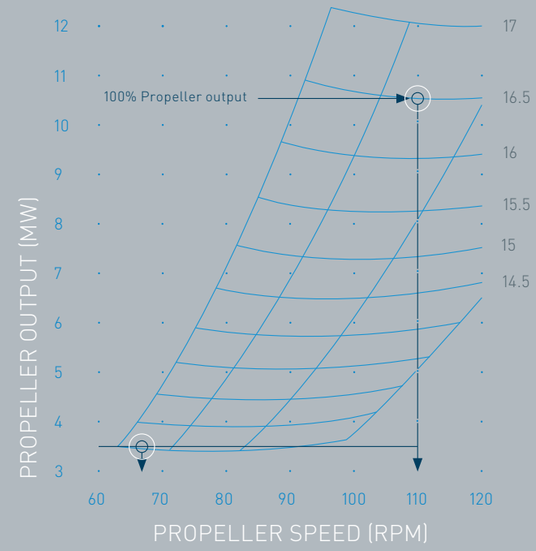
SHIFT INTO HIGH GEAR WITH 2-SPEED ECONOMY.

Many ships proceed to their deployment location in high-speed mode. Then upon arrival they switch to slow speed, running as smoothly as possible. The ideal application for our NAVILUS 2-speed gear units, which are available for single- and twin-engine vessels.

NAVILUS GUCK
SSISO 2-speed gear unit with primary or secondary PTO/PTH



Engine map and propeller curve



2-speed gear units are always designed for the special characteristic curves of the specific ship.

Smooth ride with concurrent electricity generation. NAVILUS 2-speed gear units with separate PTO and PTI stages make it possible.

But a disengaging gear unit can also do much more. Enabling a diesel engine to run near its optimal operating point minimizes wear and tear on the engine. To operate at the same speed but with reduced power, the Controllable Pitch Propeller (CPP) must be operated with reduced pitch and thus also at lower efficiency. With the option of a second gear stage, the speed of the propeller can be reduced to minimize the penalty incurred by "off-design" operation. In parallel, a PTO can be used to generate electricity.

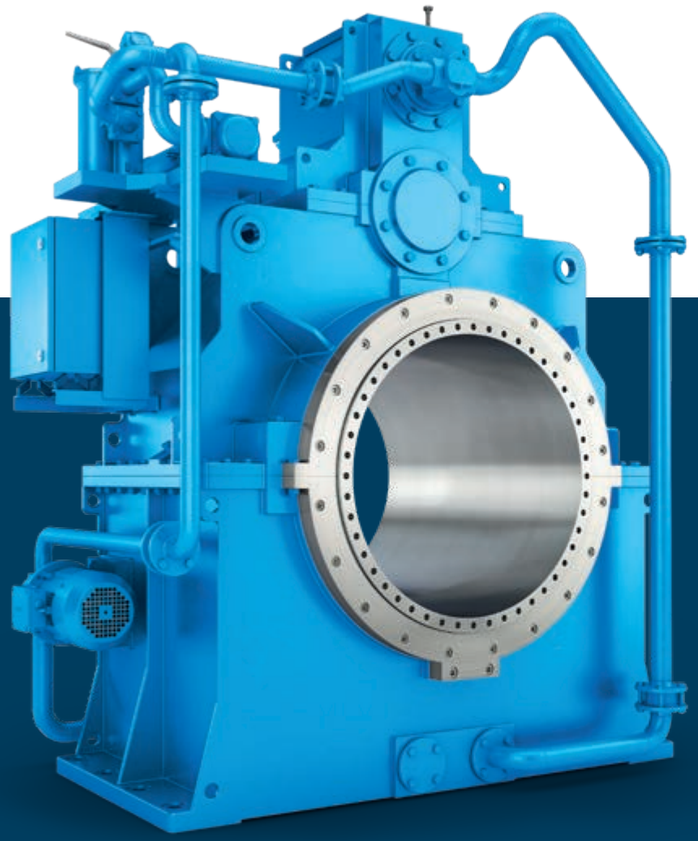
Ships carrying hazardous cargo must remain maneuverable under all circumstances. For that reason, they require redundancy systems that safeguard propulsion by an alternative system via a PTH.

NAVILUS 2-speed gear units are hybrid-compatible. An electric motor can provide slow-speed propulsion. The main engine is only needed at high speeds. This methodology is predestined for government and rescue vessels as well as megayachts.

Our gear unit expertise and our maritime know-how are what make our propulsion systems so exceptional. Flender constantly confronts new challenges and applies its extensive experience to respond with new 2-speed gear unit solutions for:

- Single-engine ships
- Multi-engine ships
- Horizontal and vertical configurations
- All standard classifications and design regulations
- All power classes up to 20 MW

LOW SPEED, LOTS OF ELECTRICITY.

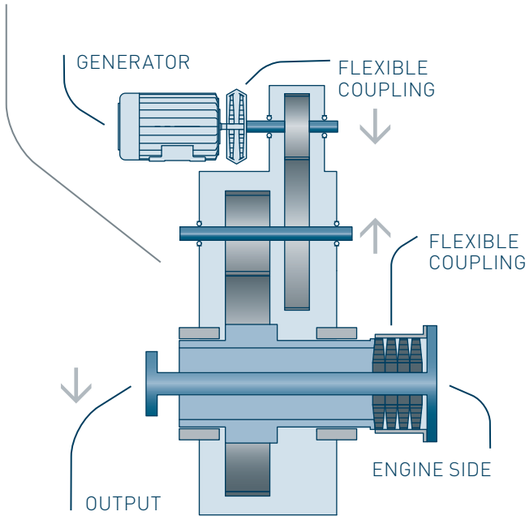


Ships that travel long distances at sea with diesel engines running at slow speeds can use tunnel gear units to generate inexpensive onboard electricity.

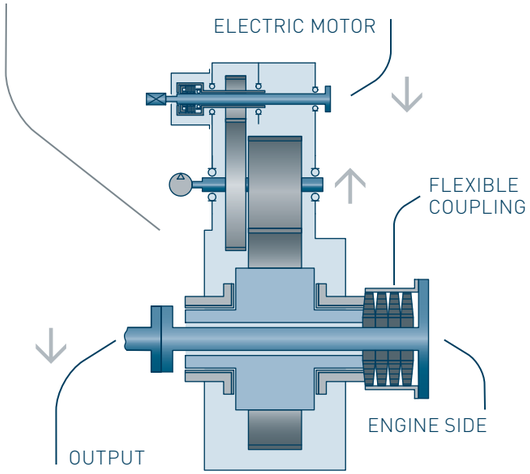
APPLICATIONS:

- ROPAX and RORO ferries
- Bulk carriers
- Tankers
- Chemical tankers

NAVILUS GUG
Tunnel gear unit with secondary PTO



NAVILUS GUG
Tunnel gear unit with integrated hydraulic clutch and secondary PTO



Making effective use of the engine's power helps reduce fuel costs.

NAVILUS tunnel gear units are ideal for generating inexpensive onboard electricity with diesel engines running at slow speeds. They are installed on the propeller shaft or on the front of the main engine. An extremely wide range of systems is available for this purpose. They can transmit up to 8,000 kW of power. Interposing an auxiliary gear unit permits the design of a smaller and lighter tunnel generator that also runs at high speeds of 1,800 or 3,600 rpm.

Tunnel gear units can be used both for generator operation and for PTI/PTH operation. In emergency mode, a disconnect coupling is used to decouple the output shaft of the diesel engine and the polarity of the generator is reversed to operate it as a motor. Our two-speed tunnel gear units are also designed for PTO/PTI operation, to make power distribution as flexible as possible.

Flender gear units have been used in these applications for many years. Their high quality materials and workmanship ensure the long service life and trouble-free continuous operation of the generator.

YOUR BENEFITS

- Outputs starting from 500 kW
- Simple energy production with the main engine
- Multi-stage design
- Vertical or diagonal shaft offset
- Welded housing
- Integrated hydraulic clutch
- Low-vibration and noise-optimized
- Compact design
- Extremely high efficiency
- Optimum power-to-weight ratio
- Complete with auxiliary equipment
- Easy to install
- Suitable for PTO/PTI and PTI/PTH operation

GLOBAL PARTNERS AND SERVICE.

Our global presence enables us to provide our comprehensive expertise and large product portfolio the world over. A seamless network of Flender subsidiaries and Flender representatives makes contacting us fast and easy.

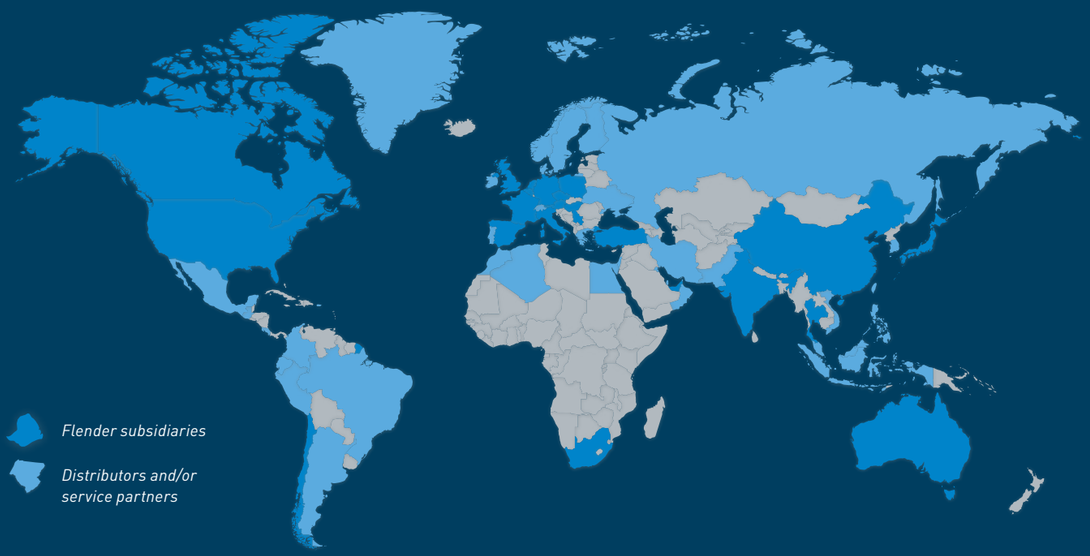
Also known as Bruinhof Marine, Flender B.V. is the global Lifecycle Support Unit of Flender, enabling us to specialize in the worldwide delivery of spare parts and the deployment of service technicians. Both functions support the full mechanical drive portfolio, comprising propulsion, generator and dredger gear units as well as couplings, clutches and shaft bearings.

Commissioning by experts
Complex equipment must be professionally installed and put into operation to ensure their long service life. To assure this function, we have an experienced start-up team that inspects the installation, tests the alarm systems, calibrates the sensors and conducts load and performance tests.

Monitoring your gear unit
To prevent damage and breakdowns, initial symptoms must be recognized early. With that in mind, and to maintain the optimum reliability of your gear unit, we offer you our condition monitoring service. As gear unit specialists, we use analysis, diagnostics and inspection to ensure that your drive is well maintained. In this context, we can use remote diagnostics, mobile vibration analyses, acceptance measurements or load and torque measurements, inspections and endoscopic inspections. Online, with continuous remote support and analysis, or offline, with a visit by our engineers. Above all, condition monitoring makes it possible to schedule rational maintenance intervals.

Preventive maintenance
You can also improve the availability of your drives through our preventive maintenance service. Regular measures specifically suited to the age and operating hours of the gear unit help you maintain its optimum operating condition.

Visit our websites listed on the back of this brochure. They provide various contact options.



WORLDWIDE RESPONSIBILITY.

Flender is a reliable partner whose business relationships are based on trust and responsibility. Qualified and dedicated employees are the key to our innovative strength, performance and consulting expertise. That's why we continuously invest in training and continuing education, provide progressive working conditions and believe that diversity enriches our work environment.

But we do not want our responsible actions to be confined to our company. We develop our processes in a way that makes our products and production as eco-friendly as possible. We are particularly proud of the fact that by the end of 2022 our power consumption will be carbon-free. We have also initiated various projects to reduce waste, optimize recycling and avoid harmful substances.

Our products also have an impact on the environment. We bear that in mind in our material selection and manufacturing, and view their high quality and the resulting long useful life as beneficial to the environment. With its harmonized torque spectrum, our product portfolio always enables users to select the right gear unit size, thereby significantly increasing energy efficiency.

As a company with global operations, we are also aware of our global impact. Accordingly, along with ecological issues, economic and social ones are also important to us. We also want to take a lead role here and continuously align our actions with the 17 Sustainable Development Goals of the UN. With the ambition of enabling all people to lead a dignified human existence while permanently protecting the natural basis for life at the same time.

For more information about NAVILUS gear units
www.flender.com/en/industry/marine

For more information about marine services
www.flender.com/en/bruinhofmarine

WE **MOVE** the WORLD

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