MARINE PRODUCTS AND SYSTEMS
Our technologies, products and systems are continually improving. For the latest information please go to www.km.kongsberg.com

All information is subject to change without notice.
# Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>03</td>
</tr>
<tr>
<td>Ship design</td>
<td>05</td>
</tr>
<tr>
<td>Propulsion systems</td>
<td>25</td>
</tr>
<tr>
<td>Diesel and gas engines</td>
<td>35</td>
</tr>
<tr>
<td><strong>PROPULSORS</strong></td>
<td></td>
</tr>
<tr>
<td>• Azimuth thrusters</td>
<td>49</td>
</tr>
<tr>
<td>• Propellers</td>
<td>61</td>
</tr>
<tr>
<td>• Waterjets</td>
<td>67</td>
</tr>
<tr>
<td>• Tunnel thrusters</td>
<td>75</td>
</tr>
<tr>
<td>• Promas</td>
<td>81</td>
</tr>
<tr>
<td>• Poded propulsors</td>
<td>87</td>
</tr>
<tr>
<td>Reduction gears</td>
<td>97</td>
</tr>
<tr>
<td><strong>STABILISATION AND MANOEUVRING</strong></td>
<td></td>
</tr>
<tr>
<td>• Stabilisers</td>
<td>101</td>
</tr>
<tr>
<td>• Steering gear</td>
<td>109</td>
</tr>
<tr>
<td>• Rudders</td>
<td>117</td>
</tr>
<tr>
<td>Deck machinery solutions</td>
<td>123</td>
</tr>
<tr>
<td><strong>ELECTRICAL POWER AND AUTOMATION SYSTEMS</strong></td>
<td></td>
</tr>
<tr>
<td>• Electrical power systems</td>
<td>145</td>
</tr>
<tr>
<td>• Automation systems</td>
<td>163</td>
</tr>
<tr>
<td>Global service and support</td>
<td>171</td>
</tr>
</tbody>
</table>
Maximizing performance by providing

THE FULL PICTURE

We are determined to provide our customers with innovative and dependable marine systems that ensure optimal operation at sea. By utilising and integrating our technology, experience and competencies within design, deck machinery, propulsion, positioning, detection and automation we aim to give our customers the full picture - shaping the future of the maritime industry.

Our industry expertise covers a fleet of more than 30,000 vessels. While we are the largest marine technology specialist organisation in the world, with the most extensive product and knowledge base, our focus continues to be on customers and the environment. Only by listening to you and predicting industry needs can we enable the transformation needed to put safety and sustainability first, while continuing to generate value for all stakeholders.

The Full Picture consists of our product portfolios, world class support networks and more than 3500 expert staff located in 34 countries across the globe.

We are shaping the maritime future with leading edge operational technology, solutions for big data and digital transformation, new electric and hybrid power systems and truly game-changing developments in remote operations and Maritime Autonomous Surface Ships (MASS).

Welcome to the Full Picture. Welcome to the future.
A Kongsberg designed vessel is more than just a hull design. It is a hydrodynamic, efficient vessel with diesel or LNG engines and all major systems fully integrated for the best performance, enabling vessels to be built anywhere in the world.

For all designs we deliver a comprehensive system design integration.
Offshore vessels

Kongsberg offers a range of ship designs for the offshore sector from its well known UT design family, launched in the mid 1970s. The range includes: platform supply vessels, anchor-handling/tug/supply vessels, multipurpose service vessels and other specialised vessels.

Platform supply vessels/multi-purpose service vessels (PSV/MPSV)
The UT range of platform supply vessel provides excellent seakeeping capabilities with optimised operational cost versus cargo capacity and flexibility. The range reflects the changes in regulations regarding the transport of offshore products as well as the need to transport new product types. The range also includes multi-purpose service vessels equipped with a wide range of crane, ROV systems, moonpool and/or winches.

Platform supply vessel range:
- Medium to large sized platform supply vessels
- Deck area 650 to 1200 sq. m
- Deadweight range between 3000 and 6000 DwT
- Solutions for type 1 and toxic products transport under latest IOSV code available
- Flexible power systems, diesel-electric, diesel-mechanic, hybrid and gas-electric
- Azipull, azimuthing or conventional CPP thrusters available

Multi-purpose service vessel range:
- A-frame and / or subsea cranes with heave compensation
- Multiple ROV systems
- Moonpool(s)
- SPS notation
- Helideck
- Dynamic positioning, DP 2 or DP 3

UT 776 CD
- Length : 92.80 m
- Breadth : 20.00 m
- Deadweight : 5300 DwT
- Deck area : 1000 m²
Anchor-handling/tug/supply vessels (AHTS)
The design for AHTS vessels range from small and compact vessels to large and complex mooring installation vessels with world record in bollard pull. They are fitted with advanced winch systems from Kongsberg and can be powered with advanced hybrid propulsion solutions for a fuel efficient operational profile.

Anchor handling, tug, supply vessel range:
- Bollard pull range from 85 T to 425 + Tons
- Conventional propulsion lines or hybrid solutions with diesel-mechanic and diesel-electric alternative
- Sophisticated winch configurations with capacities of 150 to 600+Tons
- A-frame or offshore crane
- Moonpool and ROV capabilities
- SPS notation

UT 790 WP
- Length : 90.60 m
- Breadth : 23.00 m
- Deadweight : 3400 DwT
- Bollard pull: 270 t
Emergency response/field support vessels (ERRV)
The emergency response and field support vessel range includes designs for purse standby and rescue operations to vessel with multi-role capabilities, including supply and field maintenance work. The design feature optimised power generation set-ups to provide efficient operation over the whole of the vessel’s operational profile.

Emergency response and field support vessel range:
- Rescue capacity from 150 to 400 + persons according various standards
- Oil recovery according latest NOFO standards
- Cargo deck area from 300 to 700 m²
- Optional offshore products transport capacity
- Optional equipped for field maintenance task
- Speed range from 17 to over 21 kn
- Hybrid propulsion systems with possible energy storage
- Various boat and survivor handling systems available
- Helicopter landing deck options
- SPS notation possible

**UT 5218**
- Length: 92.60 m
- Breadth: 18.00 m
- Rescue capacity: Up to 370 persons
- Oil recovery: 1500 m³
- Speed: 20 kn
Wind farm support vessels (SOV/CSOV)
The UT range of wind farm service operation and construction support vessels provides a comfortable and operational efficient platform for wind turbine support operations. The vessels feature a high DP capability as well as optimised propulsion and power system for the specific operations they perform.

The SOV/CSOV range:
• Versions for operation as well a construction support
• Technician capacity from 20 to above 120 persons
• High comfort level and high-standard living environment
• Optimum operational and hotel logistics
• Optimum motions for comfort and transfer operations
• Energy efficient power generation system with energy storage solutions
• Designs suitable for wide range of gangway systems
• Crane (with or without 3D motion compensation) with large lifting height and outreach
• One or more daughter crafts with efficient deployment and recovery systems

UT 540 WP
Length : 83.00 m
Breadth : 17.00 m
Technicians : Up to 40
Total persons on board : Max. 60
Deadweight : 1500 DwT
Subsea construction vessel

The UT-range of subsea construction vessels provides a comfortable, safe and efficient platform for a wide diversity of subsea construction operations. The vessels features high DP capability, as well as optimised propulsion and power system for the specific operations the vessel platform shall perform.

Special focus has been made on operability in regards to motion characteristics which benefit the crew comfort, crew changes with helicopters and the operational limits given by different topside installations which has it’s limits in regards to accelerations.

The subsea construction range:

- Vessel designs can be supplied in all size-ranges, and according to specific customer needs
- High comfort level and high-standard living environment
- Optimum operational and hotel logistics
- Kongsberg redundant thruster solution for maximized DP capability
- Energy efficient power generation system with energy storage solutions
- Crane(s) with backback or winch system(s) below deck
- Crane(s) with fibre rope or wire
- Work moonpool(s)
- ROV Systems in hangar through moonpool(s) and/or the over side.
- Optimum motion characteristics
- High pay load / deck load capacity
- Easy built hull form/accommodation module with a minimum of curvatures.
- Possibility for winterization and ice-class
- Optimised fuel efficient hull form based on comprehensive experience through testing and CFD analysis

UT 7623

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>124.00 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>23.00 m</td>
</tr>
<tr>
<td>Persons on board</td>
<td>120</td>
</tr>
<tr>
<td>Deadweight (w.250 crane)</td>
<td>8900 DwT</td>
</tr>
<tr>
<td>Deckload (w/250t crane, winch below deck)</td>
<td>4500 tonnes</td>
</tr>
</tbody>
</table>
Diving support vessels (DSV)
The UT-range of diving support vessels provides a comfortable, safe and efficient platform for all the personnel on board.

Special focus has been made on operability in regards to motion characteristics which benefit the crew comfort, crew changes with helicopters and the operational acceleration limits valid for the different diving systems.

The DSV range:
• Vessel designs can be supplied in all size-ranges, and according to specific customer needs
• High comfort level and high-standard living environment
• Optimum operational and hotel logistics
• Energy efficient power generation system with energy storage solutions
• Optimum motion characteristics for both crew comfort, helicopter and diving operations
• Easy built hull form/accommodation module with a min. of curvatures.
• Possibility for winterization and ice-class
• Optimised fuel efficient hull form based on comprehensive experience through testing and CFD analysis

UT 7623 DSV
Length : 102.00 m
Breadth : 23.00 m
Accommodation : 120 persons
Hyperbaric diving system : 18 divers system
Moonpools : 2 x diver bell moonpools
Inspection, maintenance and repair vessel (IMR)
The UT-range of IMR vessels provides a comfortable, safe and efficient platform for IMR duties

Special focus has been made on operability in regards to motion characteristics which benefit the crew comfort, crew changes with helicopters and the operational acceleration limits valid for the different crane and module handling systems.

The IMR range:
• Vessel designs can be supplied in all size-ranges, and according to specific customer needs
• High comfort level and high-standard living environment
• Optimum operational and hotel logistics
• Kongsberg redundant thruster solution for the maximized DP capability
• Energy efficient power generation system with energy storage solutions
• Wide range of customised module handling towers.
• Crane(s) with backback or winch system(s) below deck
• Crane(s) with fiber rope or wire
• ROV Systems in hangar through moonpool(s) and/or the over side.
• Optimum motion characteristics
• High pay load / deck load capacity
• Easy built hull form/accommodation module with a minimum of curvatures.
• Possibility for winterization and ice-class
• Optimised fuel efficient hull form based on comprehensive experience through testing and CFD analysis

UT 7625 IMR
Length : 126.00 m
Breadth : 25.00 m
Persons on board : 120
DP capability (ERN/ERN*) : Up to 99.99
Mobile offshore units (MOU)/mobile offshore drilling units (MODU)
The UT-range of MOU & MODU provides a comfortable, safe and efficient platform for a wide diversity of Intervention and drilling activities, including but not limited to wireline Intervention work, tophole drilling, coiled tubing, plug & abandon, etc.

Special focus has been made on operability in regards to motion characteristics which benefit the crew comfort, crew changes with helicopters and the operational acceleration limits valid for the different crane and module handling systems.

The MOU/MODU range:
- Vessel designs are made to specific customer needs.
- Highest possible comfort level and high-standard living environment (Up to comfort class 1)
- Optimum operational and hotel logistics, including NORSOK compliance
- Kongsberg redundant thruster solution for the maximized DP3 capability
- Energy efficient power generation system with energy storage solutions
- Delivered with both vessel integrated topside hangar, or standalone derrick
- Optimum motion characteristics for minimised accelerations
- ROV Systems in hangar through moonpool(s) and/or the over side.
- Easy built hull forms/accommodation modules with a min. of curvatures.
- Possibility for winterization and ice-class

**UT 777 (MOU/MODU)**
- Length: 170.00 m
- Breadth: 28.00 m
- DP capability - Worst single failure: Hs 7 meters at Åsgard field
- Comfort class: V(1)C(1)
- Capacity: 91 persons in single cabins
Specialised vessels

The NVC range also includes other specialised vessels like research, emergency response, rescue, Oceanographic research vessels, livefish carriers, seismic and emergency response vessels. Vessels comply with stringent environmental standards within specific application areas while providing optimum performance with regard to speed, fuel efficiency, comfort and ease of construction.

Coastguard vessel

Suitable for a variety of tasks such as patrolling, fisheries protection, emergency standby, pollution control, salvage and towing.

Coastguard vessel range:
- 50-200 T bollard pull
- Speed range 15-21 knots
- Fire fighting
- Oil recovery
- Tug
- SPS notation
- Ice classed

**UT 512**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>83.00 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>15.50 m</td>
</tr>
<tr>
<td>Draft (max)</td>
<td>6.00 m</td>
</tr>
<tr>
<td>Deadweight</td>
<td>1500 DwT</td>
</tr>
<tr>
<td>Speed</td>
<td>&gt;18.50 knots</td>
</tr>
<tr>
<td>Bollard pull</td>
<td>over 100 t</td>
</tr>
</tbody>
</table>
Oceanographic research vessels
The UT range of oceanographic research vessels provides excellent seakeeping capabilities and optimised arrangements for multi disciplinary scientific work. The range includes also vessels with high ice class and with icebreaking capability.

Suitable for a variety of tasks such as multidisciplinary scientific operations, transport of solid and liquid cargo, helicopter operations.

Oceanographic research vessel range:
- Medium to large sized vessels
- Underwater radiated noise acc to DNV Silent-R
- Crew size 40 persons to 120 persons
- Ice class up to PC3
- Shaftlines or azimuth propulsion
- Icebreaking capability >1.5m ice

UT 851
- Length: 128.90 m
- Breadth: 24.00 m
- Accommodation: 90 persons
- Ice class: PC3/PC4
Seismic vessels
The UT range of seismic vessels provides fuel efficient designs for the whole range with excellent seakeeping capabilities and optimised arrangements. Both seismic streamer vessels and seismic support vessels can be offered.

Hybrid propulsion system for optimum fuel efficiency and redundancy.

Seismic vessel range:
• 2D and 3D streamer vessels
• Underwater radiated noise acc to DNV Silent-S
• Hybrid propulsion systems
• Ice classed
• SPS compliant
• Winterized
• Wave piercing hull design

UT 833 WP
Length : 110.00 m
Breadth : 26 m/28 m
Capacity : 20 streamers
Live fish carrier
The NVC range of fish carriers is developed to provide the highest level of gentle fish handling, redundancy, safety and efficiency.

Our live fish carriers are designed with a space efficient diesel-electric propulsion system.

Live fish carrier range:
• 1500 m$^3$-7500 m$^3$ hold capacity
• Movable bulkheads
• RO fresh water production
• Fresh water treatment system
• Vacuum loading/pressure unloading

NVC 387
Length : 79.90 m
Breadth : 18.00 m
Well capacity : 3200 m$^3$
**Fishing vessels**

Our NVC design range of fishing vessels is developed to provide optimal fuel consumption, fish handling and working conditions at sea. Safe working conditions are guaranteed on an optimal freeboard, and modern fish handling solutions are included in the designs.

**Stern trawlers**

Our designs for stern trawlers range from small and compact wet fish trawlers to large and powerful factory freeze trawlers. The vessels can be arranged with hydraulic or electric deck machinery.

- Stern trawler developed for fuel efficient operations through a wave piercing hull design and HSG machinery system
- Bottom and mid-water trawling
- Low emission and fuel consumption levels
- Seakeeping and comfort
- Gentle fish handling

**NVC 375 WP**
- **Length**: 81.80 m
- **Breadth**: 17 m
- **Cargo hold**: 2400m³
Pelagic trawlers
Our range of pelagic vessels consists of all sizes of RSW-cooled bulk carrying vessels in addition to large factory processing freezer trawlers.

- Highly efficient pelagic trawlers
- Can be delivered with HSG propulsion system
- Low emission and fuel consumption levels
- Seakeeping and comfort
- Gentle fish handling

NVC 331
Length: 74.80 m
Breadth: 15.5 m
Cargo hold: 2200m³
Merchant vessels

General cargo vessels
We offer a wide range of NVC design for merchant vessels including tankers, cargo carriers, RoPax vessels, cruise vessels and explorer yachts. For best possible performance, comfort and safety, our designs are optimised against owners operational philosophy and real sea conditions from intended operational areas.

NVC 405
- Length: 119.95 m
- Breadth: 20.80 m
- Deadweight: 5000 DwT
- Speed: approx 14 kn
- Main engine: 3940 kW
- Cargo capacity: 4200 m³
- Endurance: 3400 NM

- 4 cargo decks, 1 stern ramp, moveable interior ramps, side door with 2 cargo lifts and container deck crane
- Deck area: 5000 m²
- Gas fuelled

NVC 466
- Length: 140.00 m
- Breadth: 19.00 m
- Deadweight: 6300 DwT
- Speed: approx 15 kn
- Main engines: 5700 kW
- Cargo capacity: 780 TEU cont.
- Endurance: 5300 NM

- Cargo holds for bulk or containers
- Diesel or gas fuelled
Passenger vessels and explorer yachts
The NVC range of designs for passenger vessels includes cruise ferries, Ro-Pax vessels, cruise vessels and explorer yachts, and fulfils the highest expectations of comfort, reliability and safety. We are putting high effort into developing modern efficient and attractive designs, incorporating latest technologies to give best possible benefits for owner.

- Optimised for efficient Ro-Ro cargo handling and designed for excellent passenger and crew comfort
- Diesel or gas fuelled

**NVC 2130 LNG**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>130.00 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>24.00 m</td>
</tr>
<tr>
<td>Draft (max)</td>
<td>5.50 m</td>
</tr>
<tr>
<td>Deadweight</td>
<td>3300 DwT</td>
</tr>
<tr>
<td>Speed</td>
<td>19 knots</td>
</tr>
<tr>
<td>Main engines</td>
<td>2 x 5250 kW</td>
</tr>
<tr>
<td>Endurance</td>
<td>1800 NM</td>
</tr>
</tbody>
</table>

**NVC 2140**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>140.00 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>23.60 m</td>
</tr>
<tr>
<td>Draft (max)</td>
<td>5.50 m</td>
</tr>
<tr>
<td>Deadweight</td>
<td>1800 DwT</td>
</tr>
<tr>
<td>Speed</td>
<td>16 knots</td>
</tr>
<tr>
<td>Main engines</td>
<td>4 x 3600 kW</td>
</tr>
<tr>
<td>Endurance</td>
<td>6000 NM</td>
</tr>
</tbody>
</table>

- Optimised for Exploring cruise operation and capable of operation in the most austere areas of the world.
- Diesel fuelled
LNG/LPG carriers
We are at the forefront of the development of natural gas-fuelled vessels and therefore have the expertise to design and outfit vessels carrying LNG or LPG. Vessels can be designed to utilise boiloff from the gas tanks as fuel, removing the need for separate fuel installations and comfortably meeting upcoming emissions legislation.

NVC 601 GT

- For small-scale transport and distribution of LNG to land-based industry and for bunkering of gas-fuelled vessels
- Available with a range of cargo tank capacities: 1000 to 10000 m³
- Gas fuelled

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>56.40 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>12.00 m</td>
</tr>
<tr>
<td>Draft (max)</td>
<td>3.60 m</td>
</tr>
<tr>
<td>Deadweight</td>
<td>700 DWT</td>
</tr>
<tr>
<td>Speed</td>
<td>12 knots</td>
</tr>
<tr>
<td>Main engines</td>
<td>1620 kW</td>
</tr>
<tr>
<td>Cargo capacity</td>
<td>1250 m³</td>
</tr>
<tr>
<td>Endurance</td>
<td>2000 NM</td>
</tr>
</tbody>
</table>
Tankers
We provide safe, reliable and economical transport of chemical and petroleum products. The design incorporates propulsive redundancy from the simplest single screw propulsion alternative with a “take-me-home” device, to the most comprehensive systems with two totally independent propulsion lines including twin screw or twin azimuthing propulsion.

- Tanker for transporting chemical and petroleum products
- Stainless steel cargo tanks, closed deck trunk, deepwell cargo pumps
- Gas fuelled

**NVC 605 CT**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>99.90 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>17.20 m</td>
</tr>
<tr>
<td>Draft (max)</td>
<td>6.20 m</td>
</tr>
<tr>
<td>Deadweight</td>
<td>5300 DwT</td>
</tr>
<tr>
<td>Speed</td>
<td>14 knots</td>
</tr>
<tr>
<td>Main engines</td>
<td>2 x 1460 kW</td>
</tr>
<tr>
<td>Cargo capacity</td>
<td>6400 m³</td>
</tr>
<tr>
<td>Endurance</td>
<td>3000 NM</td>
</tr>
</tbody>
</table>
A key design goal of any Kongsberg system is to ensure it is matched to the individual vessel profile. There are many trade-offs to be considered in arriving at the optimum propulsion system solution. What is the top priority for the shipowner? Is it speed, fuel consumption or through life costs, and what is the expected life of the vessel? These and many other factors impact on the investment decision and the value it represents.

As Kongsberg has such a wide range of Bergen engines and propulsion products they can be packaged into systems that accommodate most customer preferences, and are then tailored to the exact user requirements. These systems can then be inserted into our own or other ship designs to speed up the design and build process. This leaves the Naval Architect free to concentrate on the all import look and operation of the ship.
Offshore vessels

Kongsberg provides a wide range of propulsion systems for offshore service vessels. Depending on the vessels operational profile and customer’s preferences the system can be a diesel-mechanical, diesel-electric or a hybrid system. Powered by gas or liquid fuel or a combination of the two.

Platform supply vessels (PSV)
A platform supply vessel equipped with a flexible hybrid gas/diesel-electric propulsion systems comprising:

- 2 x pulling azimuth thrusters
- 1 x swing-up azimuth thruster
- 2 x Super Silent tunnel thruster
- 2 x gas generator sets
- 2 x diesel generator sets
- Automation and control systems
- Dynamic positioning system

Anchor-handling/tug/supply vessels (AHTS)
An anchor handling/tug/supply vessel equipped diesel-mechanical hybrid propulsion systems comprising:

- 2 x CP propellers
- 2 x reduction gears
- 2 x rudders and steering gear
- 1 x swing-up azimuth thruster
- 4 x tunnel thrusters
- 4 x diesel propulsion engines
- 4 x diesel generator engines
- Automation and control systems
- Dynamic positioning system

Drillships
A drillship equipped with diesel-electric propulsion systems comprising:

- 6 x azimuth underwater mountable thrusters
- 6 x diesel generator engines
- Propulsion control systems
Seismic vessels
A seismic research vessel equipped with a flexible hybrid propulsion system comprising:

- 2 x CP propellers
- 2 x reduction gears with shaft generator
- 2 x rudders and steering gear
- 1 x swing-up azimuth thruster
- 1 x tunnel thruster
- 2 x propulsion engines
- 2 x diesel generator engines
- Automation and control systems

Subsea vessels
A subsea construction vessel equipped with diesel-electric propulsion system comprising:

- 2 x pulling azimuth thrusters
- 1 x CP propeller
- 1 x reduction gear
- 1 x retractable azimuth thruster
- 2 x tunnel thrusters
- 6 x diesel generator engines
- Propulsion control systems
- Automation and control systems

Shuttle tankers
A shuttle tanker equipped with hybrid propulsion system comprising:

- 1 x CP propeller
- 1 x rudder and steering gear
- 2 x retractable azimuth thruster
- 2 x tunnel thrusters
- 1 x propulsion engine with shaft generator
- 3 x diesel generator engines
- Propulsion control systems
Seismic

Subsea

Shuttle tanker
Platforms and rigs
A drilling rig equipped with:

- 8 x azimuth underwater mountable thrusters
- 2 x diesel generator engines
- Propulsion control systems

Other specialised vessels
Kongsberg provides a wide range of propulsion systems for coastguard, EEZ and oil spill recovery vessels. Depending on the vessels operational profile the system can be a diesel mechanical, diesel electric or a hybrid system. Powered by gas or liquid fuel or a combination of the two.

Coastguard, OPV and EEZ vessels
A coastguard vessel equipped with a hybrid diesel-electric propulsion system comprising:

- 2 x CP propellers
- 2 x reduction gear with a shaft generator
- 1 x tunnel thruster
- 1 x swing-up azimuth thruster
- 2 x diesel propulsion engines
- 4 x diesel generator engines
- Dynamic positioning system

Fishing vessels
Kongsberg provides a wide range of propulsion systems for fishing vessels. Depending on the vessels operational profile and customer’s preferences the system can be a diesel mechanical, diesel electric or a hybrid system.

Pelagic trawlers
A pelagic trawler equipped with a diesel-mechanical hybrid shaft generator propulsion systems comprising:

- Controllable pitch propeller
- 1 x reduction gear with a shaft generator
- 1 x high lift flap rudder with steering gear
- 2 x tunnel thrusters
- 1 x diesel propulsion engine
- 1 x diesel generator set
- Power electric system
- Automation and control systems
Rig

Coastguard

Pelagic trawler
Merchant vessels

Kongsberg provides a wide range of propulsion systems for merchant vessels. Depending on the vessels operational profile and customer’s preferences the system can be a diesel-mechanical, diesel-electric or a hybrid system powered by gas or liquid fuel or a combination of the two.

Tugs
A tug equipped with mechanical gas propulsion system comprising:

- 2 x azimuth thrusters
- 2 x propulsion gas engines
- 2 x auxiliary generators
- Automation and control system
- Power electric system

Ferries
A double ended ferry with mechanical hybrid gas propulsion system comprising:

- 4 x azimuth thrusters
- 4 x propulsion gas engines
- 2 x auxiliary generators
- Propulsion control and integrated automation system, including gas safety and monitoring
- Power electric system

Passenger ships
A ropax vessel with mechanical hybrid gas propulsion system comprising:

- 2 x Promas integrated propeller and rudder systems
- 2 x tunnel thrusters
- 2 x gas propulsion engines
- 2 x rotary vane steering gear
- Fin stabilisers
- Propulsion control and integrated automation system, including gas safety and monitoring
- Power electric system
DIESEL AND GAS ENGINES*

*Kongsberg Maritime is the exclusive distributor of Rolls-Royce Bergen medium speed engines for commercial marine applications.

The Bergen engine range of medium speed diesels, gas engines and generator sets, meets the requirements of ship owners for robust, reliable and economical power. As the marine industry is increasingly turning towards burning natural gas for propulsion, Bergen gas engines have built an unrivalled track record in powering ships, and reducing exhaust emissions of carbon dioxide, NOx, SOx and particulates.
General conditions for Bergen marine engines

Marine liquid fuel engines
Ratings are according to ISO 3046-1, at maximum 45°C ambient air temperature and maximum 32°C sea water temperature. Specific fuel oil consumption is based on MDO with a net calorific value of 42,7 MJ/kg and no engine driven pumps. For each engine driven pump, there is a need to add 0,5%.

Emissions
The marine diesel engines comply with the requirements of the IMO Tier II without any external cleaning system. IMO Tier III is met by the use of a Selective Catalytic Reactor (SCR) system.

The marine gas engines comply with IMO Tier III with no need for a SCR system.

Heavy fuel oil operation
The engines are designed for operation on heavy fuel oil with viscosity up to 700 cSt at 50°C ISO 8217 RMK77. Ratings will be specified subject to type of application.

Marine gas engines
The marine gas engines give the following reductions in emissions compared with diesels IMO Tier II: 92% NOx, net 22% greenhouse gases and close to zero SOx and particulate matter. Marine gas engine ratings are according to ISO 3046-1, at maximum 45°C ambient air temperature and maximum 32°C sea water temperature. Specific fuel gas consumption excluding engine driven pumps is based on reference natural gas with Methane number above 70 and net calorific value of 36 MJ/nm3. If there are engine driven pumps, add 0,5% for each pump. Gas feed temperature is 20-40°C.

Dimensions
All dimensions are in mm. Dimensions and weights are given for guidance purposes only and are based on a typical specification. For detailed information please contact Kongsberg Marine.

Note: Due to continuous development, some data may change without notice.
Marine engine product range

Power output (kW) Liquid fuel engines

- B33:45V20: 12000 kW
- B33:45V16: 9600 kW
- B33:45V12: 7200 kW
- B33:45L9: 5400 kW
- B33:45L8: 4800 kW
- B33:45L6: 3600 kW
- C25:33L9: 3000 kW
- C25:33L8: 2865 kW
- C25:33L6: 2000 kW

Power output (kW) Gas fuel engines

- B36:45V20: 12000 kW
- B36:45V16: 9600 kW
- B35:40V20: 9500 kW
- B36:45V12: 7200 kW
- B35:40V12: 5400 kW
- B36:45L9: 5400 kW
- B36:45L8: 4800 kW
- B36:45L6: 3840 kW
- B36:45L6: 3600 kW
- C25:33L9: 2430 kW
- C25:33L8: 2160 kW
- C25:33L6: 1620 kW

KONGSBERG – DIESEL AND GAS ENGINES
Propulsion engines  
- Liquid fuel

Bergen C25:33L

Principal dimensions
Cylinder diameter 250mm. Piston stroke 330mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Weight dry engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>C25:33L6P</td>
<td>3170</td>
<td>4036</td>
<td>3179</td>
<td>1775</td>
<td>18300 kg</td>
</tr>
<tr>
<td>C25:33L8P</td>
<td>3930</td>
<td>4796</td>
<td>3195</td>
<td>1873</td>
<td>23200 kg</td>
</tr>
<tr>
<td>C25:33L9P</td>
<td>4310</td>
<td>5176</td>
<td>3230</td>
<td>1873</td>
<td>25000 kg</td>
</tr>
</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Engine speed r/min</td>
<td>900/1000*</td>
<td>900/1000*</td>
<td>900/1000*</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>10/11</td>
<td>10/11</td>
<td>10/11</td>
</tr>
<tr>
<td>Max. continuous rating (MCR) kW</td>
<td>1920/2000</td>
<td>2560/2665</td>
<td>2880/3000</td>
</tr>
<tr>
<td>Max. continuous rating (MCR) BHP (metric)</td>
<td>2610/2720</td>
<td>3480/3625</td>
<td>3915/4080</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) bar</td>
<td>26.4/24.7</td>
<td>26.4/24.7</td>
<td>26.4/24.7</td>
</tr>
<tr>
<td>Specific fuel consumpion g/kWh</td>
<td>182/185</td>
<td>182/185</td>
<td>182/185</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet °C</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

*MDO operations.
Dimensions given apply for rigidly mounted engines with wet sump. Dry sump can be supplied upon request.
Front end P.T.O. can be delivered upon request.
Propulsion engines
- Liquid fuel

Bergen B33:45L

Principal dimensions
Cylinder diameter 330mm. Piston stroke 450mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Weight dry engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>B33:45L6P</td>
<td>4535</td>
<td>5622</td>
<td>3892</td>
<td>2227</td>
<td>40500 kg</td>
</tr>
<tr>
<td>B33:45L7P</td>
<td>5055</td>
<td>6142</td>
<td>3892</td>
<td>2227</td>
<td>47000 kg</td>
</tr>
<tr>
<td>B33:45L8P</td>
<td>5575</td>
<td>6662</td>
<td>4039</td>
<td>2320</td>
<td>52100 kg</td>
</tr>
<tr>
<td>B33:45L9P</td>
<td>6095</td>
<td>7182</td>
<td>4039</td>
<td>2320</td>
<td>63200 kg</td>
</tr>
<tr>
<td>B33:45V12P</td>
<td>5410</td>
<td>6867</td>
<td>4544</td>
<td>3138</td>
<td>74300 kg</td>
</tr>
</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th>Engine type</th>
<th>B33:45L6P</th>
<th>B33:45L7P</th>
<th>B33:45L8P</th>
<th>B33:45L9P</th>
<th>B33:45V12P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Engine speed r/min</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>11.2</td>
<td>11.2</td>
<td>11.2</td>
<td>11.2</td>
<td>11.2</td>
</tr>
<tr>
<td>Max. cont. rating (MCR) kW</td>
<td>3600</td>
<td>4200</td>
<td>4800</td>
<td>5400</td>
<td>7200</td>
</tr>
<tr>
<td>Mean eff. pressure (BMEP) bar</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Specific fuel consumption g/kWh</td>
<td>175*</td>
<td>175*</td>
<td>175*</td>
<td>175*</td>
<td>176</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Cooling water temp. eng. outlet °C</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

* At 85% load along propeller curve

Weight dry engine excludes flywheel and transport foundation.
Dimensions given apply for resiliently mounted engines.
Propulsion engines - Gas

Bergen C26:33L

Principal dimensions
Cylinder diameter 260mm. Piston stroke 330mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Weight dry engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>C26:33L6PG</td>
<td>3170</td>
<td>4176</td>
<td>3161</td>
<td>1729</td>
<td>17500 kg</td>
</tr>
<tr>
<td>C26:33L8PG</td>
<td>3930</td>
<td>4936</td>
<td>3261</td>
<td>1785</td>
<td>25800 kg</td>
</tr>
<tr>
<td>C26:33L9PG</td>
<td>4310</td>
<td>5316</td>
<td>3161</td>
<td>1785</td>
<td>29000 kg</td>
</tr>
</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th>Engine type</th>
<th>C26:33L6PG</th>
<th>C26:33L8PG</th>
<th>C26:33L9PG</th>
</tr>
</thead>
<tbody>
<tr>
<td>C26:33L6PG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Engine speed r/min</td>
<td>900/1000</td>
<td>900/1000</td>
<td>900/1000</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>10/11</td>
<td>10/11</td>
<td>10/11</td>
</tr>
<tr>
<td>Max. continuous rating (MCR) kW</td>
<td>1460/1620</td>
<td>1940/2160</td>
<td>2190/2430</td>
</tr>
<tr>
<td>Max. continuous rating (MCR) BHP (metric)</td>
<td>1985/2205</td>
<td>2675/2935</td>
<td>2980/3305</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) bar</td>
<td>18.5</td>
<td>18.5</td>
<td>18.5</td>
</tr>
<tr>
<td>Specific energy consumption kJ/kWh</td>
<td>7550</td>
<td>7550</td>
<td>7550</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet ºC</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>
Propulsion engines - Gas

Bergen B36:45 - lean-burn gas engine

Principal dimensions
Cylinder diameter 350mm. Piston stroke 400mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Weight dry engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>B36:45L6PG</td>
<td>4447</td>
<td>5759</td>
<td>3920</td>
<td>2540</td>
<td>41410 kg</td>
</tr>
<tr>
<td>B36:45L8PG</td>
<td>5575</td>
<td>6682</td>
<td>4170</td>
<td>2884</td>
<td>55200 kg</td>
</tr>
<tr>
<td>B36:45L9PG</td>
<td>6007</td>
<td>7319</td>
<td>4170</td>
<td>2884</td>
<td>63200 kg</td>
</tr>
<tr>
<td>B36:45V12PG</td>
<td>5410</td>
<td>6867</td>
<td>4544</td>
<td>3138</td>
<td>74350 kg</td>
</tr>
</tbody>
</table>

* Preliminary data.

Technical data

<table>
<thead>
<tr>
<th>Engine type</th>
<th>B36:45L6PG</th>
<th>B36:45L8PG*</th>
<th>B36:45L9PG*</th>
<th>B36:45L12PG*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Engine speed r/min</td>
<td>750</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>11.25</td>
<td>11.25</td>
<td>11.25</td>
<td>11.25</td>
</tr>
<tr>
<td>Max. continuous rating (MCR) kW</td>
<td>3600</td>
<td>4800</td>
<td>5400</td>
<td>7200</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) bar</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Specific energy consumption kJ/kWh</td>
<td>7300</td>
<td>7300</td>
<td>7300</td>
<td>7300</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet °C</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

* Preliminary data.
Designed for robustness, harsh operational environments, and exceptional levels of reliability

- Compact and powerful
- Low fuel oil consumption
- No leakage of fuel to lubricating oil system
- Service friendly
- Impulse type turbo charging system
  - Optimum response at all engine load points
- Super silent resilient mounting
Generating set - Liquid fuel

Bergen C25:33L

Principal dimensions
Cylinder diameter 250mm. Piston stroke 330mm.

Technical data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td></td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Engine speed (r/min)</td>
<td></td>
<td>900/1000*</td>
<td>900/1000*</td>
<td>900/1000*</td>
</tr>
<tr>
<td>Mean piston speed (m/s)</td>
<td></td>
<td>10/11</td>
<td>10/11</td>
<td>10/11</td>
</tr>
<tr>
<td>Max. cont. rating (MCR) (kW)</td>
<td></td>
<td>1920/2000</td>
<td>2560/2665</td>
<td>2880/3000</td>
</tr>
<tr>
<td>Max. cont. rating altern, (η=0.96) (kW)</td>
<td></td>
<td>1843/1920</td>
<td>2457/2558</td>
<td>2764/2880</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.8) (kVA)</td>
<td></td>
<td>2303/2400</td>
<td>3071/3197</td>
<td>3455/3600</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.9) (kVA)</td>
<td></td>
<td>2047/2133</td>
<td>2730/2961</td>
<td>3071/3200</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) (bar)</td>
<td></td>
<td>26.4/24.7</td>
<td>26.4/24.7</td>
<td>26.4/24.7</td>
</tr>
<tr>
<td>Specific energy consumption* (KJ/kWh)</td>
<td></td>
<td>182/185</td>
<td>182/185</td>
<td>182/185</td>
</tr>
<tr>
<td>Specific lub. oil consumption (g/kWh)</td>
<td></td>
<td>0.7</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet (°C)</td>
<td></td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

*MDO operations. Engine ** Engine and foundation
Dimensions given apply for resiliently mounted engines. Choice of alternator may effect the given dimensions and weights.

Weights dry

<table>
<thead>
<tr>
<th>Engine type</th>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Engine**</th>
<th>Alternator</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C25:33L6A</td>
<td>A</td>
<td>2698</td>
<td>4716</td>
<td>6874</td>
<td>2300</td>
<td>3195</td>
<td>23960 kg</td>
<td>10350 kg</td>
<td>34310 kg</td>
</tr>
<tr>
<td>C25:33L8A</td>
<td>B</td>
<td>2838</td>
<td>4796</td>
<td>7709</td>
<td>2304</td>
<td>3261</td>
<td>30200 kg</td>
<td>12200 kg</td>
<td>42400 kg</td>
</tr>
<tr>
<td>C25:33L9A</td>
<td>C</td>
<td>3038</td>
<td>5176</td>
<td>8214</td>
<td>2304</td>
<td>3230</td>
<td>30900 kg</td>
<td>12200 kg</td>
<td>43100 kg</td>
</tr>
</tbody>
</table>
Generating set - Liquid fuel

Bergen B33:45L

Principal dimensions
Cylinder diameter 330mm. Piston stroke 450mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Engine**</th>
<th>Alternator</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B33:45L6A</td>
<td>3410</td>
<td>5870</td>
<td>9280</td>
<td>2431</td>
<td>4100</td>
<td>46000 kg</td>
<td>18200 kg</td>
<td>64200 kg</td>
</tr>
<tr>
<td>B33:45L7A</td>
<td>3410</td>
<td>6405</td>
<td>9815</td>
<td>2431</td>
<td>4100</td>
<td>53100 kg</td>
<td>19600 kg</td>
<td>72700 kg</td>
</tr>
<tr>
<td>B33:45L8A</td>
<td>3505</td>
<td>6940</td>
<td>10445</td>
<td>2488</td>
<td>4250</td>
<td>60100 kg</td>
<td>21000 kg</td>
<td>81100 kg</td>
</tr>
<tr>
<td>B33:45L9A</td>
<td>3505</td>
<td>7475</td>
<td>10980</td>
<td>2488</td>
<td>4250</td>
<td>67100 kg</td>
<td>22300 kg</td>
<td>89400 kg</td>
</tr>
<tr>
<td>B33:45V12A*</td>
<td>4033</td>
<td>6870</td>
<td>10900</td>
<td>3140</td>
<td>4800</td>
<td>85000 kg</td>
<td>25000 kg</td>
<td>110000 kg</td>
</tr>
</tbody>
</table>

Weights dry

Technical data

<table>
<thead>
<tr>
<th>Engine type</th>
<th>B33:45L6A</th>
<th>B33:45L7A</th>
<th>B33:45L8A</th>
<th>B33:45L9A</th>
<th>B33:45V12A*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Engine speed</td>
<td>r/min</td>
<td>720/750</td>
<td>720/750</td>
<td>720/750</td>
<td>720/750</td>
</tr>
<tr>
<td>Mean piston speed</td>
<td>m/s</td>
<td>10.8/11.2</td>
<td>10.8/11.2</td>
<td>10.8/11.2</td>
<td>10.8/11.2</td>
</tr>
<tr>
<td>Max. cont. rating (MCR) kW</td>
<td>3600</td>
<td>4200</td>
<td>4800</td>
<td>5400</td>
<td>7200</td>
</tr>
<tr>
<td>Max. cont. rating altern, (η=0.97) kW</td>
<td>3492</td>
<td>4074</td>
<td>4656</td>
<td>5238</td>
<td>6950</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.8) kVA</td>
<td>4365</td>
<td>5093</td>
<td>5820</td>
<td>6548</td>
<td>8690</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) bar</td>
<td>26/25</td>
<td>26/25</td>
<td>26/25</td>
<td>26/25</td>
<td>26/25</td>
</tr>
<tr>
<td>Specific fuel consumption g/kWh</td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>176</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet °C</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

*Preliminary data. Engine ** Engine and foundation
Dimensions given apply for resiliently mounted engines. Choice of alternator will effect the given dimensions and weights.
Generating set - Gas

Bergen C26:33L

Principal dimensions
Cylinder diameter 260mm. Piston stroke 330mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Engine**</th>
<th>Alternator</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C26:33L6AG</td>
<td>2835</td>
<td>4176</td>
<td>7011</td>
<td>2304</td>
<td>3161</td>
<td>22605 kg</td>
<td>11300 kg</td>
<td>33905 kg</td>
</tr>
<tr>
<td>C26:33L8AG</td>
<td>2835</td>
<td>4936</td>
<td>7771</td>
<td>2304</td>
<td>3161</td>
<td>31520 kg</td>
<td>11300 kg</td>
<td>42820 kg</td>
</tr>
<tr>
<td>C26:33L9AG</td>
<td>2835</td>
<td>5316</td>
<td>8315</td>
<td>2304</td>
<td>3161</td>
<td>34720 kg</td>
<td>11300 kg</td>
<td>46020 kg</td>
</tr>
</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th>Engine type</th>
<th>C26:33L6AG</th>
<th>C26:33L8AG*</th>
<th>C26:33L9AG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Engine speed</td>
<td>r/min</td>
<td>900/1000</td>
<td>900/1000</td>
</tr>
<tr>
<td>Frequency</td>
<td>hz</td>
<td>60/50</td>
<td>60/50</td>
</tr>
<tr>
<td>Mean piston speed</td>
<td>m/s</td>
<td>10/11</td>
<td>10/11</td>
</tr>
<tr>
<td>Max. cont. rating (MCR)</td>
<td>kW</td>
<td>1460/1620</td>
<td>1940/2160</td>
</tr>
<tr>
<td>Max. cont. rating altern, (η=0.96)</td>
<td>kW</td>
<td>1401/1555</td>
<td>1840/2050</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.8)</td>
<td>kVA</td>
<td>1751/1943</td>
<td>2300/2563</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.9)</td>
<td>kVA</td>
<td>1556/127</td>
<td>2044/2278</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP)</td>
<td>bar</td>
<td>18.5</td>
<td>18.5</td>
</tr>
<tr>
<td>Specific energy consumption</td>
<td>KJ/kWh</td>
<td>7550</td>
<td>7550</td>
</tr>
<tr>
<td>Specific lub. oil consumption</td>
<td>g/kWh</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet</td>
<td>°C</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

Engine* Engine and foundation
Depending on type of alternator the weight and dimensions may change.
### Generating set - Gas

**Bergen B36:45**

**Principal dimensions**

Cylinder diameter 350mm. Piston stroke 400mm.

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Weight dry gen set</th>
</tr>
</thead>
<tbody>
<tr>
<td>B36:45L6AG</td>
<td>3410</td>
<td>5870</td>
<td>9280</td>
<td>2540</td>
<td>3920</td>
<td>64200 kg</td>
</tr>
<tr>
<td>B36:45L8AG</td>
<td>3410</td>
<td>6405</td>
<td>9815</td>
<td>2884</td>
<td>4170</td>
<td>72700 kg</td>
</tr>
<tr>
<td>B36:45L9AG</td>
<td>3505</td>
<td>6940</td>
<td>10445</td>
<td>2884</td>
<td>4170</td>
<td>81100 kg</td>
</tr>
<tr>
<td>B36:45V12AG</td>
<td>3899</td>
<td>6867</td>
<td>10766</td>
<td>3138</td>
<td>4722</td>
<td>112050 kg</td>
</tr>
</tbody>
</table>

**Technical data**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>B36:45L6AG</th>
<th>B36:45L8AG*</th>
<th>B36:45L9AG*</th>
<th>B36:45V12AG*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Engine speed r/min</td>
<td>720/750</td>
<td>720/750</td>
<td>720/750</td>
<td>720/750</td>
</tr>
<tr>
<td>Mean piston speed m/s</td>
<td>11.25</td>
<td>11.25</td>
<td>11.25</td>
<td>11.25</td>
</tr>
<tr>
<td>Max. cont. rating (MCR) kW</td>
<td>3450/3600</td>
<td>4600/4800</td>
<td>5175/5400</td>
<td>6900/7200</td>
</tr>
<tr>
<td>Max. cont. rating altern, (η=0.97) kW</td>
<td>3347/3492</td>
<td>4462/4656</td>
<td>5020/5328</td>
<td>6693/6984</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.8) kVA</td>
<td>4170/4350</td>
<td>5576/5820</td>
<td>6275/6548</td>
<td>8366/8730</td>
</tr>
<tr>
<td>Max. cont. rating altern, (Cosφ=0.9) kVA</td>
<td>3725/3885</td>
<td>4978/5195</td>
<td>5600/5844</td>
<td>7437/7760</td>
</tr>
<tr>
<td>Mean effective pressure (BMEP) bar</td>
<td>21</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Specific energy consumption KJ/kWh</td>
<td>7300</td>
<td>7300</td>
<td>7300</td>
<td>7300</td>
</tr>
<tr>
<td>Specific lub. oil consumption g/kWh</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Cooling water temp. engine outlet ºC</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

* Preliminary data.
AZIMUTH THRUSTERS

Kongsberg is a global leader in the supply of azimuth thrusters. In an azimuth thruster the propeller rotates 360° around the vertical axis so the unit provides propulsion, steering and positioning thrust for superior manoeuvrability. Designs have been developed for propulsion and dynamic positioning in response to market requirements. As a result there is a design available to suit virtually any application. Simple and robust construction provides high operational reliability together with simple maintenance for low through life costs. Units can be supplied for diesel or electric drive together with a remote control system.
Azimuth thruster range

**US Type**
- Powers: 250 - 5000kW

**Azipull**
- Powers: 900 - 5000 kW

**Contaz**
- Mountable
- Powers: 2000 - 3700 kW

**Underwater Mountable UUC Type**
- Powers: 2300 - 6500 kW

**Retractable UL Type**
- Powers: 400 - 3800 kW

**Swing-up/ Combi**
- Powers: 880 - 2000 kW
Contaz thrusters

The Contaz azimuth thruster range with contra-rotating propellers provide high propulsive efficiency and reduced vibration. Efficiency gains are 10 - 15 per cent over conventional azimuth thrusters. The aft propeller regains some of the energy losses in the stream as well as significant rotational losses, therefore there is a lower installed power requirement that can release space on board and lowers fuel consumption. Contaz units have a range of stem lengths and are ideal for passenger/car ferries and vessels requiring high propulsive efficiency, i.e. low fuel consumption.

Model variations:
- Each unit custom designed to suit the vessel
- Select from a wide range of stem lengths
- Reduction ratios optimised for application

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Max Input Power (kW)</th>
<th>Input speed (rpm)</th>
<th>Dry wt* (t)</th>
<th>Max Prop. Dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTAZ 15</td>
<td>2200</td>
<td>900 - 1500</td>
<td>32</td>
<td>3200</td>
</tr>
<tr>
<td>CONTAZ 25</td>
<td>3000</td>
<td>900 - 1500</td>
<td>50</td>
<td>3700</td>
</tr>
<tr>
<td>CONTAZ 35</td>
<td>3700</td>
<td>750 - 1200</td>
<td>70</td>
<td>4000</td>
</tr>
<tr>
<td>CONTAZ 50</td>
<td>5300</td>
<td>750 - 1200</td>
<td>78</td>
<td>4200</td>
</tr>
</tbody>
</table>

*Dry weight at shortest stem length
All data subject to change without prior notice
Fixed mounted thrusters

The Kongsberg US range comprises standard azimuth thruster units with input powers from 250 - 5000 kW to deliver a bollard pull ranging from 11 to over 170 tonnes. Modular design allows the configuration, mounting type and size to be closely matched to user requirements. The US type is available with FP/CP propeller, open or ducted. For high propulsive efficiency contra-rotating propellers are available. Different propeller diameters are available to suit the vessel application.

Mounting options

Weld in: The thruster is mounted in two stages: upper assembly with the hull fitting is raised/ lowered into position and welded in place. The underwater assembly is then bolted to the thruster.

Bolt-in, top mounted: The casing plate is welded into the hull. The complete thruster unit is lowered onto the casing flange and bolted into position.

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Max Input Power (kW)</th>
<th>Input speed (rpm)</th>
<th>Weight (t)</th>
<th>Bollard pull two units (t)</th>
<th>Prop. Dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 55-P4</td>
<td>330</td>
<td>1500 - 2100</td>
<td>1.9</td>
<td>10</td>
<td>1050</td>
</tr>
<tr>
<td>US 105-P6</td>
<td>480</td>
<td>1500 - 1800</td>
<td>3.6</td>
<td>16</td>
<td>1300</td>
</tr>
<tr>
<td>US 105-P9</td>
<td>720</td>
<td>1000 - 1800</td>
<td>6</td>
<td>24 - 25</td>
<td>1500 - 1600</td>
</tr>
<tr>
<td>US 155-P14</td>
<td>1280</td>
<td>750 - 2000</td>
<td>11.5 - 12.5</td>
<td>38 - 43</td>
<td>1800 - 2000</td>
</tr>
<tr>
<td>US 205-P18</td>
<td>1500</td>
<td>750 - 1800</td>
<td>18</td>
<td>51</td>
<td>2200</td>
</tr>
<tr>
<td>US 205-P20</td>
<td>1920</td>
<td>750 - 1800</td>
<td>18 - 19</td>
<td>60 - 63</td>
<td>2300 - 2400</td>
</tr>
<tr>
<td>US 255-P30</td>
<td>2470</td>
<td>750 - 1800</td>
<td>27 - 28</td>
<td>78 - 83</td>
<td>2600 - 2800</td>
</tr>
<tr>
<td>US 35</td>
<td>2790</td>
<td>750 - 1800</td>
<td>36 - 37.5</td>
<td>90 + - 94 +</td>
<td>2800 - 3000</td>
</tr>
<tr>
<td>US 305-P40</td>
<td>3200</td>
<td>750 - 1600</td>
<td>41 - 43</td>
<td>102 + - 108 +</td>
<td>3000 - 3200</td>
</tr>
<tr>
<td>US 355-P50</td>
<td>3700</td>
<td>720 - 1200</td>
<td>54 - 56</td>
<td>115 + - 125 +</td>
<td>3200 - 3500</td>
</tr>
<tr>
<td>US 60</td>
<td>5000</td>
<td>750 - 1200</td>
<td>78 - 82</td>
<td>165 + - 173 +</td>
<td>3800 - 4000</td>
</tr>
</tbody>
</table>

For performance predictions please contact Kongsberg.
Azimuth-PM thrusters

AZ-PM combines a ring-type permanent magnet electric motor, propeller and nozzle in a tightly integrated propulsion unit. It offers improved efficiency and simplicity compared to conventional geared azimuth thrusters with separate electric motors in the thruster room. The permanent magnet azimuthing thruster is a new addition to the Kongsberg family of thrusters, building on the design developed and verified on the permanent magnet tunnel thrusters with regard to thruster design and motor integration.

The AZ-PM meets operational requirements with focus on performance and reliability. The rotor of the motor forming a ring around the propeller blades combined with advanced blade shapes, suppresses or eliminates cavitation. The motor stator is incorporated in the nozzle which controls water flow and provides increased thrust over a wide speed range. The underwater unit can be rotated in azimuth to give steering and vectored thrust in any direction.

A steel structure carries the steering bearing and this is simply bolted into the hull. Only limited footprint space and headroom is required in the thruster room as the only components there are the slipring case that transfers power to the thruster and the compact electric steering motors. Speed control is by varying the frequency of the voltage supplied to the thruster motor.

A very high motor efficiency, 97% at nominal speed and high efficiency over the whole load range, and the submerged motor mean that no cooling equipment is required, saving space and reducing installation cost. Simple bearings in the rotor hub carry all loads, and no oil circulation pump is required for the underwater unit.

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Power (kW)</th>
<th>Thruster (kN)</th>
<th>RPM</th>
<th>Prop. Dia (mm)</th>
<th>Propeller type</th>
<th>Direction of rotation</th>
<th>Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ-PM 1900</td>
<td>500 - 1100</td>
<td>191kN at 0knot</td>
<td>239</td>
<td>1900</td>
<td>Monoblock /FP</td>
<td>CW/CCW</td>
<td>AFE or 12-pulse drive</td>
</tr>
<tr>
<td>AZ-PM 2600</td>
<td>1100 - 2600</td>
<td>411kN at 0knot</td>
<td>187</td>
<td>2600</td>
<td>Monoblock /FP</td>
<td>CW/CCW</td>
<td>AFE or 12-pulse drive</td>
</tr>
</tbody>
</table>

Approximate values, provided for information only. Actual thrust may vary for given applications. De-rating may be required on 12-pulse drive installations. All data is subject to change without prior notice.
Azipull thrusters

The Kongsberg Azipull is a low drag, high efficiency pulling thruster that provides both steering and propulsion. It combines the advantage of the pulling propeller with the flexibility of using almost any type of drive to suit specific vessel requirements. Azipull thrusters are designed for continuous service speeds up to 24 knots, while maintaining excellent manoeuvrability. They offer high hydrodynamic and fuel efficiency with low noise and vibration levels. A substantial rudder area delivers excellent course stability. Azipull units also allow the aft end of the hull to be optimised for minimum resistance and simplified construction.

Model variations:
- All Azipull units are available with CP or FP propellers and can be delivered with remote control systems.
- The AZP 085 and 100 can also be available with FF propeller.

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Power MCR (kW)</th>
<th>Input speed (rpm)</th>
<th>Dry wt (t)</th>
<th>Prop. Dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZP 085</td>
<td>900 - 1600</td>
<td>1200 - 2000</td>
<td>13</td>
<td>1900 - 2300</td>
</tr>
<tr>
<td>AZP 100</td>
<td>1400 - 2500</td>
<td>720 - 1800</td>
<td>31</td>
<td>2300 - 2800</td>
</tr>
<tr>
<td>AZP 120</td>
<td>1800 - 3500</td>
<td>720 - 1200</td>
<td>45</td>
<td>2800 - 3300</td>
</tr>
<tr>
<td>AZP 150</td>
<td>3000 - 5000</td>
<td>600 - 1000</td>
<td>85</td>
<td>3300 - 4200</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice.
Azipull-PM thrusters

The new Azipull-PM (AZP-PM) have an L-drive configuration using essentially the same underwater unit as the conventional Azipull, but with a vertical shaft permanent magnet (PM) motor integrated into a new upper unit. The PM motor maintains a very high efficiency over a wide speed range.

Combined with the proven high propulsive and hydrodynamic efficiency of the Azipull this will be a winning combination, especially as there is a further small gain in mechanical efficiency by eliminating the upper gearbox. Space requirements in the thruster room are reduced because the new thruster is compact, the PM motor lying within the diameter of the mounting flange giving a small footprint and avoiding the complication of a coupling and foundations for the separate motor of a conventional Z or C drive electric configuration.

First to be introduced to the market is the AZP-PM L-drive 120 size, rated at 2,500 -3,500kW continuous. This will be followed by two smaller frame sizes, 085 and 100, and one larger, the 150, so that this azimuth thruster series will in due course span a power range from 600kW to 5,000kW. They will cover the speed range up to 24 knots.

Key features:
• Highly efficient pulling thruster
• Space saving compact thruster
• Reduced installation time for shipyards
• Available with CP or FP propeller
• The AZP-PM 085-L and 100-L can also be available with FF propeller

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Power MCR (kW)</th>
<th>Dry wt (t)</th>
<th>Prop. Dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZP-PM 085-L*</td>
<td>600 - 1700*</td>
<td>-</td>
<td>1900 - 2300</td>
</tr>
<tr>
<td>AZP-PM 100-L*</td>
<td>1800 - 2500*</td>
<td>-</td>
<td>2300 - 2800</td>
</tr>
<tr>
<td>AZP-PM 120-L</td>
<td>2500 - 3500</td>
<td>59</td>
<td>2800 - 3300</td>
</tr>
<tr>
<td>AZP-PM 150-L*</td>
<td>3000 - 5000*</td>
<td>-</td>
<td>3300 - 4200</td>
</tr>
</tbody>
</table>

* In development.
All data subject to change without prior notice.
Underwater mountable thrusters

A robust, heavy-duty L-drive azimuth thruster specifically designed for extended and reliable DP operation on offshore rigs and drillships. Compact construction affords advantages for mounting at the shipyard and during maintenance. UUC models have two ways of connecting the lifting wires for underwater removal and mounting. From inside the ship to the thruster flange or externally to the lifting lugs on the thruster flange.

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>MCR (kW)</th>
<th>Input Speed (rpm)</th>
<th>Prop. Dia (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UUC 305</td>
<td>3200</td>
<td>720</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.2</td>
</tr>
<tr>
<td>UUC 355</td>
<td>3800</td>
<td>720</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>4000</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>UUC 405</td>
<td>4600</td>
<td>720</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>4800</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>UUC 455</td>
<td>5200</td>
<td>720</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>5500</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>UUC 505</td>
<td>6500</td>
<td>600</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.5</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Retractable thrusters

The retractable range uses components from the Kongsberg standard azimuth thruster range and provides fast hydraulic lifting and lowering of the unit, enabling it to retract into the hull when not in use, reducing the vessel’s drag. The UL models are designed for horizontal drive with automatic drive shaft disconnection system. ULE models are designed for vertical drive. Both are available with CP or FP propellers.

The lifting and lowering is activated by a push button on the bridge. Unlocking/locking in position and the engagement of the drive shaft coupling is automatic.

Drive shaft arrangement
A complete assembly with a solid shaft including bearings and a remote controlled clutch and a flexible coupling for prime mover.

### Technical data UL

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Max Input Power (kW)</th>
<th>Input speed (rpm)</th>
<th>Dry wt (t)</th>
<th>Prop. Type</th>
<th>Prop. dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL 601</td>
<td>440</td>
<td>1500 - 1800</td>
<td>6</td>
<td>FP</td>
<td>1300</td>
</tr>
<tr>
<td>UL 901</td>
<td>660</td>
<td>1000 - 1800</td>
<td>12</td>
<td>FP</td>
<td>1600</td>
</tr>
<tr>
<td>UL 1201</td>
<td>880</td>
<td>750 - 1800</td>
<td>16.5</td>
<td>FP / CP</td>
<td>1800</td>
</tr>
<tr>
<td>UL 1401</td>
<td>1200</td>
<td>750 - 1800</td>
<td>24</td>
<td>FP / CP</td>
<td>2000</td>
</tr>
<tr>
<td>UL 2001</td>
<td>1500</td>
<td>750 - 1800</td>
<td>27.5</td>
<td>FP / CP</td>
<td>2300</td>
</tr>
<tr>
<td>UL 255</td>
<td>2200</td>
<td>900 - 1800</td>
<td>47</td>
<td>FP / CP</td>
<td>2800</td>
</tr>
<tr>
<td>UL 305</td>
<td>3000</td>
<td>750 - 1600</td>
<td>66</td>
<td>FP</td>
<td>3000</td>
</tr>
<tr>
<td>UL 355</td>
<td>3700</td>
<td>720 - 1200</td>
<td>97</td>
<td>FP</td>
<td>3500</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice

### Technical data ULE

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Max Input Power (kW)</th>
<th>Input speed (rpm)</th>
<th>Dry wt (t)</th>
<th>Prop. Type</th>
<th>Prop. dia (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ULE 1201</td>
<td>880</td>
<td>1000</td>
<td>21</td>
<td>FP</td>
<td>1800</td>
</tr>
<tr>
<td>ULE 2001</td>
<td>1500</td>
<td>720, 750</td>
<td>32</td>
<td>FP / CP</td>
<td>2300</td>
</tr>
<tr>
<td>ULE 255</td>
<td>2200</td>
<td>720, 750</td>
<td>43</td>
<td>FP</td>
<td>2800</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Swing-up/Combi thrusters

TCNS/TCNC range - In the lowered position these thrusters act as azimuth thrusters, vectoring thrust in any desired direction for propulsion or station keeping.

When raised it swings-up into a garage so that nothing extends below the ships baseline. Combi units swing-up into a specially shaped recess in the hull so it can function as a tunnel thruster in the raised position, and as an azimuth thruster when lowered. They also function well as a ‘get you home’ emergency propulsor.

Options:
- Available in powers from 880 to 3,000kW
- Suitable for electric or diesel drive
- FP or CP propellers

Technical data

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Max. power (kW)</th>
<th>Input speed (rpm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCNS/TCNC 73/50</td>
<td>880</td>
<td>1800</td>
<td>9500 10000</td>
</tr>
<tr>
<td>TCNS/TCNC 92/62</td>
<td>2000*</td>
<td>1800</td>
<td>17000 17000</td>
</tr>
<tr>
<td>TCNS/TCNC 120/85</td>
<td>3000</td>
<td>720 - 750</td>
<td>45000 50000</td>
</tr>
</tbody>
</table>

** Delivery upon special request
* For electric drive only
Swing-up thrusters

TCNS/C 075 and 100 range – These units can be rapidly swung down and incorporate an improved nozzle design with the thruster lower section angled 5° downwards when fully deployed. This offset directs the propeller slipstream to limit the Coanda effect, which can reduce effective thrust. The angle of tilt can be manually increased by 3.5° to obtain the best thruster performance match to the hull.

Units are supplied complete with a small hull module carrying all the lifting, locking, steering and transmission systems. This weld-in module has a small footprint and can be trimmed by the yard to suit the installation. The yard provides the rest of the garage so it can be designed to match the hull lines.

Features:
• High bollard pull
• Integral hull mounting module
• CP or FP propellers

Technical data

<table>
<thead>
<tr>
<th>Unit type</th>
<th>Max. power (kW)</th>
<th>Input speed (rpm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thruster w/ steering gear</td>
<td>+ Hull module</td>
<td></td>
</tr>
<tr>
<td>TCNS/C 075</td>
<td>750 - 1000</td>
<td>1500 - 2000</td>
<td>11100</td>
</tr>
<tr>
<td>TCNS/C 100</td>
<td>1665 - 2000</td>
<td>1500 - 1800</td>
<td>19400</td>
</tr>
</tbody>
</table>
Kongsberg is a world leader in propeller design and supplies controllable pitch propellers, fixed pitch propellers, and the innovative adjustable bolted propeller. Unlike other propulsor designers we have our own hydrodynamics research centre, equipped with two cavitation tunnels. In over 40 years of operation the centre has tested around 1,400 propellers and waterjet pumps to perfect and prove the design. Kongsberg propellers deliver good fuel economy, low vibration and noise levels and minimal cavitation.
Controllable pitch propellers

A wide range of hub sizes is available for powers from around 500kW up to 75MW for both four and five bladed propellers.

The Kamewa CP-A controllable pitch hub is an evolution of XF5 system, renowned for its high reliability and blade bearing arrangement designed to avoid peak pressures and cavitation. Compared to its predecessor, the CP-A offers a 20 per cent improved power-to-weight ratio, a significant increase in efficiency and a blade foot with decreased exposure to cavitation. Propellers can be supplied with four or five blades of high skew or moderate skew type, conventional or nozzle design. The propeller is also available as full feathering.

Key features:

- Two main hub types are available: 'standard' for speeds below 30 knots and 'H' for speeds above 30 knots
- The CP-A hub offers normal pitch control and can be supplied with full blade feathering for reduced drag when not driving
- Bronze or stainless steel blades and hub can be specified
- Open water, nozzle, and ice-class options
- Full US Mil-Spec shock versions are available

Computational fluid dynamics (CFD) and cavitation tank testing were used to refine the contours of the propeller hub and blade roots for optimum performance.
Oil distribution systems

Kamewa CP propellers are available with three types of oil control system, to match most vessel requirements.

System D-F: The oil distribution box is mounted on the forward end of the reduction gearbox. Additional intermediate shafts can be arranged between the propeller shaft and the gearbox.

System D-M: A separate shaft carries the oil distribution box, and additional intermediate shafts can be arranged between the propeller shaft and the OD box shaft.

System I: Oil distribution integrated within the reduction gearbox, also part of Kongsberg supply.
Fixed pitch propellers

Propeller designs are matched to the vessel’s hull and its operating profile. The characteristics of our Kamewa range of propellers are good fuel economy, low vibration/noise levels and no harmful cavitation.

Kongsberg provides a complete package:

• Custom designed for the vessel
• Monobloc and fixed bolted propellers of moderate or high-skew designs for both open and nozzle applications
• Shafting with stern tube, bearing, seals etc
• SKF Propeller sleeve mounting, if required
• Full shaft calculations, including whirling and alignment
• Performance guarantees
• Promas optimised

SKF propeller sleeve mounting

Propellers can be supplied with the SKF propeller sleeve. It is a keyless high-grade steel sleeve with a cylindrical exterior and tapered interior that simplifies propeller removal and mounting. It offers considerable cost savings in terms of downtime, maintenance and repairs, and allows full interchangeability with a spare propeller. The SKF propeller sleeve also speeds up the installation process, eliminating match making or gauges.
Adjustable bolted propellers

The adjustable bolted propeller (ABP) allows the most efficient blade matching for optimum efficiency while simplifying installation. It uses a hollow hub with four, five or six blades bolted to it from the inside. The special bolts used to attach the blades require only simple hand tools. Slotted holes in the hub allow the blade pitch angle to be adjusted in service to compensate for variations in hull resistance through life. The propellers overall weight is reduced for easier shipment, handling and mounting. Individual blades can be replaced without drydocking. Range from 3.000 kW up to 75MW.

Key features:
- Spare propeller not needed
- Stainless steel or NiAl-bronze blades
- Slotted holes for step-less blade pitch adjustment
- Hollow hub reduces weight and extends bearing life
- Blade change possible without drydocking using simple hand tools
- Four to six blades

5 Blade ABP. Blades are attached with special bolts using only hand tools.
WATERJETS

The waterjet has many advantages over a propeller. The very high efficiency of the Kamewa waterjet pumps offer higher speeds for the same power or substantially lower fuel consumption at a constant speed with less power.

Waterjets also give the engine an easier life. At constant rpm the waterjets absorb approximately the same power regardless of the vessel’s speed, so the engine can not be overloaded, giving it a longer lifetime.

Typically waterjets produce less vibration and noise, improving passenger comfort levels. At speeds over 20 knots noise and vibration can be reduced by more than 50%.

Waterjets for naval applications can be built for special requirements regarding signature, shock and other higher requirements.

Kongsberg control systems offers excellent manoeuvrability, allowing vessels to be berthed quickly and with high precision. Kamewa waterjets are designed for ease of installation, in hulls made of different materials, reducing vessel build time and simplifying shipyard logistics. They can be supplied with steering and reversing buckets or as booster units providing forward thrust only.
Steel series

Our steel waterjets have the best pump efficiency on the market. Kongsberg can offer the best performance for any application and requirements thanks to different pump types and our modularised scope of supply. Also the requirement for high efficiency at speeds around 30 knots can now be met.

The high efficiency can be utilised for reduced fuel consumption for a given workload and consequently reduced CO2 emissions, as well as increased range. In addition, use of inboard hydraulics also reduces the risk of oil spills.

The steel series incorporates numerous improvements made possible by advanced design calculation methods and testing and production techniques.

Our modular set-up means two alternative steering and reversing units are available.

The compact split type reversing bucket and steering nozzle enables superior position keeping and manoeuvrability at low and high speeds. This helps to reduce fuel consumption. It also cuts noise and emissions in harbour manoeuvring and saves time, as well as improving safety. In high speed turns, the jets maintain speed with high efficiency – a highly valued benefit for patrol vessels and other vessels.

The box shaped steering and reversing unit occupies the smallest possible installation space. This is important for fitting into narrow hulls, such as trimarans. On yacht applications the reversing bucket must fit under the swimming platform.

Close attention has been paid to extending service life. Maintenance is intended to be easy and needed only infrequently, with a time between overhauls involving replacement of parts subject to wear up to 25,000 running hours or five years. As an option larger waterjet shaft seals can be replaced with the vessel afloat using the inflatable seal provided.

Several types of controls systems are available. From the most rugged system typically for
patrol vessels, via a standardised system for easy installation and to a new system which can be customised to meet most demands.

The later is the CanMan Touch, a touch-screen based control system. Among its features are ‘Auto Positioning’ automatic manoeuvring which controls the jets to keep the vessel at a desired point.

Skid version waterjets can also be supplied with a factory-mounted and pre-calibrated control box.

Technical data

<table>
<thead>
<tr>
<th>Waterjet steel series</th>
<th>Max power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>450</td>
</tr>
<tr>
<td>28</td>
<td>570</td>
</tr>
<tr>
<td>32</td>
<td>750</td>
</tr>
<tr>
<td>36</td>
<td>950</td>
</tr>
<tr>
<td>40</td>
<td>1250</td>
</tr>
<tr>
<td>45</td>
<td>1500</td>
</tr>
<tr>
<td>50</td>
<td>2000</td>
</tr>
<tr>
<td>56</td>
<td>3000</td>
</tr>
<tr>
<td>63</td>
<td>4000</td>
</tr>
<tr>
<td>71</td>
<td>4500</td>
</tr>
<tr>
<td>80</td>
<td>6000</td>
</tr>
<tr>
<td>90</td>
<td>8000</td>
</tr>
<tr>
<td>100</td>
<td>10000</td>
</tr>
<tr>
<td>112</td>
<td>12000</td>
</tr>
<tr>
<td>125</td>
<td>16000</td>
</tr>
<tr>
<td>140</td>
<td>20000</td>
</tr>
<tr>
<td>160</td>
<td>25000</td>
</tr>
<tr>
<td>180</td>
<td>30000</td>
</tr>
<tr>
<td>200</td>
<td>36000</td>
</tr>
</tbody>
</table>

Max power is related to high speed (+ 50 knots), lower speed will require larger waterjet size.

Steering and manoeuvring forces are obtained by moving the bucket up and down the nozzle from side to side.
Steel series – Modular installation

Steel series waterjets are designed to be easy to install in hulls constructed from different materials. The owner or yard can choose from three delivery concepts, each of which can also have a choice of three different materials for the inlet duct. Kongsberg recognises that shipyards have their individual preferences for the way in which a waterjet is integrated into the vessel, the installation sequence, and whether the inlet duct is supplied or built by the yard to drawings.

Depending on size, the delivery programme is divided into three ways of supplying steel series waterjets.

The first is that the yard receives the waterjet as a complete skid mounted unit with pump and inlet together and possibly even the hydraulics mounted. This results in a simple and effective installation.

The second option is that the inlet, hydraulics and controls are supplied as a loose items, while the waterjet unit is supplied as a separate unit to be bolted in place at a later stage of the construction of the vessel.

The third option appeals to shipyards that prefer to fabricate their own inlet ducts as part of the hull construction using the same material. This way they can achieve to have highest strength of the hull as well as the

Delivery program - Steel series

Aluminium inlet

The final data is subject to application and to be confirmed by Kongsberg.
optimal inlet duct efficiency. In this case Kongsberg supplies the waterjet unit with controls and hydraulics, and provides the drawings with optimum inlet shape for the yard to manufacture.

Irrespective of which of these options is chosen, the inlet can be made of steel, aluminium or composite (FRP) to suit the material chosen for the hull. In all cases the pump which forms the outboard unit will be in stainless steel.

**Different impeller blade pitch angles are available for fine adjustment of the rpm for optimum performance.**

**The impeller’s task is to pressurise the water. The reaction force that is created when the water leaves the pump is utilised to propel the ship.**

**Delivery programme**

The diagram shows the ways in which a steel series waterjet can be supplied with a choice of three ways of delivering the waterjet to suit yard or owner preferences.
Aluminium series

Major components in aluminium make for a light and efficient waterjet. The aluminium inlet duct is integral with the thrust bearing and hydraulic system making the waterjet a complete package.

The pump section is outboard and uses an axial flow aluminium pump. The interior surface of the impeller housing lined with a special rubberlike material to minimise wear and noise. Impeller and shaft are made of stainless steel.

Aluminium series waterjets provide a high volume flow from the axial pump, with a good driving thrust at lower speeds making them suitable for both planing and displacement craft. They can be installed as single, twin, triple or quadruple systems to suit the vessel design, with steering/reversing or as boosters.

Impellers are made to match optimally the engine and gearbox range available for best performance.

Aluminium waterjets are normally supplied as skid-mount self-contained units ready for rapid installation, but tailor-made inlets can be provided to meet particular requirements, for example specialist naval craft. Complementing the waterjets, modular interceptor trim tabs are available which bolt directly to the waterjet and help control boat trim and ride.

All waterjets are supplied with a control system ideal for smaller fast boats whose operator interface can be console or chair mounted to suit the customer’s preference.

Axial flow impellers are made to match engine rpm for optimal performance.
A5 Series waterjets
We have unveiled a new range of Kamewa waterjets. Taking more than three-years research and development, the new A5 Series improves upon the popular FF range of Kamewa waterjets by providing greater thrust from a waterjet with a more compact inboard footprint.
Geared towards smaller boats and craft up to 25m in length, the A5 series is manufactured from high-grade marine aluminium and available in seven sizes with power outputs between 100kW and 1230kW. The A5 will eventually replace the FF range and size 29 will be first to hit the market.

Technical data

<table>
<thead>
<tr>
<th>Waterjet aluminium series</th>
<th>Max power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>260</td>
</tr>
<tr>
<td>270</td>
<td>370</td>
</tr>
<tr>
<td>310</td>
<td>500</td>
</tr>
<tr>
<td>340</td>
<td>460</td>
</tr>
<tr>
<td>29</td>
<td>1230</td>
</tr>
<tr>
<td>37</td>
<td>585</td>
</tr>
<tr>
<td>41</td>
<td>735</td>
</tr>
<tr>
<td>45</td>
<td>885</td>
</tr>
<tr>
<td>500</td>
<td>1100</td>
</tr>
<tr>
<td>550</td>
<td>1390</td>
</tr>
<tr>
<td>600</td>
<td>1800</td>
</tr>
<tr>
<td>67</td>
<td>2000</td>
</tr>
</tbody>
</table>

Typical applications:
Smaller waterjets - high speed vessels such as:
- Smaller passenger ferries
- Rescue crafts
- Smaller naval craftss
- Wind farm support vessels
TUNNEL THRUSTERS

The tunnel thruster is designed to provide side force to the ship to enhance manoeuvring capability in port or additional station keeping power when dynamic positioning. Versions specified should be matched to the vessel application. All are available with CP or FP propellers, and for ships requiring maximum passenger comfort, we have the ‘Super Silent’ range. A system normally consists of the thruster unit with tunnel, hydraulic equipment, remote control and electric drive motor with starter.
Tunnel thrusters

Users can select from eleven diameters and four different models, in each size designed to suit a specific application.

AUX: Standard type for auxiliary use only
ICE: High ice-class with stainless steel propeller blades
DPN: Continuous DP service - shallower draught vessels
DPD: Continuous DP service - deeper draught vessels

Units comprise standard tunnel, propeller unit, hydraulic system and remote control.

Key features:
- Available with FP or CP propellers
- Skewed blades for efficiency/low noise
- Heavy duty propeller for DP units
- Shaft seal pressure control with drain connection in DP thrusters
- Mechanical locked bearings in DP thrusters
## Technical data

<table>
<thead>
<tr>
<th>TT size</th>
<th>Tip speed m/s</th>
<th>Motor RPM</th>
<th>Propeller RPM</th>
<th>Power AUX</th>
<th>Power DP</th>
<th>Prime mover type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100 CP</td>
<td>26.8 - 32.0</td>
<td>1465 - 1755</td>
<td>465 - 556</td>
<td>330 - 390</td>
<td>300 - 350</td>
<td>El. motor</td>
</tr>
<tr>
<td>1100 CP</td>
<td></td>
<td></td>
<td></td>
<td>290 - 340</td>
<td>260 - 310</td>
<td>Diesel</td>
</tr>
<tr>
<td>1300 CP</td>
<td>26.5 - 31.8</td>
<td>1470 - 1760</td>
<td>390 - 467</td>
<td>495 - 595</td>
<td>445 - 535</td>
<td>El. motor</td>
</tr>
<tr>
<td>1300 CP</td>
<td></td>
<td></td>
<td></td>
<td>435 - 520</td>
<td>390 - 475</td>
<td>Diesel</td>
</tr>
<tr>
<td>1300 FP</td>
<td>26.5 - 31.8</td>
<td>1470 - 1760</td>
<td>390 - 467</td>
<td>390 - 500</td>
<td>350 - 450</td>
<td>El. motor</td>
</tr>
<tr>
<td>1650 CP</td>
<td>27.0 - 32.3</td>
<td>1180 - 1770</td>
<td>312 - 374</td>
<td>720 - 865</td>
<td>645 - 780</td>
<td>El. motor</td>
</tr>
<tr>
<td>1650 CP</td>
<td></td>
<td></td>
<td></td>
<td>630 - 760</td>
<td>570 - 685</td>
<td>Diesel</td>
</tr>
<tr>
<td>1650 FP</td>
<td>27.0 - 32.3</td>
<td>1180 - 1770</td>
<td>312 - 374</td>
<td>600 - 720</td>
<td>530 - 640</td>
<td>El. motor</td>
</tr>
<tr>
<td>1850 CP</td>
<td>24.2 - 32.7</td>
<td>1180 - 1770</td>
<td>250 - 337</td>
<td>880 - 1050</td>
<td>700 - 950</td>
<td>El. motor</td>
</tr>
<tr>
<td>1850 CP</td>
<td></td>
<td></td>
<td></td>
<td>780 - 930</td>
<td>700 - 840</td>
<td>Diesel</td>
</tr>
<tr>
<td>1850 FP</td>
<td>24.2 - 32.7</td>
<td>1180 - 1770</td>
<td>250 - 337</td>
<td>620 - 860</td>
<td>550 - 770</td>
<td>El. motor</td>
</tr>
<tr>
<td>2000 CP</td>
<td>25.6 - 32.8</td>
<td>980 - 1480</td>
<td>245 - 313</td>
<td>1030 - 1400</td>
<td>925 - 1200</td>
<td>El. motor</td>
</tr>
<tr>
<td>2000 CP</td>
<td></td>
<td></td>
<td></td>
<td>905 - 1040</td>
<td>815 - 1025</td>
<td>Diesel</td>
</tr>
<tr>
<td>2000 FP</td>
<td>25.6 - 32.8</td>
<td>980 - 1480</td>
<td>245 - 313</td>
<td>830 - 1150</td>
<td>730 - 1050</td>
<td>El. motor</td>
</tr>
<tr>
<td>2200 CP</td>
<td>26.2 - 31.8</td>
<td>880 - 1190</td>
<td>225 - 276</td>
<td>1150 - 1510</td>
<td>1050 - 1355</td>
<td>El. motor</td>
</tr>
<tr>
<td>2200 CP</td>
<td></td>
<td></td>
<td></td>
<td>1020 - 1325</td>
<td>925 - 1190</td>
<td>Diesel</td>
</tr>
<tr>
<td>2200 FP</td>
<td>26.2 - 31.8</td>
<td>980 - 1190</td>
<td>228 - 276</td>
<td>750 - 1200</td>
<td>680 - 1070</td>
<td>El. motor</td>
</tr>
<tr>
<td>2400 CP</td>
<td>26.6 - 32.3</td>
<td>980 - 1190</td>
<td>211 - 257</td>
<td>1550 - 1910</td>
<td>1400 - 1720</td>
<td>El. motor</td>
</tr>
<tr>
<td>2400 CP</td>
<td></td>
<td></td>
<td></td>
<td>1320 - 1680</td>
<td>1180 - 1510</td>
<td>Diesel</td>
</tr>
<tr>
<td>2400 FP</td>
<td>26.6 - 32.3</td>
<td>980 - 1190</td>
<td>211 - 257</td>
<td>1100 - 1600</td>
<td>980 - 1500</td>
<td>El. motor</td>
</tr>
<tr>
<td>2650 CP</td>
<td>26.9 - 31.6</td>
<td>880 - 980</td>
<td>194 - 228</td>
<td>2050 - 2400</td>
<td>1850 - 2160</td>
<td>El. motor</td>
</tr>
<tr>
<td>2650 CP</td>
<td></td>
<td></td>
<td></td>
<td>1892 - 2110</td>
<td>1700 - 2000</td>
<td>Diesel</td>
</tr>
<tr>
<td>2650 FP</td>
<td>26.9 - 31.6</td>
<td>880 - 980</td>
<td>194 - 228</td>
<td>1260 - 1520</td>
<td>1120 - 1350</td>
<td>El. motor</td>
</tr>
<tr>
<td>2800 CP</td>
<td>29.2 - 32.5</td>
<td>880 - 980</td>
<td>199 - 222</td>
<td>2380 - 2650</td>
<td>2140 - 2385</td>
<td>El. motor</td>
</tr>
<tr>
<td>2800 CP</td>
<td></td>
<td></td>
<td></td>
<td>2090 - 2330</td>
<td>1880 - 2095</td>
<td>Diesel</td>
</tr>
<tr>
<td>2800 FP</td>
<td>29.2 - 32.5</td>
<td>880 - 980</td>
<td>199 - 222</td>
<td>1630 - 1800</td>
<td>1450 - 1600</td>
<td>El. motor</td>
</tr>
<tr>
<td>3000 CP</td>
<td>25.9 - 32.1</td>
<td>710 - 880</td>
<td>165 - 204</td>
<td>2450 - 3000</td>
<td>2200 - 2700</td>
<td>El. motor</td>
</tr>
<tr>
<td>3000 CP</td>
<td></td>
<td></td>
<td></td>
<td>2210 - 2640</td>
<td>1990 - 2370</td>
<td>Diesel</td>
</tr>
<tr>
<td>3000 FP</td>
<td>25.9 - 32.1</td>
<td>710 - 880</td>
<td>165 - 204</td>
<td>1750 - 2150</td>
<td>1520 - 1880</td>
<td>El. motor</td>
</tr>
<tr>
<td>3300 CP</td>
<td>25.7 - 31.9</td>
<td>710 - 880</td>
<td>149 - 185</td>
<td>2700 - 3700</td>
<td>2700 - 3330</td>
<td>El. motor</td>
</tr>
<tr>
<td>3300 CP</td>
<td>26.6 - 31.9</td>
<td>735 - 880</td>
<td>154 - 185</td>
<td>2730 - 3250</td>
<td>2450 - 2930</td>
<td>Diesel</td>
</tr>
<tr>
<td>3300 FP</td>
<td>25.7 - 31.9</td>
<td>710 - 880</td>
<td>149 - 185</td>
<td>2100 - 2850</td>
<td>1850 - 2500</td>
<td>El. motor</td>
</tr>
</tbody>
</table>
Super Silent type

The Super Silent (SS) tunnel thruster has a modified hydraulic power pack for low noise. It has double walls through the full tunnel length and a flexibly mounted inner tunnel.

Key features:
- Reduced tip speed
- Noise reduction of up to 10 dB compared to standard design
- Reduction of up to 25 dB can be reached in combination with floating floors and other measures by shipbuilder

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Dia. (mm)</th>
<th>Motor (rpm)</th>
<th>Propeller output (rpm)</th>
<th>Max power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT1850 SS</td>
<td>1850</td>
<td>1180</td>
<td>289</td>
<td>800</td>
</tr>
<tr>
<td>TT2000 SS</td>
<td>2200</td>
<td>800</td>
<td>225</td>
<td>1205</td>
</tr>
<tr>
<td>TT2200 SS</td>
<td>2200</td>
<td>1190</td>
<td>242</td>
<td>1150</td>
</tr>
<tr>
<td>TT2400 SS</td>
<td>2400</td>
<td>1190</td>
<td>230</td>
<td>1500</td>
</tr>
<tr>
<td>TT2400 SS</td>
<td>2800</td>
<td>880</td>
<td>119</td>
<td>2140</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Permanent magnet

The Permanent magnet tunnel thruster (TT-PM) is the latest tunnel thruster design from Kongsberg and has been engineered with reliability and through life costs as the focus. Using permanent magnet motor technology increases efficiency and makes the installation more compact, only the variable frequency drive unit is housed in the thruster room, freeing up space on board. It also simplifies maintenance as the patented mount means units can be removed and replaced without drydocking. PM thrusters are currently available in two sizes with powers of 1,000 and 1,600 kW. These thrusters have been developed for the most demanding applications such as DP.

Key features:
- Efficient and space saving PM technology
- Fast response times to full power
- Rugged design with high reliability
- Equal thrust in both directions
- Patented resilient mounting system reduces noise and vibration, simplifies tunnel fabrication and removal/installation
- Oil filled stator for superior cooling and protection
- Robust centre shaft carries all propeller loads

Technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Dimensions (mm)</th>
<th>Weight (kg)</th>
<th>Performance</th>
<th>Hull mount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prop. Dia</td>
<td>Tunnel Dia</td>
<td>Thruster Dia</td>
<td>Connection &amp; mounts</td>
</tr>
<tr>
<td>TT PM 1600</td>
<td>1600</td>
<td>2180</td>
<td>7250</td>
<td>1957</td>
</tr>
<tr>
<td>TT PM 2000</td>
<td>2000</td>
<td>2600</td>
<td>12217</td>
<td>2540</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
PROMAS

The Promas propulsion and manouevring system offers increased propulsive efficiency and improved manoeuvrability by adapting the propeller and rudder into one propulsive unit. It is suitable for conventional single and twin screw ships.

Each installation comprises a twisted full spade rudder with a Costa bulb that is smoothly connected to the propeller by a hubcap, and a propeller design adapted to the rudder.

A well designed twist adapts the rudder to the rotation of the propeller slipstream and reduces the angle of attack on the rudder’s leading edge. This gives a more efficient rudder profile with lower drag and better recovery of rotational energy from the propeller slipstream.
Promas integrates the propeller, a hubcap, rudder bulb and the rudder itself into a single hydrodynamic efficient unit. A tapered hubcap fitted to the propeller hub leads the waterflow onto a bulb which forms part of the spade rudder. The rudder has a twisted leading edge, optimized for the flow from the propeller, which converts to into additional forward thrust some of the swirl energy in the slipstreams that is normally lost.

The result is an increase in propulsive efficiency of up to 8 per cent depending on the application, leading to reduced fuel consumption and emissions. Large steering forces can also be developed. Promas has been developed using the latest CFD technologies together with extensive model testing in our own hydrodynamic research centre facility. As the risk of hub vortex cavitation is removed., the radial distribution of hydrodynamic loads on the propeller blades can be modified, reducing tip loading and helping to limit the intensity of blade pressure pulses (up to 25 per cent) and associated noise and vibration.

**Promas + nozzle**

A new nozzle, propeller, hubcap, bulb and rudder profile combined and designed as one unit to maximise free-running efficiency and improve bollard pull. Water flow leaving the nozzle passes over the special profile rudder to provide high steering forces yet minimum drag. Testing indicating bollard pull improvement of more than 5% possible and a fuel reduction of more than 15% in transit the special profile rudder to provide high steering forces yet minimum drag.

**Key features:**

- Propeller and rudder designed as a single system for optimum efficiency
- Propulsive efficiency increased by 3 – 8 per cent
- Nozzle option can reduce fuel consumption in transit by 15 per cent or more
- Improved low speed manoeuvrability
- Improved possibility for low pressure pulse/low noise propeller design
- Almost as easy to install as a conventional propeller-rudder system
- Simple and robust with short payback time
Propulsive efficiency improved
In general, the Promas efficiency gain is in the region of 3 – 8 per cent for single screw, and 2 – 6 per cent for twin screw vessels. Comparison tests between a conventional propeller-rudder system and Promas are shown in the graphs below.

The rudder area, profile shape and position are identical for the conventional and Promas cases in the graphs below. So the increase in efficiency shown is the pure effect of the bulb, hubcap, rudder twist and adapted propeller design.

Relative power delivered vs. ship speed - single screw vessel

Relative power delivered vs. ship speed - twin screw vessel
Improved manoeuvring at low speed
At low speed manoeuvring ie. harbour manoeuvring, a maximum side force and a maximum rudder drag is important. The graph below shows the non-dimensional lift against rudder angle for a single screw vessel.

Rudder lift vs. rudder angle - bollard pull (equivalent to low speed manoeuvring)
Promas Lite

Promas Lite is a version of the successful Promas system that can be easily fitted to vessels already in service. The installation is simple with only three areas of modification:

- Welding a prefabricated bulb in position on the existing rudder
- Bolting the hubcap to the propeller hub
- Fitting of a new propeller or reblading the original one

Improving propulsive efficiency is key to reducing fuel burn and emissions. Promas Lite installations on vessels operating significantly off their original design speed should provide an efficiency improvement in the region of 5 – 15 per cent. Recent installations on twin screw cruise vessels have demonstrated efficiency improvements within these guidelines giving a payback period of well under two years. The improvement it delivers in propulsive efficiency means that engine loads are reduced, which also helps to lower wear and tear on the engine.

Key features:
- Reduced fuel consumption of between 5 – 15 per cent
- Lower exhaust emissions
- Short payback time
- Simple and quick installation (7 – 10 days)
PODDED PROPULSORS

The Kongsberg electrical pods, type Mermaid have steadily evolved over the last decade. The range offers five fame sizes from 1,850mm to 2,770mm motor stator diameter, with five powers from 5 to 27MW. Advances in design have increased the power density, which means for a given power the pod diameter can be reduced allowing a more streamlined form for the underwater unit for improved efficiency. Both induction and syncronous motors are offered. For ice-going vessels induction motors are normally specified due to their good torque characteristics at low speed. The application of Mermaid pods is not restricted to passenger vessels or ice going ships. Underwater mountable units are available for rigs, and Mermaid pods are also powering naval vessels.
ELegance propulsion system

The ELegance pod system includes a new Permanent Magnet (PM) motor driven Pod, making our offers within ELegic driven thrusters the widest in the industry. These Pods provide propulsion for precise and efficient vessel operation. It has a built-in permanent magnet electric motor for optimal efficiency over a large speed range, combined with an excellent hydrodynamic design developed in our well renowned Hydrodynamic Research Centre.

ELegance pod

Key features:
- Open propeller in pulling configuration
- Ducted propeller in pushing configuration
- 6 sizes covering 1.5 - 7.5MW
- Ice-class up to FS 1A Super and PC6

Technical data

<table>
<thead>
<tr>
<th>Size*</th>
<th>850</th>
<th>960</th>
<th>1080</th>
<th>1230</th>
<th>1380</th>
<th>1570</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Power [kW]</td>
<td>2000</td>
<td>2700</td>
<td>3500</td>
<td>4600</td>
<td>6000</td>
<td>7500</td>
</tr>
<tr>
<td>Propeller diameter [m]</td>
<td>1.8 - 2.9</td>
<td>2.1 - 3.4</td>
<td>2.4 - 3.9</td>
<td>2.7 - 4.4</td>
<td>3.0 - 4.9</td>
<td>3.3 - 5.4</td>
</tr>
<tr>
<td>Hat [mm]</td>
<td>1700</td>
<td>1950</td>
<td>2100</td>
<td>2550</td>
<td>2900</td>
<td>3200</td>
</tr>
<tr>
<td>Approx. Weight [tonnes]</td>
<td>27</td>
<td>34</td>
<td>45</td>
<td>58</td>
<td>75</td>
<td>95</td>
</tr>
</tbody>
</table>

* Size definition = stator outer diameter in mm.

ELegance ducted pod

Key features:
- Open propeller in pulling configuration
- Ducted propeller in pushing configuration
- 6 sizes covering 1.5 - 7.5MW
- Underwater mounting

Technical data

<table>
<thead>
<tr>
<th>Size*</th>
<th>850</th>
<th>960</th>
<th>1080</th>
<th>1230</th>
<th>1380</th>
<th>1570</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power, BP [kW]</td>
<td>1600</td>
<td>2150</td>
<td>2800</td>
<td>3700</td>
<td>4900</td>
<td>6300</td>
</tr>
<tr>
<td>Propeller diameter [m]</td>
<td>2.4</td>
<td>2.8</td>
<td>3.2</td>
<td>3.6</td>
<td>4.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Shaft speed, BP [rpm]</td>
<td>255</td>
<td>225</td>
<td>200</td>
<td>175</td>
<td>160</td>
<td>145</td>
</tr>
<tr>
<td>H [mm]</td>
<td>3250</td>
<td>3750</td>
<td>4300</td>
<td>4850</td>
<td>5400</td>
<td>5950</td>
</tr>
<tr>
<td>BP [tonnes]</td>
<td>32</td>
<td>44</td>
<td>57</td>
<td>74</td>
<td>96</td>
<td>123</td>
</tr>
<tr>
<td>Approx. weight [tonnes]</td>
<td>29</td>
<td>37</td>
<td>50</td>
<td>65</td>
<td>85</td>
<td>110</td>
</tr>
</tbody>
</table>

* Size definition = stator outer diameter in mm.
Elegance benefits:
- A variety of electric system and drive alternatives to provide an optimal solution for each application
- Permanent magnet motor technology for optimal electric efficiency and compact design
- Combined cooling by air and surrounding sea water provides high efficiency and compact air cooling cubicle
- Optimised drive/motor and hydrodynamic design for excellent overall efficiency
- Adjustable design to provide optimal adaption to hull for each vessel
- VGP compliant Anti-Pollution Seal System to ensure environmental safe operation
- Hydrodynamic Research Centre to support customer in hull/pod optimisation
- Easy access of all service points and long service intervals of main components

Typical applications:
- Cruise & passenger
  - Expedition cruise
  - Ropax
  - Yachts
- Offshore
  - PSV
  - OSV/CSV
  - Windfarm
- Cargo
  - Short sea
  - Ice-classed
- Naval
  - Auxilliary and Coastguard
Suitable for ice-class operation
Podded propulsors

Mermaid pods offer flexibility in vessel design and machinery layout. They combine the functions of a propulsion motor, main propeller, rudder and stern thruster in a single unit. The integrated electric motor drives the shaft, saving space on board and eliminates the need for a gearbox.

The propeller is a fixed pitch high skew design for low noise and vibration. It can be supplied as a monobloc or with separately bolted blades, that can be simply changed in the event of damage. All seals are environmentally friendly, with no oil release in the event of a failure.

Key features:
- Powers from 5 to 27MW
- Synchronous motor with brushless excitation, or induction motor
- Excellent manoeuvring capability
- Flexible machinery arrangement with simpler machinery installation
- High efficiency with low noise and vibration
- Environmentally friendly sealing arrangement
- Remote controlled brake and locking unit
- Pulling azimuth unit for maximum propulsive efficiency

Technical data

<table>
<thead>
<tr>
<th>Standard Mermaid sizes</th>
<th>Power synchronous motor (MW)</th>
<th>Power induction motor (MW)</th>
<th>Shaft speed (rpm)</th>
<th>Weight (t)</th>
<th>Prop. dia. (m)</th>
<th>Speed (knots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>185</td>
<td>6 - 11</td>
<td>6 - 11</td>
<td>110 - 210</td>
<td>70 - 115</td>
<td>3.6 - 5.4</td>
<td>Up to 24</td>
</tr>
<tr>
<td>210</td>
<td>8 - 16</td>
<td>8 - 16</td>
<td>105 - 195</td>
<td>110 - 155</td>
<td>4.1 - 5.9</td>
<td></td>
</tr>
<tr>
<td>232</td>
<td>11 - 20</td>
<td>11 - 20</td>
<td>100 - 180</td>
<td>145 - 190</td>
<td>4.5 - 5</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>13 - 23</td>
<td>13 - 23</td>
<td>95 - 170</td>
<td>185 - 220</td>
<td>4.9 - 7</td>
<td></td>
</tr>
<tr>
<td>277</td>
<td>15 - 27</td>
<td>15 - 27</td>
<td>90 - 160</td>
<td>210 - 270</td>
<td>5.4 - 8.0</td>
<td></td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Main components:

1. Cooling cubicle: Mounted on the steering unit and contains the fans, coolers and air drying equipment.

2. Steering unit: The steering machinery is mounted in the pod seat and contains the slewing bearing, steering gear wheel and steering motors. These can be either electric or hydraulic.

3. Pod seating: Custom built for each hull. Is delivered fairly early to the yard and becomes an integral part of the hull.

4. Pod unit: Rotates 360°, +/- 35° in transit. Equipped with slip rings and fluid distribution swivel inside steering unit.
Mermaid ICE and HICE

Mermaid ice-strengthened pods are specifically designed for all vessels that operate in the toughest arctic conditions. Mermaid ICE units are designed to IACS PC4 and provide excellent hydrodynamic performance for open sea voyages for fuel savings in a mixed operating profile. HICE pods (illustrated below) for heavy duty ice applications are designed for ice classes to IACS PC1. Both types are equipped with robust heavy duty induction PWM motors with high torque at low rpm suitable for tough ice milling conditions.

HICE pods are designed for heavy duty applications.

Technical data

<table>
<thead>
<tr>
<th>Pod size</th>
<th>Bollard pull (MW)</th>
<th>Shaft speed (rpm)</th>
<th>Weight (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>185</td>
<td>4 - 7</td>
<td>110 - 170</td>
<td>80 - 145</td>
</tr>
<tr>
<td>210</td>
<td>6 - 11</td>
<td>105 - 155</td>
<td>70 - 115</td>
</tr>
<tr>
<td>232</td>
<td>8 - 13</td>
<td>100 - 147</td>
<td>110 - 155</td>
</tr>
<tr>
<td>250</td>
<td>10 - 15</td>
<td>95 - 140</td>
<td>145 - 190</td>
</tr>
<tr>
<td>277</td>
<td>12 - 18</td>
<td>90 - 132</td>
<td>250 - 325</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Key features:
• Power range 5 to 18MW
• Induction PWM motor
• High torque at low shaft speed for good ice milling capability
• Stator shrink fitted to pod housing for efficient cooling
• Stainless steel fixed pitch propeller with bolted blades for simple change out

<table>
<thead>
<tr>
<th>Prop. dia (m)</th>
<th>Bollard pull thrust (kN)</th>
<th>Open water speed (knots)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2 - 4.5</td>
<td>450 - 850</td>
<td></td>
</tr>
<tr>
<td>3.7 - 5.0</td>
<td>950 - 1200</td>
<td></td>
</tr>
<tr>
<td>4.5 - 5.65</td>
<td>1550 - 1500</td>
<td>Up to 20</td>
</tr>
<tr>
<td>4.7 - 6.0</td>
<td>1200 - 1650</td>
<td></td>
</tr>
<tr>
<td>5.2 - 6.6</td>
<td>1300 - 2050</td>
<td></td>
</tr>
</tbody>
</table>
The Mermaid pushing pods are designed for low speed, high load and high bollard pull applications. Fitted with a hydrodynamically optimised nozzle for maximum efficiency, they enable offshore operators to utilise the full benefits of space saving electrical pod propulsion.

## Technical data

<table>
<thead>
<tr>
<th>Pod size</th>
<th>Bollard pull (MW)</th>
<th>Shaft speed (rpm)</th>
<th>Weight (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>185</td>
<td>4 - 8</td>
<td>110 - 190</td>
<td>60 - 120</td>
</tr>
<tr>
<td>210</td>
<td>7 - 12</td>
<td>105 - 160</td>
<td>110 - 160</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Key features:
- Power range 4 to 11MW
- Induction or Synchronous motor
- Excellent performance for applications requiring high thrust and reliability
- Underwater mountable option for most hull designs
- Choice of fixed pitch monobloc or bolted propeller
REDUCTION GEARS

The Kongsberg reduction gear range is of the proven single-input single-output design with built-in clutch and thrust block. They have a variety of power take-offs that enable large shaft generators to be driven, and electric motors to feed in power for get-you-home propulsion or as part of a hybrid system. Power, torque and shaft offsets correspond to current and anticipated market demands in terms of engine power/speed and propeller revolutions for a wide range of vessels. Large reduction ratios allow for all popular medium speed engines and give slow and efficient propeller speeds. They can be specified with one-step reduction up to 6.1 - 6.3 and two-step reduction with max. ratio up to 12:1.
GHC type: max. torque output - 90 to 950 kNm

- Available with a range of both vertical and horizontal shaft offsets
- Four configurations can be specified:
  - Standard GHC
  - P – with primary
    (power take in/off) PTI/PTO
  - S – with secondary PTO
  - SC – with secondary PTO and clutch

Technical data

<table>
<thead>
<tr>
<th>Technical data</th>
<th>GHC</th>
<th>GHC-P</th>
<th>GHC-S (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. torque in (kNm)</td>
<td>23 - 275</td>
<td>23 - 275</td>
<td>23 - 275</td>
</tr>
<tr>
<td>Max. torque out (kNm)</td>
<td>90 - 1100</td>
<td>90 - 1100</td>
<td>90 - 1100</td>
</tr>
<tr>
<td>Reduction ratio min.</td>
<td>1.8:1 - 2.0:1</td>
<td>1.8:1 - 2.0:1</td>
<td>1.8:1 - 2.0:1</td>
</tr>
<tr>
<td>Reduction ratio max. (one step)</td>
<td>6.0:1 - 6.3:1</td>
<td>6.0:1 - 6.3:1</td>
<td>6.0:1 - 6.3:1</td>
</tr>
<tr>
<td>Gearbox PTI/PTO transmitted power (kW)</td>
<td>-</td>
<td>800 - 5.000</td>
<td>1.000 - 5.000</td>
</tr>
<tr>
<td>PTO/PTI speed (rpm)</td>
<td>-</td>
<td>1.200 - 1.800</td>
<td>1.200 - 1.800</td>
</tr>
<tr>
<td>PTO/PTI max. Ratio</td>
<td>-</td>
<td>1:3</td>
<td>1:3</td>
</tr>
<tr>
<td>PTO/PTI min. Ratio</td>
<td>-</td>
<td>1:1</td>
<td>1:1.33</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice

Integrated hydraulic system with Kongsberg gear

Hydraulic for pitch, clutch and lubrication is mounted on and integrated on the gearbox in combination with Kongsberg main propeller. The hydraulic oil inlet ring (OD-box) and pitch control valves are integrated in the reduction gearbox. The gearbox also incorporates the propeller pitch feed back system.

Oil inlet ring
**Technical data**

<table>
<thead>
<tr>
<th>Mode no.</th>
<th>Descr.</th>
<th>Gear configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No PTI/PTO</td>
</tr>
<tr>
<td>1</td>
<td>Propulsion only</td>
<td>OK</td>
</tr>
<tr>
<td>2</td>
<td>Propulsion + PTO</td>
<td>Not possible</td>
</tr>
<tr>
<td>3</td>
<td>Propulsion + PTI</td>
<td>Not possible</td>
</tr>
<tr>
<td>4</td>
<td>PTI only</td>
<td>Not possible</td>
</tr>
<tr>
<td>5</td>
<td>PTO only</td>
<td>Not possible</td>
</tr>
</tbody>
</table>
Various types of Kongsberg stabiliser technology can be selected to match the vessel and its operating requirements. Fin stabilisers are popular and suitable for a broad range of vessels and reduce roll when underway. Tank stabilisation and anti-heeling systems are effective at low speeds or when stationary. The Neptune range uses a retractable fin that folds into slots in the hull, flush with the vessel’s side, and is ideal for cruise ships and larger ferries. The smaller and lightweight Aquarius range is suitable for large yachts and smaller cruise vessels. Fin designs have been modified and control systems developed to provide stabilisation at rest capability for large yachts using both Aquarius and Neptune range. Where it is not necessary or required for the fin to retract, both the Modular and Gemini range cater for a variety of applications including military vessels.
Fin stabilisers

Kongsberg manufactures the broadest range of stabilisers in the market, suitable for commercial or naval vessels of all sizes. The most recent addition is ‘stabilisation at rest’ (SAR) specifically developed for large yachts using retractable fins – a world first.

Non-retractable stabilisers

Modular

The Modular range uses a simplified design configuration that offers reduced maintenance costs. In operation, the superior hydrodynamic profile of the fin blade remains unbroken, reducing the potential for cavitation. The range fully satisfies military standards for noise, shock and vibration levels where required to meet specifications.

Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Fin Area (m²)</th>
<th>Maximum dimensions (m)</th>
<th>Weight* (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>NR22</td>
<td>1.9 - 4.8</td>
<td>1.30</td>
<td>1.35</td>
</tr>
<tr>
<td>NR26</td>
<td>5.0 - 6.5</td>
<td>1.30</td>
<td>1.70</td>
</tr>
<tr>
<td>NR30</td>
<td>7.0 - 9.0</td>
<td>1.50</td>
<td>1.88</td>
</tr>
<tr>
<td>NR35</td>
<td>9.5 - 12.0</td>
<td>1.75</td>
<td>1.95</td>
</tr>
<tr>
<td>NR41</td>
<td>13.0 - 16.5</td>
<td>2.00</td>
<td>2.20</td>
</tr>
</tbody>
</table>

*Weights shown include the hull plates
All data subject to change without prior notice
Gemini
The compact and ruggedly designed Gemini range is supplied with a plain high performance fabricated fin and is suitable for commercial vessels and government/military applications where Milspec requirements are not required. It can be supplied with or without hull plate to allow a balance of cost against ease of installation.

Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Fin Area (m²)</th>
<th>Maximum dimensions (m)</th>
<th>Weight* (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>10</td>
<td>1.0 - 2.0</td>
<td>1.20</td>
<td>1.17</td>
</tr>
<tr>
<td>20</td>
<td>2.0 - 3.0</td>
<td>1.55</td>
<td>1.29</td>
</tr>
<tr>
<td>30</td>
<td>3.0 - 4.0</td>
<td>1.86</td>
<td>1.72</td>
</tr>
<tr>
<td>40</td>
<td>4.0 - 5.0</td>
<td>2.2</td>
<td>1.82</td>
</tr>
<tr>
<td>50</td>
<td>5.0 - 6.0</td>
<td>2.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Weights shown include the hull plates
All data subject to change without prior notice
Retractable stabilisers

The Neptune and Aquarius retractable-fin stabilisers both incorporate a one-piece fin construction, with a 'fishtail' high-lift profile. When not in use, the fins are folded into recesses in the hull, flush with the vessel’s side.

Aquarius

The Aquarius folding-fin stabiliser range gives high performance roll damping, with a compact, lightweight design and state-of-the-art controls. The fin operating mechanism is specially configured for smaller vessels.

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Fin Area (m²)</th>
<th>Maximum dimensions (m)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>A25</td>
<td>1.06 - 2.05</td>
<td>2.44</td>
<td>3.77</td>
</tr>
<tr>
<td>A50</td>
<td>1.82 - 3.51</td>
<td>3.19</td>
<td>4.94</td>
</tr>
<tr>
<td>A100</td>
<td>4.21 - 5.78</td>
<td>3.99</td>
<td>6.18</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice.
Neptune

The Neptune one-piece fin is built of fabricated materials, with a modified NACA section to maximise lift properties and minimise drag.

Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Fin Area (m²)</th>
<th>Maximum dimensions (m)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>N200</td>
<td>5.45 - 7.48</td>
<td>4.54</td>
<td>6.68</td>
</tr>
<tr>
<td>N300</td>
<td>7.00 - 9.62</td>
<td>5.14</td>
<td>7.54</td>
</tr>
<tr>
<td>N400</td>
<td>9.42 - 12.95</td>
<td>5.97</td>
<td>8.71</td>
</tr>
<tr>
<td>N500</td>
<td>12.5 - 17.19</td>
<td>6.88</td>
<td>9.96</td>
</tr>
<tr>
<td>N600</td>
<td>16.24 - 22.33</td>
<td>7.84</td>
<td>11.35</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
Stabilisation-at-rest

The stabilisation-at-rest system uses the proven and reliable Aquarius and Neptune ranges of retractable stabilisers. The system is ideal for medium to large yachts and is the world’s first to be made available with the benefits of retractable fins.

The fins can be folded away when not required to improve safety, maintain manoeuvrability in confined spaces or when travelling at high speed. With the fin retracted drag is negligible, and compared to the industry standard there is also less fin drag in the working condition.

`Active` fin control and advanced hydrodynamic design give outstanding roll reduction at anchor and the usual excellent performance whilst underway.

Key features:

- Kongsberg retractable stabilisers will deliver the required roll reduction with only a single pair of fins
- Fewer components and the sub-systems means reliability, and availability, with less maintenance
- Units normally fit into the main machinery space, with simple access for routine maintenance
- Electro-hydraulic actuation for low noise

Stabiliser fins have a larger surface area for optimum performance at rest.
Neptune stabilisation at rest stabiliser

Aquarius stabilisation at rest stabiliser

Technical data

<table>
<thead>
<tr>
<th>Model</th>
<th>Max. Fin Area (m²)</th>
<th>Maximum dimensions (m)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Aquarius</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A25</td>
<td>4.0</td>
<td>2.44</td>
<td>3.77</td>
</tr>
<tr>
<td>A50</td>
<td>4.79 - 6.1</td>
<td>3.19</td>
<td>4.94</td>
</tr>
<tr>
<td>A100</td>
<td>8.0 - 9.0</td>
<td>3.99</td>
<td>6.18</td>
</tr>
<tr>
<td>Neptune</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N200</td>
<td>9.0 - 12.0</td>
<td>4.54</td>
<td>6.60</td>
</tr>
<tr>
<td>N300</td>
<td>15.0</td>
<td>5.14</td>
<td>7.5</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
STEERING GEAR

Kongsberg supplies a complete range of steering gear – suitable for all ship sizes and types, including VLCCs, large container vessels, offshore and naval applications and built on a 60 year pedigree during which time more than 30,000 units have been delivered. All steering gears are delivered as a complete system, including hydraulic power units, control and alarm systems. We also see more navies and coastguards selecting our ‘COTS’ steering gear.

Rotary vane steering gears are very compact – they include integrated rudder carrier bearings (lubricated by the hydraulic system oil) and are typically 50 – 60 per cent the weight of some competing designs, with low noise and vibration. Operationally, rotary vane is widely selected as it ensures full torque is available at all rudder angles. It gives more flexibility in the design of the steering system as the steering gear is optimised for the type of rudder it will be used with. Units come in 2, 3 and 4 vane variants with 70, 45 and 35° rudder angles respectively.
**SR series**

The SR series is suitable for small to medium-sized vessels. The steering gear is designed with integrated frequency-controlled pumps. The pump utilises a reversible hydraulic pump motor together with a frequency converter to reduce the power consumption and to change the speed and the direction of the pump. The design gives smooth starting and stopping of the steering gear, and enables a precise analogue control system. The pump units are mounted directly on the rudder actuator, which lessens the need for piping work on board a vessel. Full frequency control means the pumps and motors are only running when a steering command is given, this reduces the amount of heat generated and leads to cleaner hydraulic system, improving the lifetime of components.

**Key features:**
- Compact
- Low weight
- Easy installation
- Easy maintenance
- High positioning accuracy
- No external moving parts
- Up to 70° rudder angle
- Available with steering control and rudder angle indicators as one complete system
- Built-in rudder carrier
- Polymer sealings internally for optimal tightness
- Simple and robust components

### Technical data

<table>
<thead>
<tr>
<th>Type</th>
<th>Std. rudder stock diameter (mm)</th>
<th>Max working pressure (bar)</th>
<th>Max working torque (kNm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR562L</td>
<td>120</td>
<td>54</td>
<td>16</td>
</tr>
<tr>
<td>SR562</td>
<td>160</td>
<td>133</td>
<td>40</td>
</tr>
<tr>
<td>SR622</td>
<td>200</td>
<td>125</td>
<td>70</td>
</tr>
<tr>
<td>SR642</td>
<td>240</td>
<td>125</td>
<td>110</td>
</tr>
<tr>
<td>SR662</td>
<td>280</td>
<td>125</td>
<td>170</td>
</tr>
<tr>
<td>SR722</td>
<td>300</td>
<td>125</td>
<td>275</td>
</tr>
<tr>
<td>SR723</td>
<td>320</td>
<td>125</td>
<td>412</td>
</tr>
<tr>
<td>SR742</td>
<td>340</td>
<td>125</td>
<td>433</td>
</tr>
<tr>
<td>SR743</td>
<td>360</td>
<td>125</td>
<td>650</td>
</tr>
</tbody>
</table>

All data subject to change without prior notice
SR series: 16 - 650kNm

<table>
<thead>
<tr>
<th>Max mechanical rudder angle (deg)</th>
<th>Weight approx. (kg)</th>
<th>Max radial load (kN)</th>
<th>Max axial load (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 61</td>
<td>400</td>
<td>175</td>
<td>104</td>
</tr>
<tr>
<td>2 x 61</td>
<td>400</td>
<td>175</td>
<td>104</td>
</tr>
<tr>
<td>2 x 71.5</td>
<td>620</td>
<td>400</td>
<td>200</td>
</tr>
<tr>
<td>2 x 72</td>
<td>920</td>
<td>600</td>
<td>250</td>
</tr>
<tr>
<td>2 x 72</td>
<td>1800</td>
<td>700</td>
<td>354</td>
</tr>
<tr>
<td>2 x 72</td>
<td>2750</td>
<td>855</td>
<td>370</td>
</tr>
<tr>
<td>2 x 44</td>
<td>2800</td>
<td>855</td>
<td>370</td>
</tr>
<tr>
<td>2 x 72</td>
<td>3700</td>
<td>1400</td>
<td>480</td>
</tr>
<tr>
<td>2 x 44</td>
<td>3750</td>
<td>1400</td>
<td>480</td>
</tr>
</tbody>
</table>
The RV series of steering gear is suitable for large and medium sized vessels and is available with 2, 3 and 4 vane options. A dual, submerged pump powerpack simplifies installation as no expansion tank is needed. Modulated flow control gives a soft start and precise control for small rudder movements. The IRV series incorporates a double sealing system, completely separating the actuator into two individual pressure systems. Automatic isolation of the actuator’s dual hydraulic system is a feature to meet IMO single failure criteria for large tankers over 100,000dwt. They can be supplied with steering controls, CANBUS alarm system and rudder angle indicators.

**RV/IRV 2 & 3 vane: 430 – 3916kNm**

**Key features:**
- Rudder angles 35 - 70°
- Complies with IMO regulations
- Compact and lightweight
- Installation with reamer bolts or stoppers
- Modulated flow for precise rudder movements

2-Vane:
up to 70° rudder angle

3-Vane:
up to 45° rudder angle
RV/IRV 4 vane: 845 – 6550kNm

**Key features:**
- Compact size
- Excellent power-to-weight ratio
- Simplified maintenance: 4-piece split bearings and seals on base and cover
- Integrated storage tank and rudder carrier
- Full overhaul possible without removing the rudder stock connection for steering gear sizes of RV2600-4 and over

An integrated lifting device enables access to all bearings and seals without loosening the rudderstock connection.
## Technical data

<table>
<thead>
<tr>
<th>SG fam</th>
<th>SG type</th>
<th>Max rudder stock diameter (mm)</th>
<th>Max mech. rudder angle (*)</th>
<th>Max working pressure (bar)</th>
<th>Design torque theoretical (kNm)</th>
<th>Max working torque (kNm)</th>
<th>Theoretical loss (kNm)</th>
<th>Theoretical loss (%)</th>
<th>Net WT (kNm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RV450-2</td>
<td>360</td>
<td>2x71,5</td>
<td>80</td>
<td>537</td>
<td>430</td>
<td>49</td>
<td>11,4</td>
<td>381</td>
</tr>
<tr>
<td>A</td>
<td>RV550-2</td>
<td>370</td>
<td>2x71,5</td>
<td>80</td>
<td>710</td>
<td>568</td>
<td>53</td>
<td>9,3</td>
<td>515</td>
</tr>
<tr>
<td>A</td>
<td>RV650-3</td>
<td>390</td>
<td>2x46,5</td>
<td>80</td>
<td>805</td>
<td>644</td>
<td>51</td>
<td>7,9</td>
<td>593</td>
</tr>
<tr>
<td>B</td>
<td>RV700-2</td>
<td>410</td>
<td>2x71,5</td>
<td>80</td>
<td>846</td>
<td>677</td>
<td>73</td>
<td>10,8</td>
<td>604</td>
</tr>
<tr>
<td>A</td>
<td>RV850-3</td>
<td>420</td>
<td>2x46,5</td>
<td>80</td>
<td>1066</td>
<td>853</td>
<td>56</td>
<td>6,6</td>
<td>797</td>
</tr>
<tr>
<td>-</td>
<td>RV850-4</td>
<td>390</td>
<td>2x36,5</td>
<td>170</td>
<td>1058</td>
<td>846</td>
<td>70</td>
<td>8,3</td>
<td>776</td>
</tr>
<tr>
<td>B</td>
<td>RV900-2</td>
<td>450</td>
<td>2x71,5</td>
<td>80</td>
<td>1093</td>
<td>874</td>
<td>78</td>
<td>8,9</td>
<td>796</td>
</tr>
<tr>
<td>B</td>
<td>RV1050-3</td>
<td>450</td>
<td>2x46,5</td>
<td>80</td>
<td>1269</td>
<td>1015</td>
<td>75</td>
<td>7,4</td>
<td>940</td>
</tr>
<tr>
<td>-</td>
<td>RV1050-4</td>
<td>420</td>
<td>2x36,5</td>
<td>170</td>
<td>1311</td>
<td>1065</td>
<td>87</td>
<td>8,2</td>
<td>978</td>
</tr>
<tr>
<td>C</td>
<td>RV1100-2</td>
<td>510</td>
<td>2x71,5</td>
<td>80</td>
<td>1368</td>
<td>1094</td>
<td>143</td>
<td>13,1</td>
<td>951</td>
</tr>
<tr>
<td>B</td>
<td>RV1350-3</td>
<td>495</td>
<td>2x46,5</td>
<td>80</td>
<td>1640</td>
<td>1312</td>
<td>82</td>
<td>6,3</td>
<td>1230</td>
</tr>
<tr>
<td>B</td>
<td>RV1400-2</td>
<td>500</td>
<td>2x71,5</td>
<td>80</td>
<td>1765</td>
<td>1412</td>
<td>91</td>
<td>6,4</td>
<td>1321</td>
</tr>
<tr>
<td>-</td>
<td>RV1450-4</td>
<td>470</td>
<td>2x36,5</td>
<td>170</td>
<td>1796</td>
<td>1437</td>
<td>108</td>
<td>7,5</td>
<td>1329</td>
</tr>
<tr>
<td>C</td>
<td>RV1650-3</td>
<td>550</td>
<td>2x46,5</td>
<td>80</td>
<td>2052</td>
<td>1641</td>
<td>140</td>
<td>8,5</td>
<td>1501</td>
</tr>
<tr>
<td>C</td>
<td>RV1700-2</td>
<td>560</td>
<td>2x71,5</td>
<td>80</td>
<td>2136</td>
<td>1708</td>
<td>156</td>
<td>9,1</td>
<td>1552</td>
</tr>
<tr>
<td>-</td>
<td>RV1850-4</td>
<td>510</td>
<td>2x36,5</td>
<td>170</td>
<td>2325</td>
<td>1860</td>
<td>132</td>
<td>7,1</td>
<td>1728</td>
</tr>
<tr>
<td>D</td>
<td>RV/IRV2050-2</td>
<td>580</td>
<td>2x71,5</td>
<td>80</td>
<td>2536</td>
<td>2029</td>
<td>163</td>
<td>8,0</td>
<td>1866</td>
</tr>
<tr>
<td>C</td>
<td>RV2600-3</td>
<td>620</td>
<td>2x46,5</td>
<td>80</td>
<td>3204</td>
<td>2563</td>
<td>160</td>
<td>6,2</td>
<td>2403</td>
</tr>
<tr>
<td>-</td>
<td>RV/IRV2600-4</td>
<td>580</td>
<td>2x36,5</td>
<td>170</td>
<td>3232</td>
<td>2586</td>
<td>284</td>
<td>11,0</td>
<td>2302</td>
</tr>
<tr>
<td>D</td>
<td>RV/IRV2700-2</td>
<td>650</td>
<td>2x71,5</td>
<td>80</td>
<td>3333</td>
<td>2666</td>
<td>176</td>
<td>6,6</td>
<td>2490</td>
</tr>
<tr>
<td>E</td>
<td>RV/IRV3050-2</td>
<td>700</td>
<td>2x71,5</td>
<td>80</td>
<td>3780</td>
<td>3024</td>
<td>206</td>
<td>6,8</td>
<td>2818</td>
</tr>
<tr>
<td>D</td>
<td>RV3050-3</td>
<td>660</td>
<td>2x46,5</td>
<td>80</td>
<td>3804</td>
<td>3043</td>
<td>170</td>
<td>5,6</td>
<td>2873</td>
</tr>
<tr>
<td>-</td>
<td>RV/IRV3900-4</td>
<td>670</td>
<td>2x36,5</td>
<td>170</td>
<td>4853</td>
<td>3882</td>
<td>388</td>
<td>10,0</td>
<td>3494</td>
</tr>
<tr>
<td>D</td>
<td>RV4000-3</td>
<td>700</td>
<td>2x46,5</td>
<td>80</td>
<td>5000</td>
<td>4000</td>
<td>191</td>
<td>4,8</td>
<td>3809</td>
</tr>
<tr>
<td>E</td>
<td>RV/IRV4200-2</td>
<td>730</td>
<td>2x71,5</td>
<td>80</td>
<td>5250</td>
<td>4200</td>
<td>229</td>
<td>5,5</td>
<td>3971</td>
</tr>
<tr>
<td>-</td>
<td>RV/IRV5500-4</td>
<td>750</td>
<td>2x36,5</td>
<td>170</td>
<td>6872</td>
<td>5498</td>
<td>495</td>
<td>9,0</td>
<td>5003</td>
</tr>
<tr>
<td>-</td>
<td>RV/IRV6550-4</td>
<td>800</td>
<td>2x36,5</td>
<td>170</td>
<td>8206</td>
<td>6565</td>
<td>591</td>
<td>9,0</td>
<td>5974</td>
</tr>
</tbody>
</table>

* Only accepted for maximum rudderstock diameter
<table>
<thead>
<tr>
<th>Model</th>
<th>Max radial load (kN)</th>
<th>Max axial load (kN)</th>
<th>Swept volume (l/min)</th>
<th>Pump (l/min)</th>
<th>With (mm)</th>
<th>Height (mm)</th>
<th>Weight approx. (kg)</th>
<th>Max working pressure, ABS (bar)</th>
<th>Net working torque, ABS (kNm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A RV450-2</td>
<td>360</td>
<td>2x71,5</td>
<td>80</td>
<td>537</td>
<td>430</td>
<td>49</td>
<td>11,4</td>
<td>381</td>
<td>1400</td>
</tr>
<tr>
<td>A RV550-2</td>
<td>370</td>
<td>2x71,5</td>
<td>80</td>
<td>710</td>
<td>568</td>
<td>53</td>
<td>9,3</td>
<td>515</td>
<td>1400</td>
</tr>
<tr>
<td>A RV650-3</td>
<td>390</td>
<td>2x46,5</td>
<td>80</td>
<td>805</td>
<td>644</td>
<td>51</td>
<td>7,9</td>
<td>593</td>
<td>1400</td>
</tr>
<tr>
<td>B RV700-2</td>
<td>410</td>
<td>2x71,5</td>
<td>80</td>
<td>846</td>
<td>677</td>
<td>73</td>
<td>10,8</td>
<td>604</td>
<td>1800</td>
</tr>
<tr>
<td>A RV850-3</td>
<td>420</td>
<td>2x46,5</td>
<td>80</td>
<td>1066</td>
<td>853</td>
<td>56</td>
<td>6,6</td>
<td>797</td>
<td>1400</td>
</tr>
<tr>
<td>- RV850-4</td>
<td>390</td>
<td>2x36,5</td>
<td>170</td>
<td>1058</td>
<td>846</td>
<td>70</td>
<td>8,3</td>
<td>776</td>
<td>500</td>
</tr>
<tr>
<td>B RV900-2</td>
<td>450</td>
<td>2x71,5</td>
<td>80</td>
<td>1093</td>
<td>874</td>
<td>78</td>
<td>8,9</td>
<td>796</td>
<td>1800</td>
</tr>
<tr>
<td>B RV1050-3</td>
<td>450</td>
<td>2x46,5</td>
<td>80</td>
<td>1269</td>
<td>1015</td>
<td>75</td>
<td>7,4</td>
<td>940</td>
<td>1800</td>
</tr>
<tr>
<td>- RV1050-4</td>
<td>420</td>
<td>2x36,5</td>
<td>170</td>
<td>1331</td>
<td>1065</td>
<td>87</td>
<td>8,2</td>
<td>978</td>
<td>600</td>
</tr>
<tr>
<td>C RV1100-2</td>
<td>510</td>
<td>2x71,5</td>
<td>80</td>
<td>1368</td>
<td>1094</td>
<td>143</td>
<td>13,1</td>
<td>951</td>
<td>3000</td>
</tr>
<tr>
<td>B RV1350-3</td>
<td>495</td>
<td>2x46,5</td>
<td>80</td>
<td>1640</td>
<td>1312</td>
<td>82</td>
<td>6,3</td>
<td>1230</td>
<td>1800</td>
</tr>
<tr>
<td>B RV1400-2</td>
<td>500</td>
<td>2x71,5</td>
<td>80</td>
<td>1765</td>
<td>1412</td>
<td>91</td>
<td>6,4</td>
<td>1321</td>
<td>1800</td>
</tr>
<tr>
<td>- RV1450-4</td>
<td>470</td>
<td>2x36,5</td>
<td>170</td>
<td>1796</td>
<td>1437</td>
<td>108</td>
<td>7,5</td>
<td>1329</td>
<td>600</td>
</tr>
<tr>
<td>C RV1650-3</td>
<td>550</td>
<td>2x46,5</td>
<td>80</td>
<td>2052</td>
<td>1641</td>
<td>140</td>
<td>8,5</td>
<td>1501</td>
<td>3000</td>
</tr>
<tr>
<td>C RV1700-2</td>
<td>560</td>
<td>2x71,5</td>
<td>80</td>
<td>2136</td>
<td>1708</td>
<td>156</td>
<td>9,1</td>
<td>1552</td>
<td>3000</td>
</tr>
<tr>
<td>- RV1850-4</td>
<td>510</td>
<td>2x36,5</td>
<td>170</td>
<td>2325</td>
<td>1860</td>
<td>132</td>
<td>7,1</td>
<td>1728</td>
<td>700</td>
</tr>
<tr>
<td>D RV/IRV2050-2</td>
<td>580</td>
<td>2x71,5</td>
<td>80</td>
<td>2536</td>
<td>2029</td>
<td>163</td>
<td>8,0</td>
<td>1866</td>
<td>3000</td>
</tr>
<tr>
<td>C RV2600-3</td>
<td>620</td>
<td>2x46,5</td>
<td>80</td>
<td>3204</td>
<td>2563</td>
<td>160</td>
<td>6,2</td>
<td>2403</td>
<td>3000</td>
</tr>
<tr>
<td>- RV/IRV2600-4</td>
<td>580</td>
<td>2x36,5</td>
<td>170</td>
<td>3232</td>
<td>2586</td>
<td>284</td>
<td>11,0</td>
<td>2302</td>
<td>700</td>
</tr>
<tr>
<td>D RV/IRV2700-2</td>
<td>650</td>
<td>2x71,5</td>
<td>80</td>
<td>3333</td>
<td>2666</td>
<td>176</td>
<td>6,6</td>
<td>2490</td>
<td>3000</td>
</tr>
<tr>
<td>E RV/IRV3050-2</td>
<td>700</td>
<td>2x71,5</td>
<td>80</td>
<td>3780</td>
<td>3024</td>
<td>206</td>
<td>6,8</td>
<td>2818</td>
<td>3000</td>
</tr>
<tr>
<td>D RV3050-3</td>
<td>660</td>
<td>2x46,5</td>
<td>80</td>
<td>3804</td>
<td>3043</td>
<td>170</td>
<td>5,6</td>
<td>2873</td>
<td>3000</td>
</tr>
<tr>
<td>- RV/IRV3900-4</td>
<td>670</td>
<td>2x36,5</td>
<td>170</td>
<td>4853</td>
<td>3882</td>
<td>388</td>
<td>10,0</td>
<td>3494</td>
<td>900</td>
</tr>
<tr>
<td>D RV4000-3</td>
<td>700</td>
<td>2x46,5</td>
<td>80</td>
<td>5000</td>
<td>4000</td>
<td>191</td>
<td>4,8</td>
<td>3809</td>
<td>3000</td>
</tr>
<tr>
<td>E RV/IRV4200-2</td>
<td>730</td>
<td>2x71,5</td>
<td>80</td>
<td>5250</td>
<td>4200</td>
<td>229</td>
<td>5,5</td>
<td>3971</td>
<td>3000</td>
</tr>
<tr>
<td>- RV/IRV5500-4</td>
<td>750</td>
<td>2x36,5</td>
<td>170</td>
<td>6872</td>
<td>5498</td>
<td>495</td>
<td>9,0</td>
<td>5003</td>
<td>1250</td>
</tr>
<tr>
<td>- RV/IRV6550-4</td>
<td>800</td>
<td>2x36,5</td>
<td>170</td>
<td>8206</td>
<td>6565</td>
<td>591</td>
<td>9,0</td>
<td>5974</td>
<td>1250</td>
</tr>
</tbody>
</table>
116 KONGSBERG – STABILISATION AND MANOEUVRING
RUDDERS

Kongsberg has over 20 years experience in rudder design and cavitation prediction. With experience drawn from the Kongsberg Hydrodynamic Research Centre and in-house Hydrodynamics specialists, advanced computer programmes have been developed to simulate manoeuvres to evaluate different rudder sizes and types to optimise the rudder design for each vessel.
Conventional spade rudders

Type: CB / CM / CS

This range of rudders is built as full spade rudders, with three different standard profiles and no rudder angle limitation, to ensure optimal manoeuvrability for passenger, cargo vessels and high-speed craft. The medium and slim profiles can be combined with a twisted leading-edge for improved efficiency and reduced cavitation risk.
Type Cb

**Type CB:**
for lower speeds
A bulbous profile and large vane end plates improve low speed manoeuvrability. It shares the same profile as the FB flap rudder and is typically used for offshore supply, cargo, fishing and seismic vessels.

**Options:**
- Heel connection module
- Wire Guard

Type CM

**Type CM:**
for medium speeds
The profile is optimised to provide good manoeuvrability with propulsive efficiency, with a tapered or rectangular blade, meeting the rudder needs of passenger and cargo vessels.

**Options:**
- Twisted leading edge
- Wire Guard

Type CS

**Type CS:**
for higher speeds
The slim profile increases overall propulsive efficiency and reduces cavitation risk. The blade is tapered with rounded corners. It has the same profile as the FS flap rudder.

**Options:**
- Twisted leading edge
- Wire Guard
Flap rudders

Type: FB / FM / FS

Kongsberg has developed and built flap rudders since the 1980s. The performance of a flap rudder is determined both by the flap, the link mechanism and the profile, as well as the hull and the propeller. Kongsberg has therefore designed a range of flap rudders suitable for different types of vessels and functions, to ensure customers receive a rudder best suited to their vessel’s operating requirements.
Type FB: for low to medium speeds
This rudder has a bulbous profile for maximum manoeuvring performance. The design also has large upper and lower vane plates. It is ideal for use on workboats, fishing vessels, offshore vessels, small tankers, cargo vessels, ferries and other coastal vessels.

Options:
- Heel connection module
- Wire Guard

Type FM: for medium speeds
Designed with a moderate profile for enhanced manoeuvrability and propulsive efficiency.

Options:
- Twisted leading edge
- Wire Guard

Type FS: for medium to high speeds
A slim profile that is purpose-designed to suit the vessel. The rudder is built around a cast cone module and has a robust link mechanism and hinge system to withstand the high forces. It is also an ideal all-round flap rudder suitable for a wide range of vessel types.

Options:
- Twisted leading edge
- Wire Guard

Trunk type: extended, with steering gear foundation or standard
- Designed for minimum installation time and cost
- Tailor-made for each vessel
- The extended trunk is available with or without fairwater/shell plating
Kongsberg offers an unrivalled range of deck machinery products and systems, ranging from cost effective winches for mooring and anchoring vessels to specialised winches, cranes and handling systems for offshore, tugs, naval ships and many other types of vessel.

Throughout, the focus is on safety and efficiency.
The safest possible working environment for operators

Kongsberg is an experienced supplier to the offshore supply and service fleet.

Complete deck machinery packages cover the vessel’s own mooring and anchoring requirements. These are tailormade from standardised modular components, with all types of drive, electric or hydraulic, to suit the customer’s preferences, and include anchor windlasses, mooring winches, warping drums and capstans.

Dry bulk tank installations are designed and supplied, with dome or cone shaped tanks for cement, barite and bentonite and an easily operated control and monitoring system. Tanks for other types of liquids such as brine, drilling mud and special cargoes are incorporated in the structure of Kongsberg designed vessels.

Safer Deck Operations are the focus, and we provide a variety of equipment that helps make life safer for crew working on deck. Remote controlled cranes running on tracks along the cargo rails command the working deck, allowing cargo to be taken over the ship’s side or stern from the quay and positioned accurately and safely. ASFA, the automated sea fastening system then uses chocks running on recessed tracks in the deck to move and secure containers or other deck cargo such as pipes firmly in place so that they cannot shift in rough seas.

The newly developed safer hose operating system with retractable hooks on the side of the PSV captures and controls rig hoses, removing the crew from hazardous locations.
The safer hose operating system with retractable hooks on the side of the PSV captures and controls rig hoses, eliminating a former risky manual operation.

The DDC crane have a very large operating envelope for efficient performance when loading and off loading. The crew use the remote control system to place cargo safely anywhere on deck.
Deck machinery for offshore anchor handling tug supply vessels (AHTS)

Kongsberg is the leader in developing the very large anchor handling/ towing winches that are the heart of an AHTS. They are made with capacities of more than 600 tonnes pull, and with drums capable of spooling wire rope for the deepest water moorings. These winches and the control winch system are suitable for all sizes of anchor handlers, and the winches are tailored to the specific vessel and its operations.

Selection of anchor handling winches

**5 - 8000 bhp**
Pull capacity: <150 tonnes

**8 - 12000 bhp**
Pull capacity: 150 - 300 tonnes

**12 - 18000 bhp**
Pull capacity: 300 - 400 tonnes

**18 - 20000 bhp**
Pull capacity: 400 - 500 tonnes

**> 20000 bhp**
Pull capacity: 400 - 600 tonnes

Drive options

Our experience shows that the key feature of an AHT winch is rapid dynamic response. Our low pressure hydraulic driven winches are established favourites because of their excellent dynamic performance. The newly developed E26 proportional pressure compensated valve offers even more precise and responsive load independent speed control, more accurate tension control and load sensing and less complex piping installation for the shipyard. A hybrid solution has also been developed where the normal loads are covered by AC asynchronous electric motors but with a hydraulic supplement providing quick response to load peaks. We are also introducing permanent magnet motors, which have similar dynamic capabilities and controllability as for the low-pressure hydraulic system for customers who prefer all-electric systems.
The illustration indicates many items of equipment from the Safer Deck Operation portfolio designed to enhance crew safety.

Product key

1. Winch control system and winch chair
2. Secondary and storage winches
3. Anchor handling cranes with manipulator and wire twister
4. Anchor launch and recovery system
5. Tugger winches
6. Rope tensioner
7. Spooling sheave
8. Stern rollers
9. Safer pennant receiver
10. Shark jaw, towing pins, centring device and stop pins
11. Spooling device for under deck reels
12. Storage winches
13. Safer hose operation system
14. Chain guides
15. Pennant winder
16. Cable lifter changer and storage rack
17. Chain hauling winch
18. Anchor handling/Towing winches
19. Tugger winch
20. Special handling winches
21. Spooling devices
22. Launch and recovery system for ROVs
23. Windlass/mooring winch

We offer three drive options

Hybrid electric/low pressure. E26 low pressure system. PM motor drive system.
Automated handling systems for subsea vessels

Deepwater installation will continue to grow strongly and the number of wells in waters of more than 1500 metres depth will increase substantially in coming years.

Kongsberg provides a full range of multi-purpose aft-deck systems for vessels involved in inspection maintenance and repair (IMR) and construction work. Our solutions have been developed to enhance operational efficiency of our customers. Features such as active heave compensation, enable vessels to execute operations in harsh weather conditions, significantly increasing the operability of our systems.

A principal item of equipment is the Kongsberg module handling towers centred on the vessel’s moon pool. The tower structure and integrated equipment is very often customised to dedicated ships or operations, but always ensure safe and easy access to subsea equipment when on deck and horizontal guiding of the equipment during launch and recovery through the moon pool. Our skid systems, consisting of pallets and tractors, ensure that modules can be transported safely between the tower and back deck without the need for lifting. The tower can utilise either traditional wire rope or low weight synthetic fibre rope, both with high performance and accurate heave compensation.

Active heave compensated subsea cranes are now available with fibre rope using the CTCU and storage drum combination.

Launch and recovery systems for ROVs
• Accurate active heave compensation
• Side launch and moon pool launch
• Gentle handling of third party equipment
• Automatic launch and recovery to a given target depth at a given target speed
• Hydraulic or AC-driven
The unique and patented CTCU technology allows the traditional steel wire rope to be replaced with synthetic fibre rope for lifting purposes. Five frame sizes of CTCU are offered, spanning safe working loads from 30 to 250 tonnes giving nearly 500 tonnes lift in a two-fall system.

Remotely operated vehicles play a key role in subsea operations, and our extensive portfolio focuses primarily on active heave compensated systems. The LARS is designed to handle the largest work class ROVs to depths exceeding 4000 metres, deployed over the side or through the moon pool. Our systems are designed, built and certified with high focus on gentle handling of umbilical and third party equipment.

Our integrated crane solutions are specially developed to meet the challenges of maritime handling operations. The cranes are fully integrated with our deck machinery handling and control systems and offer unparalleled performance as well as reliability and comfort. For general handling of offshore equipment we offer dual draglink cranes with capacities from 35 to 75 tonnes, and knuckle boom cranes in the range from 150 to 250 tonnes.
Kongsberg innovative, automated handling systems for seismic vessels are the most reliable on the market. Over the years, these handling systems have continuously improved the efficiency and safety of seismic operations and have become industry standards. We have widened the operational window, reducing time lost due to rough weather conditions and boosting profitability significantly. Our equipment simply works when you need it. This is part of our focus on providing reliability for our customers.

We are involved throughout the value chain of seismic systems and are engaged early in the design of seismic handling solutions. We collaborate closely with customers to design the ship’s entire aft deck, developing comprehensive solutions to the specified needs of each vessel. Layout of winches and other equipment can be configured to suit both conventional and innovative vessel designs and any number of streamers.

Our automated handling concepts are made up of unique components, all of which are designed and delivered by Kongsberg as individual products or built up into complete systems.

Hydraulic or electric streamer winches provide gentle and sensitive handling of streamers, with drum capacities to cover all length requirements. These are complemented by source and deflector handling systems, fairleads and the wide tow system.

As well as streamer and source handling systems for 2D and 3D seismic survey, we provide deep water ocean bottom seismic systems for vessels performing ocean bottom seismic, both cable and node types, also CSEM solutions for electromagnetic surveys.

The result is cutting-edge solutions that strengthen the efficiency of the vessel and create a safer ship for the crew. For example, our control system, a result of decades of experience in developing such systems, allows operators to direct and synchronise all winches, streamers and...
auxiliary equipment by remote radiocontrol. This user-friendly system, which features automatic spooling, reduces the need for risky manual handling on the aft deck.

We offer both simulator training for operators and combined workshop and classroom training on handling system maintenance.
Automated handling systems for oceanographic vessels

Kongsberg assists the work of an oceanographic research vessel in deploying scientific equipment from the stern or side of the ship to sample the water column, investigate life in the sea or on the seabed, and examine the geology of the ocean floor. The oceanographic equipment puts a variety of demands on the handling system. Some items are towed behind the vessel, some are lowered and lifted, others are dropped freely and then hauled up.

We typically provide a suite of specialised winches and fairleads, A-frames and side gantries, and specialised tools for safely setting out and recovering items of scientific equipment. Combined with an integrated state of the art control system, this ensures efficient operations, careful handling of in-sea equipment and increases safety.

Systems are designed to suit the particular ship, creating optimum solutions with respect to both operational needs and available space. By working together with the customers and ship designers, this ensures systems are reliable and optimised for the ship’s tasks and missions.

With the unique and patented Cable Traction Control Unit (CTCU) technology, the traditional steel wire rope can be replaced with fibre rope. The usefulness of a steel wire rope at depths greater than 4000 metres is limited, whereas the fibre rope has the same capacity at all depths. For example coring operation at depths below 4000 metres can be efficiently performed with the CTCU. The compact version of the CTCU has a pulling capacity up to 30 tonnes, and rope lengths up to 12,000 metres can be accommodated. CTCU systems with pulling capacity up to 150 tonnes can be delivered.

We offer frames for handling hydrographic equipment over the stern with ratings up to 30 tonnes, an outreach of 4.5 metres and a clear lifting height of 8 metres.

Other equipment includes parallelogram frames for side launching and recovery, deep tow and deep water coring systems, handling equipment for piston coring, with the associated active heave compensated winch systems.

The CTCU has separate drive to each sheave. Individual speed control ensures that there is no slip on the sheaves. Modes and features like active heave compensation, constant tension, pull limit and automatic landing/ lift-off are available.
In very deep water fibre rope offers more lift capacity for a given winch size.
Position mooring for exploration and production

Kongsberg provides a complete range of deck machinery for floating production, drilling and accommodation rigs in the offshore oil and gas industry.

Our product range comprises push/pull chain jacks, traction winch, anchor-chain winch, wire drum and combination winches (wire/anchor-chain) for position mooring systems. In addition, Kongsberg supplies fairleads of trunion or hinged design, chain stoppers or the combined fairlead and stopper. Most of the products are delivered with control and monitoring systems for safe handling and operation, meeting the highest regulatory requirements.

The various winches can be supplied with low-pressure hydraulic, high-pressure hydraulic or electric drive.

Kongsberg has a reputation of supplying high-quality and reliable machinery for safe operation in all climate zones, including harsh environment and winterisation. Many of our innovative solutions are the result of continuous close cooperation with customers.

Being a total supplier with in-house design and production of all major items, Kongsberg provides a single point of contact, enabling us to develop the best solutions for every task.
Typical applications:
• Semi-submersible
• Drilling rigs
• Accommodation rigs
• Pipe-laying barges
• Drill ships
• Crane vessels
Floating production storage and off loading unit (FPSO)

FPSOs are often positioned on smaller or inaccessible fields, taking oil from wells and storing it on board until it can be offloaded into shuttle tankers for transport to shore terminals. They need to be securely moored over the well and for this Kongsberg provides reliable deck machinery tailored to the customer’s needs.

In a movable windlass installation each of the moorings lines has its own fairlead and stopper. A single windlass moves along the frame to tension each chain in turn, the stoppers are actuated and locked on to the chain, transferring the mooring loads to the hull. An alternative system has a triple windlass, one lifter to each mooring, with associated stoppers and fairleads.

Spar platforms have the working decks supported by a buoyant column ballasted at the bottom to keep it vertical. It is secured on location by a spread mooring system. Fairleads are mounted around the column and the chains are tensioned by chain jacks that haul the chain up and lock it at the desired position. The system is supplemented by hydraulic power packs, a control and monitoring system with load measurement, and control consoles.

Our windlass solutions can be delivered as an all electric winch, a feature that helps our customer’s to remove unnecessary oil on deck. The fairlead is designed according to the customer’s chain requirement.
The chain jack is scalable to suit the customer’s required chain size and can be delivered with both push and pull cylinders.

Typical applications:
- FPSO
- FPU
- FPSS
- FLNG
- Spar
Fishing solutions

Kongsberg deck machinery offers a complete winch, control and monitoring system for ocean-going fishing vessels. We have high focus on safety, quality and user friendliness, and offers customised winch systems according to requirement.

Customers can choose between two drive systems:

- Low pressure hydraulic winch system, with electric frequency drive on towing pumps
- Electric winch system, with permanent magnet (PM) motors on trawl winches

Both drive systems have been developed to achieve the best possible dynamic properties in challenging conditions, which is especially important for bottom trawling where the trawl can get stuck in the seabed. In bad weather the system keeps the trawl gear in the best position to fish efficiently and reduces wear and tear on equipment.

BRH64 low pressure hydraulic winches are constructed with high torque low speed motors based on 64 bar pressure. Advantages include quiet operation and low maintenance cost. BRH64 gives high dynamic shooting speed, which gives you good and safe control of the operation. The towing pumps can be powered by frequency drive which gives variable rpm on the electric motors to suit the oil flow demands of the hydraulic motors. This gives reduced fuel consumption, less wear and tear and even quieter running. We can offer winches with pull from 3 to 74 tonnes without gear transmission, and winches from 75 to 150 tonnes with a small reduction gear ratio.

On electric trawl winches we are now using PM motors. With this technology we are able to remove the gear unit, achieving unique dynamic properties also in the electric trawl winches. Drives are either air cooled or water cooled, and can be integrated in the vessel’s main switchboard or SG to utilise the regenerative power.

Electric fishing winch systems are also available with standard AC motors and planetary or parallel gear transmission.

The trawl winch with PM motor has a pull capacity up to 50 tonnes with one motor.

The trawl winch with low pressure hydraulic motor has a pull capacity up to 50 tonnes with one motor.
Product key

1. Net sounder winches
2. Auxiliary winches
3. Auxiliary winches
4. Capstan winches
5. Capstan winches
6. Trawl winches
7. Net drum winches
8. Gilson winches
9. Sweep line winches
10. Anchor and mooring winches

Autotrawl system

The Synchro RTX Autotrawl system provides dynamic control of single-rig and twin-rig bottom trawling, pelagic trawling and pair trawling. The trawl system is one of the most advanced on the market, using integrated safety logic and a user-friendly interface. Essential control and monitoring functions are fully integrated, giving major benefits during commissioning and operation. This system keeps the trawls fully open when changing course during trawling. The trawl is kept moving at constant speed, even under difficult conditions. If the trawl snags, the system pays out wire automatically to prevent damage.

The Synchro RTX Autotrawl is the optimum solution for maximising catching ability for single and double trawls. The system is based on the latest technology, providing excellent stability, simple operation and great flexibility.
Towing winch systems for tugs

Kongsberg has a portfolio of towing and escort winches developed specifically for tug operations. Hydraulic drives can be specified with power from the engine PTO or with electro-hydraulic power packs, and full electric winches have frequency control.

An Escort/Harbour tug will typically have a Kongsberg main winch on the foredeck and towing winch on the aft deck to enable it to carry out its main tasks efficiently: braking or steering the escorted vessel out of danger in case of technical failure, acting as an additional rudder for the assisted vessel, or general harbour assist and deep sea towing. Winches are designed and sized to suit the operational needs. Towing winches cover pulls from 10 to 150 tonnes, with waterfall winches extending the pull range to 300 tonnes. Our escort tug winches are designed to provide the sensitive control needed for this type of work, with pulls up to 150 tonnes and also rendering tensions in the range 10 to 200 tonnes. With AC or permanent magnet motors and frequency control they can provide rendering and recovery powers up to 1100kW.

All come with wheelhouse control and monitoring stations that display all the key data. The quality, robust construction and flexibility of these winches have made them firm favourites with major tug operators around the world. Furthermore, the equipment from our towing winch portfolio is well suitable for icebreakers operating in arctic conditions as well as to any vessel suitable for emergency towing operation, like coastal and multi-purpose vessels.

Product key

1 Towing winch
2 Escort winch

Towing winches
Pull capacity: 10 to 150 tonnes.

Hydraulic Escort winches
Pull capacity: 10 to 150 tonnes.
Rendering capacity: 15 to 200 tonnes.

Electrical Escort winches
Pull capacity: 10 to 150 tonnes.
Rendering capacity: 15 to 200 tonnes.
Anchoring and mooring winches

The Kongsberg modular concept, provided with low-pressure hydraulic, high-pressure hydraulic, frequency converter or pole change drives, offers tailor-made anchoring and mooring winches made up from standard modules. The production process enables flexibility and efficiency in customer applications as well as in delivery times. Further benefits are high quality, elimination of prototype risks, variety of layout and low life-cycle costs.

Both mechanical- and system designs are our own, and the Kongsberg team controls the whole delivery process. The equipment is tested in our assembly workshops before delivery.

Example of high-pressure hydraulic mooring winch.
Example of low-pressure hydraulic mooring winch.
Example of combined windlass/mooring winch fitted with electric drive and chain stopper unit.
Multifunctional cargo rail cranes

Cargo rail cranes have been developed to improve safety on deck, where the crew have to handle heavy moorings and deck cargo at sea. Rail cranes equipped with various manipulators are an integral part of this, enabling the crew to conduct operations on any part of the working deck by remote control from a safe location.

Working on the deck of an anchor-handler poses a risk to life and limb. To reduce this risk, the cargo rail cranes are equipped with comprehensive systems for handling ropes, wires, chains and shackles, which may be under great tension, with the minimum of manual work on deck.

Cargo rail crane with tool
The cargo rail cranes are used for safer deck operation.

Dual draglink crane for cargo handling
The Dual draglink cargo rail crane has a lifting range up to 10 tonnes.
Subsea cranes

Our integrated crane solutions are specially developed to meet the challenges of maritime handling operations. The cranes are fully integrated with our deck machinery handling and control systems and offer unparalleled performance as well as reliability and comfort. Through our cable traction control technology using fibre rope, our cranes can operate at virtually unlimited depths.

Fibre rope cranes

A range of offshore cranes up to 400 tonnes load using field proven Kongsberg fibre rope handling technology is now launched. The crane structure have been adapted to handle fibre rope, utilizing the field proven CTCU (cable traction control unit) which forms the crane winch, provides active heave compensation and stores the rope on a reel. This system has a proven track record of more than 10 years. Particular attention has been made to ease of access and maintenance of all main components.

The dual draglink hybrid crane can handle both fibre rope and steel wire and has a geometry providing unique lifting performance. The drag link geometry provides a good working height and allows for short radius operations to make use of the deck area near the pedestal. The horizontal boom provides active heave compensation (AHC), significantly increasing the life time of the lifting line compared to when AHC is performed by means of the winch.

The knuckle boom cranes are available for both wire and fibre rope with active heave compensation (AHC), and comes with main winch as back-pack or below deck arrangement. They are the product of our long experience and our constant drive for improvement, and has proven superb performance and reliability in service.
ELECTRICAL POWER SYSTEMS

The Kongsberg electrical capability incorporates a wide portfolio of skills, products and competencies that range from electric propulsion systems design and supply to turnkey contracts for the supply of onboard electrical power distribution and control packages. Systems development activities are supported by state-of-the-art simulation and modelling capabilities. As system integrators we manage the complete process from concept design to through life support ensuring the delivery of flexible and efficient solutions that meet all major classification society requirements.

We act as a prime contractor for the onboard power generation, electric-propulsion, LV electrical power distribution and automation/control packages. As we integrate the system with the power and propulsion products, they are designed to work together as an efficient system providing the best in performance.
Kongsberg provides a range of services spanning the full life-cycle of marine systems and equipment, from concept to disposal. Electrical power systems and electrical/mechanical hybrid propulsion concepts have been developed and installed on a wide range of vessels.

Kongsberg has a pedigree in the design and supply of electrical systems and is capable of taking the lead in the design and supply of vessel power systems in excess of 100MVA, tailored to specific requirements and supported by a range of high and low voltage products. Electrical networks are designed and supplied through the use of industry standard simulation tools and hardware. An integrated analysis environment has been developed that allows power system analysis on a range of equipment including the mix of mechanical and electrical systems, hybrid configurations and their controls.
Hybrid and electric propulsion systems

By moving to hybrid or electric propulsion, owners have in-built flexibility that can not only reduce emissions and optimise fuel consumption, but they are lighter and take up less space, with lower noise and vibration levels and reduced maintenance costs.

We optimise the system to match the vessels operating profile, the main designs are illustrated.

Electric systems are normally transformer-less with variable frequency motors on fixed frequency networks. This means they can also accommodate a battery power supply and can be plugged into a shore connection of variable frequency.

We select the best components from our broad supplier base and deliver a complete package. This approach relieves the shipbuilder of much of the technical risk and managing multiple equipment suppliers.

SAVe Line
Platform supply, multi-purpose, emergency response/rescue, coastguard and research vessels.

A traditional diesel-electric propulsion system already supplied to over 130 vessels operating today.

Uses active front end (AFE) technology for more stable clean voltage and fast response to load control changes.

The number of generators installed is dependent on the total shipboard power requirements and the vessel's operating profile. Those running is dependent on the power required. When transiting at slow speed or in stand-by mode with a reduced power demand, some engines can be turned off.
SAVe Cube
Platform supply, multi-purpose, emergency response/rescue, coastguard and research vessels.

The latest generation system designed with a single integrated drive-switchboard for the whole vessel.

All frequency convertors, drives and switchboards are housed in a single cabinet for a significantly smaller footprint. A single cabinet is simpler to cool and has fewer connections. It is therefore much easier to install, many more connection terminations are done at the factory.

Additional battery power is available for slow speed transits in harbour or for peak power load smoothing. All engines can operate at variable speeds to maximise their efficiency for the required power. Engine speed will automatically be adjusted to the power being demanded in the most fuel efficient way.

SAVe Step
Power intensive ships - small cruise, diving support, platform supply, construction support, jack-up and well intervention vessels. and research vessels.

Similar to the SAVe Line system but specifically designed for vessels with over 20MW of installed generated power. The main difference is the incorporation of transformers to step-down the voltage. The system uses high voltage (3-11kV) on the main switchboard and generators and low voltage on the consumers and distribution. Combined pulse (12, 18 or 24 pulse) and step-down transformers can be used in combination with pulse drive units. Alternatively, the system can be based on AFE drive units, therefore only step-down transformers are used and all the advantages of the SAVe Line system with AFE are realised in the most fuel efficient way.
SAVe Combi
Tugs, pelagic trawlers, fishing vessels.

As its name suggests this system is made up of a variety of building blocks and can be designed to almost any desired systems architecture for operation in a wide variety of modes. One cabinet performs the task of several power functions and drives. The compact design reduces footprint size to save space and weight.

Systems architecture can accommodate: Hybrid shaft generator (PTP/PTI), Battery energy storage for load smoothing/operation, shore connection, winch drive or power for any other electrical equipment.

Hybrid (bypass hybrid generator)
Fishing, coastal, offshore vessels.

Not as sophisticated as the hybrid shaft generator (HSG) system. It is an ideal option for power conversions, as the vessels existing electrical machines and switchboards can be retained and do not have to be Kongsberg supply. Fixed speed is required on the diesel when generating power for the switchboard.

An AFE drive is installed between the shaft-generator and the switchboard. This provides additional power when used with the main engine and provides full variable speed electric propulsion when the main engine is stopped, for slow speed/standby modes or as an emergency/take-me-home system. To update to the HSG concept, requires a special motor and switchboard.

Conventional hybrid
Fishing, platform supply, construction vessels. Has the simplest systems architecture with a separate generator and electric motor. The generator is normally mounted on the front of the main diesel with a standard electric motor on the gearbox. Main engine can operate as a generator set for high power requirements. When less power is required the auxiliary generator set can provide the hotel load and sufficient power for slow speed cruising.
**Hybrid Shaft Generator (HSG)**
Fishing, platform supply, coastguard, coastal vessels.

Uses AFE technology so fixed engine rpm is not required when operating the shaft generator. The switchboard sees a constant voltage and frequency, and the correct phase angle to match the other generator sets running in parallel. Propeller and engine efficiencies can be maximised by ensuring they are running at their most efficient point. The ability to reduce engine rpm to match the vessel's overall power requirements significantly reduces fuel consumption and emissions. Upgrading existing systems to HSG is normally straightforward with a short payback time.

**Boost mode – for maximum speed**
This mode is selected for maximum speed and harnesses most of the ship’s power, including output from the auxiliary generator sets for propulsion. The shaft generator is operating as a motor with an output of 2,500 kW running in parallel with the 6,000 kW main diesel engine at 750 rpm. This gives a total power of 8,500 kW on the propeller shaft.

**Diesel-electric mode – for efficient lower speeds**
Two auxiliary gensets are running at 50 per cent power providing 900 kW each to the system. 300 kW is used for hotel loads and 1,500 kW is available for propulsion. In this mode, the shaft generator is running as a motor with the HSG system controlling the shaft speed.
Parallel mode – for excess power
This is a new efficient way of running two engines, where the power required for propulsion and hotel loads exceeds that available from the generator sets alone. The shaft generator is feeding 500 kW into the electrical system in parallel with one auxiliary generator. The HSG system keeps the frequency fixed at 60 HZ even if the main engine is running at around half power with variable speed.

Transit mode – for optimum efficiency
This mode is used to optimise propeller efficiency for the required speed. The main engine runs at variable speed with the shaft generator supplying the ship’s electrical needs. Therefore, both auxiliary generators can be shut off.

Shore connection mode – for lower fuel consumption
When the ship is in harbour it has the possibility for connecting to the normal shore power and frequency (50Hz). The HSG converts the frequency to the ship power system which is 60 Hz. It can also avoid “black-out” during changeover from shore to ship power. There is no need to run any of the auxiliary gensets, which will save fuel and reduce emissions. In addition, noise and vibration levels onboard are reduced to a minimum.
SAVe Charge
Power solution well suited for ferries, tugs and any vessel where power from shore grid is the main power source.

The SAVe Charge architecture has both a DC and AC distribution system. At sea, power is supplied by energy storage. The system includes intelligent energy balancing to ensure equal utilisation between the two energy storage systems. This is particularly beneficial for double ended ferries where the load on the two propellers (one in each end) may have unequal energy consumption on each crossing. To avoid installation of oversized batteries or unequal discharging of the energy storage systems during operation, the energy use is balanced between the two systems. The balancing is arranged so that conversion losses are kept to a minimum.

The SAVe Charge solution has only one conversion between energy storage and consumers. Every electrical and mechanical conversion in a power system will introduce losses. By reducing conversions and combining with other Kongsberg Marine technologies like permanent magnet propulsion and automated crossing, the full efficiency gain of an integrated system solution can be realized.

Safety
The system is designed with the capability to supply energy in any direction and can bypass any single fault. Thereby providing additional levels of redundancy and safety for personnel and equipment. Back-up engines can be integrated for increased operational resilience (reduced charging capability, adverse weather conditions, etc.)

Benefits:
- No fuel consumption or emissions – During normal operation no engines are required
- Increased safety – Can supply energy in any direction, which enables bypass of a single failure in the power system
- Reduced losses – Combining the newest technologies in power, automation and propulsion reduces losses to a minimum
- Equal life cycle – Intelligent energy balancing to ensure equal energy storage load profile
Integrated control
The SAVe Charge by Kongsberg is simple to operate and fully automated. The power- and energy management system offers the maximum efficiency whilst ensuring reliable operations.
• Single touch mode selection for an automated operation of the power system.
• Control of engine speed to ensure minimum fuel consumption and required load capability (transient and steady state)
• Optimal combination of power sources to reduce overall operational cost
• Robust load control and fault handling to prevent black-out
• Energy Storage Health and charge diagnostic
• Energy Storage capability analyzing

Review your energy consumption and emissions
Kongsberg offers an online portal to view, record and compare energy efficiency performance of your fleet; focusing on fuel consumption, emissions and operations.
The web portal is accessible only to registered users. The information shown on the web portal includes:
• A summary of the vessel operational modes
• Energy consumption per operational mode
• Running time per propeller, per operational mode
• Energy efficiency index
• Vessel statistics comparisons

Additional functionality is available on request – contact Kongsberg to discuss your requirements.
Energy storage

Marine batteries have developed to a level where the technology is looked at with keen interest in different branches of shipping. Energy can now be stored on-board in such quantities that it enables numerous operational benefits:

Profile zero emissions
Energy storage system powers the complete system, eliminating the need for engines. No emissions, no fuel consumption or noise are some of the advantages.

Profile spinning reserve
Energy storage is connected and running, but not charging or discharging. If loss of generator capacity occurs, energy storage steps in to handle the load for a predefined period of time.

Profile peak shaving
Energy storage absorbs load variations in the power network. The energy storage will level out the power seen by engine and eliminate peak load required start of new engines. Power can be generated at peak efficiency and at the lowest cost.

Profile enhanced dynamic performance
Energy storage absorbs sudden load changes and prolongs engine ramp up. This enables optimized fuel and emission performance of engines in dynamic power applications.

While growing concern over global warming has prompted the need for overarching international treaties to reduce the carbon footprint, the uptake of marine batteries has spurred some national and regional policy makers to accelerate the shift to greener shipping.
System options

Hybrid solution
Even if the energy storage system cannot be recharged from the land-based electrical grid, several of the operational benefits can be used to improve the operating conditions for the engines and increase vessel safety.

The energy storage system can be sized to bridge intermittent load peaks so that prime movers can be smaller and operate more efficiently. Even a small energy storage solution can provide load smoothing and improve operating conditions for the engines.

Distributed energy storages can provide back-up power for propulsors, allowing it to move itself from a critical situation even after blackout on main switchboards.

Operational benefits profile:
- Spinning reserve
- Peak shaving
- Enhanced dynamic performance
Hybrid plug/in solution
In many cases, the grid is not able to provide the full energy need of the vessel within the time provided for recharging. A substantial benefit can still be achieved by hybrid operation.

This would typically allow for installation of smaller main engines. Depending on type and size, the energy storage installation can also be arranged to take all rapid transients or even allow the generator to operate at fixed load.

Both will allow engines to be operated with much lower temperature fluctuations which yields reduction of both fuel consumption and emissions as well as potential for extended maintenance intervals.

Operational benefits profile:
• Spinning reserve
• Peak shaving
• Enhanced dynamic performance

Pure electric solution
Energy storage system provides all the energy needed to perform the vessel’s duty. Within a certain time interval, single voyage or longer, the energy storage system is recharged from the land-based electrical grid.

Operational benefits profile:
• Zero emissions
Ship integration and intelligence

Power management
Kongsberg power management provides full control of the ship’s electric power distribution system and ensures coordinated and resilient operation. It automatically optimises power system operation and provides the operator with quick access to power system data and intuitive, easy to use, control interfaces.

Energy management
To help customers reduce energy consumption and become more environmentally friendly, the Kongsberg energy management system provides unprecedented access to operational data.

Data is captured, transmitted to shore and processed via a web portal. The portal is updated daily and provides detailed reports or historical trends showing data such as vessel operating modes, equipment running hours and fuel consumption. Fleet reporting enables customers to make comparisons across their fleet, for example, to see which vessels are operating most efficiently and to identify areas for energy efficiency improvement.

The system also provides evidence to illustrate compliance with emissions regulations and enables customers to verify their return on investment in efficiency improvements.

Automatic crossing system
Designed to optimise energy consumption of ferry operations, the system interacts with the power and propulsion control systems. The captain manages the course and the track by using an existing autopilot / track pilot. The crossing system provides optimal acceleration to transit speed and engages thrusters as needed for the transit and the docking. The crossing system will optimise the energy consumption by adjusting propeller pitch and rpm and the power distribution between the propulsors. Prior to arrival, the system will automatically decelerate to prepare for docking. If manual command is not taken, the ferry will fall to rest at predefined location.
Remote access
To maximise availability it is crucial that our customers receive world class in-service support. To meet high customer expectations we can provide a remote access tool to enable our engineers onshore to access the Kongsberg systems on board a vessel. When the crew grants access, the service is enabled via a safe and secure encrypted VPN connection.

Benefits include reducing the need for costly on-site service visits and provision of everyday troubleshooting assistance, leading to reduced vessel downtime. Using remote access we can find system faults, download log files, and inspect the systems’ health, allowing us to offer advice on preventive maintenance and if required, adjust some of the system settings.

Product and systems training
Any ship is made up of a large number of systems. The crew needs to understand how these systems work and interact if they are to operate the vessel safely and to the highest level of efficiency with minimum wear or equipment failures. To help crews achieve high standards of competence, Kongsberg offers a wide range of training courses on products and systems. We help customers optimise operations by delivering world class, innovative training solutions, which reduce operational risk and downtime, improve safety and meet regulatory standards. Typically, the courses include troubleshooting and maintenance training, using time in simulators where appropriate and in workshops with real equipment for hands-on experience. We also provide tailor-made courses to train crews in the operation of their new Kongsberg designed or equipped vessel. Well-equipped regional training centres with experienced instructors are established in Norway, Brazil and Singapore.
Mode shifting

Simply shifting modes
A challenge with complex hybrid systems is that changing operating modes can be complicated. The newly developed Kongsberg Acon mode shift system automates the process, so that with a single keystroke on the bridge the captain can shift from one mode to another. Optimal and economic operation also requires an overview of the ship systems, so the captain and the engineers need to see how efficiently the systems and equipment are working. Here, the Acon economy picture provides the basis for optimisation, or indicates the need to move to a different mode. Combining these products with a Kongsberg power and propulsion system gives a unique combination of user-friendliness and flexibility, not only when the vessel is new, but also later in life, when the operating profile may well have changed.

Power overview
The Acon mode shift system provides a view of the power available on the main busbar (green) for major power consumers like thrusters (orange).

Economy
Shows fuel consumption for main and auxiliary engines. By using the speed of the vessel and distance travelled fuel consumption per nautical mile is calculated.
Ship to shore connection and energy storage charging

Kongsberg can provide a full ship to shore connection and charging system that will be fully compatible with the vessel energy storage system. The overall system design will deliver the agreed ferry docking turnaround performance and mission energy transfer whilst also achieving the required battery design life.
Energy storage container

Kongsberg offers the possibility to have your selected energy storage upgrade solution in a container. The container solution will solve limited indoor space issues, simplify installation and give you flexibility.

Benefits:
- Reduced installation cost - All the components are placed and connected inside the container
- Limited space - Outdoor installation, can be placed on deck
- Limited vessel integration - Minimum changes needed regards to vessel integration
- Reduced commissioning time - Solution is tested at full load before delivery
- Additional benefits - Can easily be moved to other fleet vessels
AUTOMATION SYSTEMS

Ergonomically designed systems with an intuitive operator interface are essential in environments where operators demand maximum reliability, efficiency and safety.

Our systems are developed from an in-depth experience of over 30 years. We pay great attention to the human machine interface (HMI) to reduce operator fatigue, important when controlling complex vessels for prolonged periods. Maximum use is made of configurable controls and touch screens.

Our common system architecture and design philosophy provides proven standard modules as building blocks for fully customised systems, so that the specific operating requirements of each vessel can be met. The Kongsberg family of dynamic positioning systems uses the latest technology and our integrated bridge concept provides multiple workstations with the flexibility to switch between functions in a comfortable ergonomic environment, enhanced by the integrated operator’s chair.
Automation systems

Acon
The Kongsberg ship automation system (Acon) is designed to control and monitor ship operational systems and equipment, and comprises a wide range of control, monitoring and alarm products. Acon is integration/interface-ready for any vessel type and ship system or equipment via standard data communication protocols. Multifunctional displays allow the operator to choose between system to be controlled and the information to be presented.

All products are based on the Kongsberg common control platform and communicate via the Kongsberg ship integration network. Acon can be delivered as standalone products or as an integrated solution (IAS).

Integrated automation
Acon products are normally delivered as integrated automation systems with multifunctional operator stations - Acon IAS. Third party equipment or systems like HVAC, fire and gas etc. are easily interfaced to Acon IAS for control and monitoring. The Acon IAS user interface is tailored to the ship with access to the underlying ship systems through an ergonomic standardised interface specially designed for easy and safe operation.

Built in functions:
- Alarm and monitoring
- Machinery control
- Cargo control
- Tank sounding
- Power management
- LNG control and monitoring
- Ship operational mode control
- Acon energy management system
Propulsion control

Control solutions are supplied for the wide range of Kongsberg propulsion equipment – diesel and gas engines, controllable pitch propellers, waterjets, rudders, tunnel and azimuth thrusters of various types, as well as multi-product systems. Complex machinery installations like diesel-electric, gas-electric and hybrid propulsion are catered for. Where possible, system components are installed on equipment and calibrated at the factory to simplify shipyard installation. Maximum use is made of touch screens and joy sticks to enhance the human machine interface and improve operator performance.

Hrelicon X3

Helicon X3 is the latest model in the long and successful series of Helicon propeller and thruster (P&T) control systems and delivers automated and seamless switching between normal and back-up control. The control lever units have a compact ergonomic design with integrated pushbuttons for all key functions including command transfer, alarms acknowledge and back-up control on/off. Control lever units require very little space making control station integration both easy and flexible. One Helicon-X3 display located at each operator station is a touch screen operator panel common for all propulsion units. Helicon X3 uses the same range of components for all propeller and thruster types resulting in a unified control desk design and cable installation is reduced through use of serial line communications.
CanMan touch
CanMan touch is the latest of the proven CanMan series of propulsion control systems. It is suitable for a wide range of vessels to control and monitor engines, FP and CP propellers and systems with multiple bow and stern tunnel thrusters. Users have access to all system functions via the configurable touch screens. Information is presented in digital, graphic and mimic formats to provide an intuitive operator interface which is easy to use with operation based on the Kongsberg common controls platform.

Designed for high reliability, CanMan touch uses two parallel CAN buses to transmit data and provide a high level of redundancy. This reduces the amount of wiring required and simplifies installation as well as troubleshooting. Gateways and fire walls are an integral part of the system and prevent the failure of an individual CAN bus.

System modularity means it can be installed in stages – individual controllers (ie. propeller) can be installed and tested before the bridge electronics are operational. It also simplifies upgrading.

The control leavers for thrust control are supplied as separate units for each control station.

Features:
• Intuitive graphical user interface
• Single control point for multiple propulsors
• Built in redundancy – dual CAN bus architecture with twin screens
• Modular for ease of installation and testing

Typical main bridge control station
Aquapilot control system for azimuth thrusters
The Aquapilot ND control system is an independent follow-up control system with non-follow-up back-up control system for a single azimuth thruster - each thruster has an independent control system. The system provides an accurate, smooth and reliable thrust direction and can be interfaced with the ship’s automation system, DP, Voyager, prime mover, autopilot and joysticks.

Well known for it ergonomic and user-friendly features, Aquapilot ND has been designed for the operator and the lever can be customised to meet individual preferences. The operator can select from different operational modes suitable for various operations and the panels have LED indication on symbols.

Systems for steering, alarm and rudder angle indication
The systems are designed to meet the latest SOLAS and IMO requirements and are type approved by DNV, BV, GL, LRS, RINA and ABS. They are supplied for both solenoid operated valves and frequency controlled pumps/motors with the use of a frequency converter.

The system consists of a main control panel with pump start/stop, emergency steering, NFU/FU-steering mode selections, and low/high rudder angle selections. It is designed to interface with the autopilot, dynamic positioning system, joysticks and voyage data recorder (VDR).

Non-follow-up (NFU) steering and follow-up steering (FU) are available, as are systems for single or twin rudder vessels.
Compact control system for smaller waterjets
The system is suitable for single through twin, twin plus boost to quad waterjet installations. Control devices are calibrated and key hydraulic components installed on the jets at the factory to simplify yard installation. The system interfaces with engines, gears, autopilot, voyage data recorder and DP, with an option for a bow thruster. Another option is automatic interceptor control that links interceptor movements to steering commands.

Users can select from a joystick, twin levers or steerable lever control devices mounted in the console or on the arms of the chair. A colour touch screen presents system status and performance data. As each propulsion line is independent, there is ample redundancy and a number of interlocks for enhanced safety.

Control system for larger waterjets
A base control system consists of bridge equipment, a control unit and feedback devices. It controls the steering nozzle, reversing bucket, impeller driving engine’s RPM and clutch engagement of the waterjet unit.

The control unit can include touch screen, steering wheel, lever units with handles for thrust and steering, indication panel, and back-up panel. Individual thrust control levers can be specified for each waterjet, or multiple units can be controlled from a single lever with simultaneous control of both reversing bucket position and engine RPM.
GLOBAL SERVICE AND SUPPORT

Helping you to manage the vital balance between operational availability and cost

Kongsberg is committed to supporting our customers to ensure vessels operate safely at design efficiency and unscheduled downtime is minimised. Our commitment to ensuring vessels continually operate at their peak has led to the steady evolution of Kongsberg support operations. Conventional services range from the provision of spare parts, equipment repair and exchange programmes, to upgrades improving vessel performance and efficiency whilst reducing emissions. Innovative new offerings, such as Power by the Hour have also been introduced.

Our focus is the same as our customers’
• Maximising operational efficiency and safer operations
• Preventing unscheduled downtime and loss of operation
• Bringing predictability to maintenance budgets
• Maximising asset utilisation and capability
• Enhancing crew skills
• Having the right support, in the right place, at the right time

At the centre of our support philosophy is the recognition that all customers have different and often unique requirements based on their fleet operations. Whatever the mix of requirements, we are committed to meeting them.

Our global service and support includes:
• 24/7 Technical support
• Global service network
• Customer product training
• Equipment exchange programmes
• Containerised workshops
• Spare parts logistics
• Power by the Hour service agreements
• Performance enhancing upgrade solutions
• Vessel conversion solutions
• Equipment health monitoring

Professional service every port, every day
Training

Our training centres are strategically located for ease of access. And if your team can’t reach us in person, we’ll come to you, or provide a remote virtual classroom for approved online training courses.

Building competence

Your people are the bridge between advanced technology and optimised operations, making a well-trained and up-to-date workforce one of your most important assets for growth and sustainability. Investing in competence is a prerequisite and for over 30 years, KONGSBERG has built-up an unrivalled network of global training centres dedicated to developing the skills of more than 7000 maritime professionals every year.

Each state-of-the-art training centre delivers modular and tailored courses covering basic to advanced operational techniques, leveraging the power of world-class KONGSBERG simulator technology to deliver realistic scenarios for practice and evaluation. Our people are also one of our own most important assets. We only employ highly experienced instructors who have the skills to transfer their knowledge, experience and wisdom. Our unique combination of tools and people combine to power an unmatched training experience that brings more safety and competence to your business, regardless of your operational needs.
Marine products and systems

For more information, please visit: kongsberg.com

Switchboard: +47 815 73 700
Global Customer Support 24/7: +47 33 03 24 07
E-mail sales: km.sales@km.kongsberg.com
E-mail support: km.support@kongsberg.com

Kongsberg Maritime AS
Kirkegårdsveien 45
P.O. Box 483
NO-3601 Kongsberg
NORWAY

Ref: MPS 13/03/2019 - 2