Wärtsilä Solutions for Marine and Oil & Gas Markets

Wärtsilä is a global leader in smart technologies and complete lifecycle solutions for the marine and energy markets. By emphasising sustainable innovation, total efficiency and data analytics, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers.

wartsila.com

Visit us also on Social Media
Scan to visit wartsila.com/marine/smartmarine
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In the Marine, Oil & Gas sectors, no other company has a wider offering of environmentally and economically sound solutions.

As the industry undergoes rapid transformation in response to the need for greater operating efficiencies and better environmental performance, Wärtsilä has evolved to lead the industry towards a Smart Marine Ecosystem, whereby real-time communication and the arrival of digitalization to all aspects of
marine operations create long-term value for our customers and partners.

With an integrated product portfolio comprising full lifecycle solutions that are supported by the most extensive global services network, optimising performance is the greater goal – And in doing so achieving for our customers, the safest, most ecological and efficient operating profiles possible.
Wärtsilä’s Vision of a Smart Marine Ecosystem

The marine industries are faced with three major sources of inefficiency, each of which imposes a significant negative impact upon business operations and profitability. These are overcapacity, inadequate port-to-port fuel efficiency, and waiting times when entering ports and other high traffic areas.

The need to eliminate this waste forms the founding principle of Wärtsilä’s vision of a Smart Marine Ecosystem, a broad outlook which will harness the changes taking place in the shipping industry to deliver value and optimisation for all parties involved.

As the Smart Marine Ecosystem becomes the industry’s preeminent operating model, shared capacity will improve fill rates and reduce unit costs, big data analytics will optimise both operations and energy management,
intelligent vessels will enable automated and optimised processes, and smart ports will deliver smoother and faster port operations.

Wärtsilä already provides technologies that support developments such as autonomous shipping, the reduction of energy consumption, and the reduction of emissions; using its knowledge and vast portfolio to provide a sound basis for the generation of vessels to come.

And today, with the industry’s most complete global network of service and workshop facilities, we support our marine customers wherever they are located, and whenever help is needed. By taking a holistic approach – combining digital innovations, advanced data and expert services to help match activities to customers’ operations – we enhance our maintenance prediction capabilities and spare parts logistics to ensure that customers’ assets operate in the most energy-efficient way and in accordance with all relevant regulations.

Through the expanded adoption of digitalization and new levels of connectivity, we intend to lead the industry’s next wave of transformation. Wärtsilä is ideally positioned to help its customers and partners embrace the positive disruptive development of the marine sector – ultimately, enabling sustainable societies with smart technology.
Ballast Water Management Solutions for all Ship Types

The IMO Ballast Water Convention was introduced in 2004 to address the Control and Management of Ships’ Ballast Water and Sediments. The regulation specifies that all sea going vessels greater than 400 gross registered tonnes need to install a Ballast Water Management System.

In recognising that no one solution will be suitable across all ship types, Wärtsilä is uniquely placed to offer owners & operators a choice of Ballast Water Management Systems (BWMS).

The two Wärtsilä Aquarius® BWMS are designed to use a common filter module, and a different disinfection technology - medium pressure Ultra Violet (UV), or electro-chlorination (EC) technology.
The Wärtsilä Aquarius® BWMS range offers the following advantages:

- Proven performance to meet both USCG & IMO regulations
- Low total cost of ownership
- Fully automatic operation
- Condition-based monitoring – optional functionality
- Flexible upscaling and design
- Suitable for both new build and retrofit projects
- Technology choice

By virtue of Wärtsilä Aquarius® BWMS design, the system’s inherent flexibility allows application across the full range of ship types and sizes, for both the new build and retrofit markets. Wärtsilä offers customers a range of flexible supply options, from equipment only, to full Engineering, Procurement & Construction (EPC) covering all phases from the initial survey through to project management, supply, installation, commissioning, training and lifecycle service and support.
Wärtsilä Aquarius® UV

Wärtsilä Aquarius® UV Ballast Water Management Systems (BWMS) provide robust technology for the treatment of ballast water using ultra-violet (UV) irradiation, across the full range of ship operating and environmental conditions.

The Wärtsilä Aquarius® UV BWMS uses a simple two stage process involving filtration and UV irradiation. During uptake, seawater is first passed through a 40 micron backwashing screen to remove particulate, sediment, zooplankton and phytoplankton. Disinfection of the filtered sea water is then carried out using medium pressure UV lamps, and controlled by the BWMS control system. Upon discharge, the filter is by-passed but the ballast water is again disinfected with UV treatment before safe discharge back into the sea.

The system has a flexible design enabling it to be arranged to suit available onboard spaces. The system can be designed and supplied to treat ballast water covering the full range of ballast pump sizes. There are 13
distinct Wärtsilä Aquarius® UV BWMS system sizes available with capacities ranging from 50 m$^3$/h to 1000 m$^3$/h. Capacities above 1000 m$^3$/h up to 6000 m$^3$/h are achieved by installing multiple systems in parallel.

Available in two configurations for installation in safe environments as well as an explosion proof version certified by DEKRA for hazardous areas. For ease of installation the scope of supply is flexible from a kit of parts, standard modules or fully bespoke arrangements, meeting the individual requirements of our customers.

All Wärtsilä Aquarius® UV BWMS units have been granted IMO Type Approval by The Ministry of Infrastructure and the Environment of The Netherlands in accordance with Resolution MEPC.174(58) G8, and have been tested to meet the D2 performance discharge standard.

USCG AMS acceptance has been granted in accordance with the requirements of 33 CFR 151.2026 in all salinity ranges (fresh, brackish & sea water)

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Wärtsilä Aquarius® EC Ballast Water Management Systems (BWMS) provide robust technology for the treatment of ballast water using in-situ electro-chlorination, across the full range of ship operating and environmental conditions.

The Wärtsilä Aquarius® EC BWMS uses a simple and efficient two stage process involving filtration and electro-chlorination (EC). During uptake, seawater is first passed through a 40 micron backwashing screen filter to remove particulate, sediment, zooplankton and phytoplankton. Disinfection of the filtered sea water is then carried out using hypochlorite generated from the side stream EC process, and controlled by the BWMS control system. Upon discharge, the ballast water by-passes the filter and any residual active substance is neutralised using sodium bisulfite, to ensure that the ballast water is safe to discharge back to the sea in full compliance with MARPOL requirements.

The system has a flexible design enabling it to be arranged to suit available onboard spaces. The system can be designed and supplied to
treat ballast water covering the full range of ballast pump sizes. There are 18 distinct Wärtsilä Aquarius® EC BWMS standard modules available with capacities ranging from 250 m$^3$/h to 4000 m$^3$/h.

System capacities above 4000 m$^3$/h are achieved by installing multiple systems in parallel.

For ease of installation the scope of supply is flexible from a kit of parts, standard modules or fully bespoke arrangements, meeting the individual requirements of our customers.

The Wärtsilä Aquarius® EC BWMS received IMO Basic Approval at MEPC 64, with Final Approval following at MEPC 65 in May 2013.

All Wärtsilä Aquarius® EC BWMS units have been granted IMO Type Approval by The Ministry of Infrastructure and the Environment of The Netherlands in accordance with Resolution MEPC.174(58) G8, and have been tested to meet the D2 performance discharge standard. USCG AMS acceptance has been granted in accordance with the requirements of 33 CFR 151.2026.
Our product scope includes electric propulsion and drives, power generation and distribution systems, navigation, automation and communication systems, dynamic positioning, safety and security solutions, entertainment systems, as well as sonar and sensor technology for vessels of all types and sizes. Our state-of-the-art products and solutions are efficient, reliable
and cost effective, and are supported by 24/7 customer service around the world.

Under the motto “from bridge to propeller” we provide full integration of all electric and electronics systems, typically in close partnership with the shipyard. The level of system integration varies from a package delivery of products, with related engineering included, to complete system integration (the turnkey solution).
Integrated Vessel Control Systems

Wärtsilä NACOS Platinum is the core product for a complete series of next-generation navigation, automation and control systems, including dynamic positioning. The entire portfolio for this series is based on shared software and joint hardware components, and utilises a common network.

The use of modular components ensures unprecedented levels of usability and scalability. The design of the networked system architecture is flexible, ranging from small independent systems requiring limited integration, through to highly complex systems with unlimited integration possibilities. Moreover, each system can be easily expanded, upgraded, or modified to provide increased functionality.

The IP-radar, which is directly connected to the ship’s IP network. This enables the complete radar image to be accessible from any workstation. The HSC option with increased antenna speed provides consistent tracking of fast targets for use on high-speed crafts (HSC).

Consistency and tight integration between products simplifies and smooths the installation, while enabling efficient lifetime support from one of the largest global suppliers.

All products are developed according to User Centred Design principles. In co-operation with a leading international Human Factors institute, a very ambitious collaborative design process has been undertaken. This has
Control Systems
resulted in a Human Machine Interface (HMI) which is intuitive, transparent, and completely consistent across the full range of products.

**Automation Products**
- Integrated Automation Systems (IAS)
- Ballast Control and Monitoring
- Cargo Control and Monitoring
- Bilge Control and Monitoring
- Power Management (available as fully redundant with advanced generator protection functions)
- Propulsion Control
- Engine Governor Control
- HVAC/Fire Monitoring
- Emergency Shutdown
- Decision Support
- Safety Management
- Information Management
- Vessel Performance Monitoring

**Manoeuvring, Dynamic Positioning**
- Thruster Control
- Joystick Operation
- Dynamic Positioning
- Smart Predict
- Compliant with notations DP0 to DP3

**Navigation Products**
- Radar
- ECDIS
- Conning
- Track Control
- VDR, AIS, BNWAS
- Integrated Bridge Systems (IBS)
- Integrated Navigation Systems (INS)
- Navigation Sensors
- Helicopter Tracking
- Sonar Integration
- Berthing Assistance

Remote Service enables service engineers to access the on-board systems almost anywhere in the world. This simplifies the diagnosis of faults and problems, and allows the needed spare parts to be delivered to the nearest port in good time. In many cases, Remote Service enables faults to be remedied even when the ship is still underway, thus eliminating servicing or even the extension of docking times.

An ever increasing number of on-board security systems are IT-based and networked with LAN from radar to bilge. Interfaces to other systems and externally (to land) enable new functions, such as automatic updates of electronic sea charts and remote service. Wärtsilä offers a wide-ranging security solution that provides appropriate responses to key issues in IT security. Depending on the details of the system, the customer has access to a range of security functions to ensure the fleet is protected against all relevant threats.
Positioning and Situation Awareness

Guidance Marine has a strong track record of delivering world class position measurement and situational awareness sensors which offer the highest level of precision, safety, reliability and usability. These solutions are a valuable addition to Wärtsilä’s Smart Marine offering.

**Offshore Vessels**

We offer a wide range of local position reference sensors for PSV’s, shuttle tankers, FPSO’s and other offshore vessels.

- CyScan AS & AS Prism
- RadaScan/RadaScan View & responder
- SceneScan
- RangeGuard
- Motion Reference Unit
- Artemis & Artemis Validator
- XT Arctic Sensors

**Wind Farm Support Vessels**

We provide a complete targetless sensor solution for positioning a vessel against a wind turbine to enable the safest deployment of walk-to-work gangway and crew transfer.

- RangeGuard Monopole – targetless
- SceneScan Monopole – targetless
- CyScan AS & AS Prism

**Cruise ships, Ferries and Yachts**

Sensors can assist with docking and situational awareness as well as providing precise poisoning information on approach to and in port, without the reliance on GPS.

- SmartQuay
- RS24
- RangeGuard
- CyScan AS and AS Prism
Positioning and Situation Awareness

**Autonomous & Remote Operations**

We offer a range of sensors that provide hazard detection and situational awareness as well as sensors that can enable autodocking and automatic manoeuvres.

- RS24
- RangeGuard
- CyScan AS and AS Prism
- SceneScan

**SmartQuay**

Based on camera technology, SmartQuay projects a calibrated measurement grid onto a real-time video image of the quay during the docking manoeuvre. This is displayed on the bridge and provides an indication of the gap measurement between the vessel hull and the quayside.

**SceneScan**

The SceneScan sensor is a high-accuracy rotating laser sensor which provides positional information to allow automated approach and/or station keeping. SceneScan provides tracking information relative to natural or man-made structures within the sensor field of view.

**RS24 – High Resolution K-Band Radar**

An ultra-high resolution, low power short range 24 GHz radar that can fill in the close-range gap that is invisible to the traditional navigation radar system. The output from the sensor can be displayed directly on existing radar screens and complete the short range requirements for situational awareness within 1.5 km range. The high resolution and sharpness of image means that even in a busy harbour, the smallest vessels can be uniquely identified.

**Motion Reference Unit (MRU)**

The Guidance Marine MRUs are enhanced, high-performance strapdown Motion Sensors. Utilizing the latest developments in MEMS technology the MRU provides accurate determination of Pitch, Roll, and Heave for any vessel on which it is mounted.
Dynamic Positioning

Wärtsilä Dynamic Positioning Inc. is a leading manufacturer of vessel control systems for all segments of the marine market. Wärtsilä’s Platinum DP represents the latest generation of controls featuring a user-focused touchscreen interface for safe and efficient operation. Using a building block approach, the Platinum DP offers the flexibility to meet all applications.

Wärtsilä offers a full range of dynamic positioning and vessel control products:
- Joystick
- DP0, DP1, and DP2
- Full DP3

All systems can be fully integrated with Platinum family products including Automation, Thruster Controls and Navigation. Wärtsilä systems are designed and classed under virtually all Regulatory Bodies.

Systems can be supplied with all required sensors from basic requirements such as gyrocompasses and wind sensors to complete packages including a wide range of position references such as:
- Relative Range and Bearing (Laser/Radar)
- Hydroacoustics (USBL, SBL and LBL available)
- Tautwire
- Inertial Navigation Systems (INS)
Dynamic Positioning

With experience in all market segments, Wärtsilä can provide operational modes to meet any demand.

**Offshore Vessels**
- Hold Relative
- ROV Follow
- Track Follow

**Drilling Vessels**
- Dynamic Mooring Assist
- Blackout Prevention
- Riser Angle

**Passenger Vessels**
- Virtual Anchor
- SMART Ship Controls

**Wind Farm**
- Jack-up Compensation Mode
- Pile Gripper Interface
- Gangway Interface

**Specialty**
- Heavy Lift Modes
- Pipe/Cable Laying
- Dive Support
- Crane interface
Smart Ship Control

**Smart Ship Control**

Wärtsilä offers a complete family of advanced maneuvering modes for safer and more efficient vessel handling. As the market interest in vessel autonomy grows, Wärtsilä is partnering with industry to provide the tools necessary for the future of remote controlled and unmanned ship operations.

The Wärtsilä Smart Ship family of controls includes:

- Basic Joystick Maneuvering System
- SmartDrive
- SmartPredict
- SmartDock
- SmartTransit
- SmartCommand

The **Basic Joystick Maneuvering System** provides coordinated control for easier ship handling. All of the thruster control levers are combined into a single lever for simple vessel maneuvering.

**SmartDrive** adds closed loop control providing simplified vessel movement and basic station-keeping ability. Vessel speed and direction are controlled directly allowing the vessel to stay in one position when the joystick is centered.
Smart Ship Control

**SmartPredict** offers the latest advancements in vessel motion prediction. Incorporating a full mathematical model of the ship into the software allows more precise prediction of vessel movement. Operators can visually see the impact of their actions on screen making maneuvering safer.

**SmartDock** provides truly automated docking for ferries and other vessels. By providing consistent and repeatable docking the system increases safety and reduces fuel consumption. Smart Dock offers the first step in vessel autonomy with provided docking sensors for seamless operation.

**SmartTransit** builds on the autonomous vessel concept to offer automated transit along a specified route. Can be combined with Platinum advanced navigation systems, which provide collision detection and optimized route planning, to deliver an enhanced transit capabilities.

**SmartCommand** allows true remote control of vessels from connected locations. Using existing network connectivity including 4G, WIFI and satellite communications, complete vessel control is possible from remote terminals.
Diesel-electric Propulsion

Wärtsilä is fully aligned with the growing trend in the market for diesel-electric propulsion systems. Frequency converter fed propulsion systems offer advantages for ships with the following special requirements in the 400 kW up to 30 MW power range:

- Low noise and vibration
- High redundancy
- Maximum payload capacity and optimal utilisation of available space
- Economical operation
- Essential higher reliability, dependability and availability
- Flexible use of the torque speed characteristic
- Excellent dynamic characteristics
- High quality mains
- Reduced emissions
- High degree in automation including remote maintenance
- Reduced wear and tear

Because of these features, electrical propulsion systems are being used, particularly on ships with special requirements, such as cruise liners, ferries, cable and pipe layers, research vessels, icebreakers, multipurpose vessels, patrol boats, supply and rescue vessels, and LNG tankers.

PWM Converter Systems

PWM converters can be used to supply induction motors, synchronous motors or permanent magnet motors used for electric propulsion, pumps, compressors, winches and for drilling operations.

These converter systems use power transistors in the motor inverter and can be configured with either a 6, 12, 18 or 24 pulse rectifier front end, or an active front end inverter which allows regeneration and can also remove the need for transformers and a braking resistor.
Furthermore, these can be configured into the Wärtsilä Low Loss Concept topology, or as a DC-Hub with a common DC link.

**DC-Hub Systems**

For inverters connected to the same DC link, our patented electronic DC breakers work independently of each other. The multidrive system connects to the main grid through either active or diode rectifiers, or can be harnessed to DC sources such as batteries, solar panels or fuel cells. The system allows electrical operation with variable speed engines.

**LCI Converter System**

Frequency converters with line controlled inverters (LCI = synchroconverters) are designed with direct current (DC) intermediate circuits. They comprise thyristor rectifiers on the mains side and a thyristor inverter on the motor side. LCI converters are available for supplying synchronous motors in the high power ranges.

**Low Loss Concept**

Harmonic voltage distortion causes disturbances for the network and loads, and impairs the performance of the vessel. By reducing these to a minimum, the Total Harmonic Distortion (THD) has no influence on the vessel’s operations. Wärtsilä reduces THD by splitting the distribution bus into two sections, and placing the transformer between the two buses = Low Loss Concept (LLC).

This means that fewer transformers are needed for installations with more than 2 x drive power output connected. Where more than 2 x drives are installed, the advantage of having fewer transformers becomes even more important. In some installations, the installed transformer capacity is reduced by more than 75%.

The design of the LLC also improves system redundancy. This means that in the case of failure in one of the switchboards, the drive can continue to operate – albeit with reduced power.
Wärtsilä HY

Wärtsilä has leveraged its technological leadership in both engines and electrical & automation to develop Wärtsilä HY, a new-generation integrated hybrid power module. The various components are tuned and harmonized into a single entity through the enhanced Energy Management System. Full control over all the hardware and software enables Wärtsilä HY to be approached as a unified product during engineering, testing and its operational life.

In order to match the specific demands of different market segments, Wärtsilä HY comes in highly customizable forms: it is tailor-designed for individual vessel market segments and can be optimized for specific operating profiles, even throughout the vessel lifecycle.

The algorithms embedded in the Wärtsilä HY Energy Management System enable smart features, such as:

- **Smokeless operation:** the synergy between the energy storage system and the engine allows the avoidance of visible smoke emissions under all normal conditions
- **Instant load taking:** the module is able to react instantly to fast and broad changes in the power demand
- **Automatic power back-up:** an increased level of safety is reached through emergency back-up algorithms and built-in redundancy of the power sources
- **Start & stop:** at low loads the power is supplied exclusively by the energy storage system until it reaches a pre-set minimum state of charge. At this point the engine is automatically activated, providing power to the ship and simultaneously re-charging the energy storage system
Hybrid Solutions

- **Green mode:** when selected by the operator, power is supplied exclusively through the energy storage system until the pre-set minimum state of charge is reached.

- **Power boost:** the engine and energy storage system can supply power at the same time, thus enabling an Instant power boost in output;

- **Peak shaving:** load fluctuations are absorbed by the energy storage system, allowing stable operation of the machinery.

The standard mechanically driven configuration includes:

- Main engine with clutch
- PTO/PTI on the gearbox (or in-line shaft generator/motor)
- Energy storage system
- DC link and power drives
- Energy Management System

The standard electrically driven configuration includes:

- Generating set
- Energy storage system
- DC link and power drives
- Energy Management System
Hybrid Propulsion

**Wärtsilä Zero**

Wärtsilä Zero is an innovative utilisation of alternative energy carriers through emission free or carbon neutral fuels. Energy storage systems such as electrical batteries, supercapacitors or hydrogen can be used to achieve a clean energy system onboard.

Wärtsilä has developed solutions for harvesting renewable energy from shore through an innovative fast charging solution or shore connection system for pure electric energy storage driven vessels.

Wärtsilä has developed power modules capable of utilising electrically charged batteries in combination with supercapacitors and/or fuel cells that when driven by hydrogen or other green fuels offer an emission free solution. The fuel cells can also be driven by LNG or similar energy carriers, thereby obtaining a cleaner energy system solution than most other alternatives.

For certain applications the combination of batteries and supercapacitors achieve an even greater solution for special operations.

The offshore supply vessel Viking Lady, was converted to hybrid propulsion already in 2014.
HY Upgrade

Hybrid solutions are not only for new build vessels. Existing ships can be retrofitted to benefit from the multiple advantages offered by Wärtsilä’s advanced hybrid technology. Wärtsilä completed its first hybrid conversion project already in 2014. The ‘Viking Lady’, a platform supply vessel owned by Eidesvik Offshore, was fitted with a Wärtsilä Low Loss Hybrid system, after which a comprehensive measurement program confirmed fuel savings of 15%. Less fuel burned also means fewer exhaust emissions.

When in transit mode in heavy weather conditions, the ‘Viking Lady’ uses the battery to reduce frequent load variations on the engines. This allows one less genset to be used because a higher average load can be maintained. In critical operations, the battery is used as power redundancy while a charge / discharge strategy is also adopted. This allows one engine and a single battery to operate at the most efficient loading.
Hybrid Propulsion

**Hybrid Energy Storage Systems (ESS)**
The Hybrid Power System combines different power sources with energy storage devices. The introduction of the hybrid power system, and its integration with conventional diesel or dual-fuel engine generating sets, offers a significant improvement in efficiency by running the engines on optimal load and absorbing many of the load fluctuations through batteries.

The introduction of Hybrid Power Systems with energy storage is a new and attractive way of reducing both fuel consumption and exhaust emissions. Utilising the latest wireless charging technology, Wärtsilä can offer total electrical plug-in solutions and completely integrated vessel design concepts.

Wärtsilä’s system design incorporates energy storage capabilities in the form of battery packs, hybrid control systems, power transfer systems, and energy storage systems.

**Fuel saving and reduced emissions**
Less fuel consumption ensures a substantial reduction in emissions, and supports sustainable operations with different fuels. Annual fuel savings have proven to be between 10-20%, depending on the type and configuration of the engines.

**Optimised engine operation**
By optimising performance, the engines can be operated with optimal specific fuel consumption.

**Reduced engine transients**
Wärtsilä’s ESS reduces transient loads in engines. Transients increase both fuel consumption and emissions.

**Hybrid Control System**
The Wärtsilä Hybrid Control System controls and monitors the overall operation of the battery system, which includes:

- Charging and discharging of batteries taking into account battery characteristics.
- Versatile control for Battery (Power) and Battery (Safety) notations.
- Control strategies to optimise the performance and reduce the transient loads of engines.
- Grid support for black out prevention.
- Interface to vessel PMS and IAS systems.

Engine peak shaving in combined battery and engine modes is a configuration whereby the batteries take the load required to run the thrusters, while the engine is running with a stable load profile.
Hybrid Propulsion

**Increased redundancy and efficient operations**
Power redundancy needs require engines to run at low loads. With the battery providing the redundant power, the engine can operate more efficiently at higher loads.

**Reduced maintenance**
Thanks to more stable operations and reduced engine running hours, maintenance costs will be lowered.

**Better performance**
The fast power response from the energy storage system means that vessel performance will also be more responsive. This may also increase dynamic performance in critical operations.

**Wärtsilä Smart Energy Management**
Optimisation of power generation, energy consumption and energy storage in a vessel by utilising digital technologies comprises predictive energy management, Smart propulsion, optimised energy efficiency, and hotel load and cargo energy efficiency with Smart service loads. Voyage planning will secure the best route efficiency.

Energy control and optimisation of the complete vessel energy systems are achieved throughout the vessel by implementing solutions such as the Energy management and Hybrid control system to manage and operate the Propulsion and Power electric systems onboard. Optimisations of various components increase reliability even further: Engine and power supply, Electrical power conversion systems, Propulsion controls, Waste heat recovery, Energy storage systems (e.g. batteries), fuel cells, solar panels and Power transfer systems to/from shore.

Wärtsilä has implemented Energy optimisation on different levels of vessel management: Energy management by selection of sources and controlling consumers of energy. Power management, Stop/start and control, as well as Power electrical system control, synchronisation, AVRs, and load sharing, including Power electrical system protection (frequency, current, voltage, breakers).

Wärtsilä Smart Energy Management is an onboard energy optimisation and control solution that also comprises solutions related to fleet management, lifetime services and maintenance systems.
Power Generation

**Shaft Generator Systems – PTO/PTI/PTH Applications**

Wärtsilä provides Shaft Generators (SG), driven by the main engine to supply power to the mains within the 500 kW to 9000 kW range. The power generation has to function properly at changing propulsion shaft speeds, when the ship travels at different speeds, or in the case of very fast speed changes caused by heavy seas. To allow a stable frequency and voltage in the mains while the main engine speed is changing – a frequency converter with PWM technology is used.

Using shaft generators is a particularly economical and environmentally friendly method of generating electrical power. For this reason, more and more ships are being equipped with such systems. The use of shaft generators provides many advantages:

- Reduced maintenance costs
- Lower fuel and lubrication costs
- Fast return on investment (down to 3 Years)
- Added safety for ship and crew
- Low noise power generation
- Smaller or fewer diesel generator sets
- Continuous parallel operation together (two SG systems) or with diesel generator sets

On ships with fixed pitch propellers, the speed is set via the propeller speed. If using controllable pitch propellers, the shaft speed and the
propeller pitch are adjusted simultaneously in order to achieve optimum propeller efficiency in this so-called combinator mode. Even with this type of propeller, it is nevertheless economical to use shaft generator systems with a frequency converter for variable speeds in order to enable a combinatory mode from pier to pier.

All requirements of the ship’s mains are met without restrictions during shaft generator operation:

- Unrestricted operation during main engine speed variations resulting from heavy seas and manoeuvring
- Continuous parallel operation together (if 2 shaft generator systems are provided) and with diesel generator sets
- Generation of the required active power and reactive power
- Selective tripping of short circuits without failure of the overall system
- Starting and shut-down of large consumers without inadmissible voltage and frequency fluctuations
- Operation, including synchronisation, in the same way and with the same operating controls as with diesel generator sets
- Simple integration in automated power generation systems

For applications in combination with exhaust-gas and steam turbine generators, PTI/PTO shaft generator systems with a power range of 3.6 MW to 9.0 MW with 6.6 kV are required. They are also required for lower power demand with high redundancy of the propulsion system, PTI/PTH/PTO SG. Systems including power take home drive are possible with LV and MV applications.
Wärtsilä provides both low voltage and medium voltage switchboards that meet the most stringent requirements. Due to the growing demand for more available power, medium voltage – instead of low voltage distribution systems – are provided in the 6.6 kV or 11.0 kV range.

For the protection and control of power supply systems, Wärtsilä integrates its own developed protection system. The micro-processor based protection system covers all necessary protection functions for low and medium voltage power supply systems, as well as for the generators and power consumers. If required, a power management function for controlling the power supply system is also available. The protection system can be operated as a stand-alone solution, or in combination with other systems via data bus. Interfaces to automation systems and other control systems can be provided.

- Operation, control and monitoring of all important generator data, status indication of circuit breakers and alarms
- Integrated power management functions
- Simple parameter setting onsite (password protected)
- Online visualisation of plc-process functions
- Generator/ships main supply protection and control functions
- Interfaces to external monitoring and control systems
- Integrated plc for free programmable functions and controls (programming according to IEC 1131)
- Also available with transformer, bus-tie-breaker and motor protection functions
Power Distribution

The system is mainly intended for the protection and control of the following listed applications:
- Diesel generators
- Shaft generators
- Emergency generators
- Coupling circuit breakers
- Transfer line circuit breakers
- Transformers
- Motors
- Shore connections
- Filters
- HR grounding

Low Voltage Switchboards

Nominal voltage: up to 690 V 3AC

Bus bar system capability:
- Rated current $I_N$: up to 10,000 A
- Rated peak current $I_{pk}$: up to 330 kA
- Rated short-time current $I_{CW} 1$sec: up to 120 kA

Protection grade: IP54, bottom open
- Ambient temperature: 45°C or 50°C acc. to Class Requirements
- Basic requirements: $I^{EC}$, Classification

Motor Control Center

Nominal voltage: up to 690 V 3AC

Bus bar system capability:
- Rated current $I_N$: up to 3150 A
- Rated peak current $I_{pk}$: up to 220 kA
- Rated short-time current $I_{CW} 1$sec: up to 100 kA

Protection grade: IP54, bottom open
- Ambient temperature: 45°C or 50°C acc. to class requirements
- Basic requirements: $I^{EC}$, Classification

Plug-in motor starters
- Different sizes up to 630 A
Power Distribution

**Medium Voltage**
- Rated voltage 7.2 kV to 17.5 kV
- Thermal rated current (1s) 50 kA
- Rated current Bus bar 4000 A
- Rated current droppers 4000 A
- Enclosure doors closed (open) IP32 (IP20)
- Flame arc test IEC62271-200 50 kA

**Special Switchboards**

**Distribution Boards**
- Nominal voltage: up to 690 V 3AC
- Protection grade: up to IP54
- Feeder circuits: moulded case circuit breakers or fuse switch combination

**Lighting Distribution Boards**
- Nominal voltage: up to 400/230 V 3AC
- Protection grade: up to IP54
- Feeder circuits: miniature circuit breakers

**Single Motor Starters and Control Boxes**
- According to demands

**Special Boards**
- Shore connection box
- Test panel etc.
- 24 V DC power supply switchboard

**GPM 500 Protection System**

For protection and control of the power supply, Wärtsilä integrates its own developed protection system, the GPM 500.

The system covers all necessary protection functions for low and high voltage systems, as well as for generators and consumers.

**Alternative Marine Power – High Voltage Shore Connection**

The system design is essentially based on meeting port needs while also conforming to ICE/ISO/IEEE 80005-1 requirements. A typical configuration comprises the key components, such as the cable reel, a medium voltage switchboard, and a control and monitoring facility that includes an interface between ship and shore. A complete assembly can either be installed
separately on-board the vessel, or containerised for siting at a specific on-board location. Upon request, we can develop tailor-made solutions for all vessel types. We offer the full range of turnkey integration options.

**Wireless Charging**

Wireless charging (inductive charging) is an innovative method for power charging fully electric/hybrid operated vessels. The system uses an electromagnetic field to transfer energy of up to 2.5 MW within a range of 15–50 cm between the transferring coils. Wireless charging technology is best suited for vessel applications where a high number of charging periods per day is necessary. Thanks to contactless power transfer and the encapsulated design, it withstands harsh marine conditions.
**Wärtsilä Direct Electric Heating**

Wärtsilä DEH is an environmentally sustainable flow assurance method that replaces the use of chemicals in pipelines.

The presence of wax and hydrates in subsea pipelines is a major environmental and cost driving concern in the offshore industry, frequently solved by using chemical pollutants. DEH uses the thermally insulated pipeline as part of an electric circuit and allows the electrical losses to heat the pipe and control the flow of its contents.

Wärtsilä DEH topside delivery comprises of an integrated medium voltage equipment package, including all safety protections, that controls the current in the product flow line. The system converts the electrical load from a single phase to a symmetrical 3-phase load, and compensates for the low power factor.
Power Distribution

Key benefits
- A mature technology with our installations since the early 90s
- Environmentally friendly and cost efficient avoiding use of harmful chemicals
- Adapted to the needs of the application
- Proven reliability from global project experience
- Operates unmanned or by remote operations
- Container solution pre-tested as plug-and-play standalone design
- Safe operations

The Wärtsilä Direct Electric Heating department provides:
- FEED Studies
- Feasibility studies
- Topside system design to meet subsea power requirement
- Power system analysis to ensure its integrity with the platform system
- Project execution – interface and topside integration
- Pre-commissioning/commissioning and start up assistance
UPS Systems, Resistors

UPS Systems

Wärtsilä has a broad range of uninterruptible power supply systems for all kinds of ship applications. Our reliable power distribution systems are adapted to the specific needs of the customer. Whether automation, propulsion, navigation or communication, critical consumers are all dependent on a secure power network for safe operation.

Wärtsilä’s UPS systems are customised according to the particular ship category, and take into consideration the special ship building codes of the respective classification society. These systems enable convenient monitoring and easy servicing.

Marine UPS systems are available up to 200 kVA
- Wärtsilä JOVYSTAR OCEAN, 5-20 kVA (3-ph. in-/1-ph. output) or 5-200 kVA (3-ph. in-/output)
- Wärtsilä JOVYTEC PNT, 1-3kVA for the supply of smaller service areas and consumers

Resistors

Wärtsilä is a leading manufacturer of a broad range of resistor types for marine applications, including for bow thruster control on vessels, current controlled discharging of batteries on submarines, generator tests at harbour facilities, and more. We provide robust and reliable resistor systems adapted to the needs of the customer.
Electrical & Automation

Resistors, Converters

Resistors are available for different applications:
- Wärtsilä JOVYLOAD NGR, neutral grounding/starpoint earthing resistors
- Wärtsilä JOVYLOAD CONPOWER, load resistors for generator tests and controlled battery discharging
- Wärtsilä JOVYLOAD BRAKE, braking resistors for cranes on vessels or in harbour facilities

Wärtsilä JOVYPHASE GPC Converters

Wärtsilä provides shore power conversion for yachts, cruise liners, and other vessels. The JOVYPHASE GPC converter with power rates of 20 kVA-640 kVA and more automatically adjusts the onshore network to the onboard system, no matter what the shore voltage and frequency are (input frequency 30-70 Hz). The converter can be operated in parallel to the on-board generators for short periods. Furthermore, the concept features a compact design and high efficiency of up to 97%.
Wärtsilä Entertainment Systems

Wärtsilä provides complete integrated entertainment solutions to enhance the passengers’ experience, whilst using the latest technologies that benefit both the owner and the environment.

Ship Wide Systems

- SAT TV reception and head end distribution
- Digital signage
- Cabin control
- Dimming systems
- Background Music

Local Entertainment Solutions (for public and crew venues)

- High end audio systems
- Effect Lighting systems
- Video projection systems incl. LED video walls
- Media control system
- Broadcast studio
- Architectural lighting solutions
- Stage rigging

These integrated systems are very complex. Normally they consist of an extensive array of materials in both hard- and software. The challenge is to design and assemble all these systems and their interfaces so that they are reliable and easy to use.
Safety and Security

Wärtsilä Safety & Security

Safety is of priority importance for the ship, its crew, passengers, and goods being transported. Regulations by flag states and classification authorities demand continuously higher levels of safety. In addition, security has also become a major concern of all ship owners. Wärtsilä has the expertise and experience to design and integrate comprehensive and highly integrated safety and security systems.

Wärtsilä’s safety and security technologies include:

- Public address and general alarm PA/GA
- Automatic telephone
- DECT/wireless telephony
- Talk back
- Small alarms (hospital/ sauna/ cold store/lift/disabled persons)
- UHF/VHF walkie-talkie & paging
- Master clock
- VSAT incl. airtime
- CCTV camera system
Hydroacoustic Systems

**Sonar Systems**

Wärtsilä ELAC Nautik offers the complete range of sonars. All sonars are sea proven and well-known for their high reliability.

- Wärtsilä ELAC KaleidoScope and Wärtsilä ELAC LOPAS – Sonar suites for submarines including passive, active, ranging, intercept and own-noise sensors for submarines.
- Wärtsilä ELAC SCOUT, Wärtsilä ELAC HUNTER and Wärtsilä ELAC VANGUARD – Forward looking and anti-submarine warfare sonars for surface combatants such as OPVs and corvettes.
- Wärtsilä ELAC PILOS – Pinger location sonar for submarine rescue. These sonars are based on true and up-to-date open architecture standards, supporting the owner to upgrade, modify and maintain the sonars by own capabilities.

**Underwater Communication Systems**

During recent years, the need for underwater communication has been rapidly growing in numerous applications.

- Wärtsilä ELAC UT 2200 – An underwater communication system that can serve as a compact underwater telephone and as a submarine emergency pinger.
- Wärtsilä ELAC UT 3000 – An underwater communication system combining analogue and digital communication in one unit. In addition to data voice and telegraphy mode, the system offers unique features such as its own noise measurement, horizontal distance measurement, and transmission of SOS signals.

**Survey and Navigation Systems**

For hydrographic survey operations, Wärtsilä develops and manufactures state-of-the-art multibeam echo sounder systems. Customers appreciate the precise charting of seafloor topography in the field of hydrography for the survey of harbours, lakes and oceans, as well as for oceanography, marine geology and marine biology.

**Multibeam Systems**

Our multibeam systems cover the complete survey range from shallow water depth to full ocean depth. Our Wärtsilä ELAC SeaBeam multibeam systems are known for their outstanding high-resolution and motion-stabilised features. In the field of precise surveys in extreme condition areas, they are second to none worldwide.

- Wärtsilä ELAC SeaBeam 3012/3020 – Deep water multibeam systems with Multi-ping, Swept Beam™ Technology and Water Column
Hydroacoustic Systems

Imaging. Wärtsilä ELAC SeaBeam 3012/3020 are also available in an ice-hardened version

- Wärtsilä ELAC SeaBeam 3030/3050 – Medium water multibeam systems with Multi-ping, Water Column Imaging and Advanced Beam Steering. SeaBeam 3050 also offers a military version for submarine rescue purposes
- Wärtsilä ELAC SeaBeam 1180 – Shallow water multibeam system.

Navigation Systems

Wärtsilä ELAC Nautik produces most robust navigation echo sounders to guarantee reliable detection and navigation under all circumstances.

- Wärtsilä ELAC VE 5900 – High-end naval echo sounder system for submarines and surface vessels. No other system meets such a number of military specifications and offers such outstanding modularity for perfect adaptation into a new or existing design.
- Wärtsilä DOLOG 3000 – Doppler log for high-performance speed measurement.
- Wärtsilä ELAC LAZ 5100 – IMO conforming navigation echo sounder for shallow and deep water navigation.
- Wärtsilä ELAC LAZ 5200 – IMO conforming echo sounder for shallow and deep waters with extended integration possibilities for IBS.
- Wärtsilä ELAC ST 30 – A sonar transponder for collision avoidance with submarines, offshore wind farms, and offshore rigs.
Turnkey Solutions

Wärtsilä is one of the leading system houses for the supply of complete turnkey electrical and electronic system packages on vessels.

The turnkey solutions business unit offers system integration competences and acts as an EPC contractor for complete electrical packages – typically in close cooperation with the shipyard. The customer benefits from our systems engineering competence, and our ability to create clever solutions with less cost and shorter installation times. We combine these advantages with our overall detailed electrical system design responsibilities to offer a total on-board system that is fully optimised. Our turnkey activities also include the interfaces to all the shipyard’s sub-contractors.
Electrical & Automation

Turnkey Solutions

Our core competencies are in systems integration, project management, procurement, and site supervision. We act as the shipyard’s single point of contact for the integration of all systems, from bridge to propeller.

We provide:
- Project Management
- Systems integration
- Planning
- Cable engineering
- Cables and supports
- Cable installation
- Lighting system
- Testing and commissioning
- Procurement of sub systems
- Training
- Logistics support
- Service world wide
Energy Efficiency Management

We provide the marine industry with energy efficiency management technology to reduce fuel consumption and emissions. Our range from single onboard applications to comprehensive fleet analysis. They are used by small and large shipping companies on ships ranging from cruise liners, tankers, LNG carriers, container ships and bulkers to ferries.

Voyage Simulator / Optimizer
Simulates / optimizes: engines configurations, RPM profile, service & propulsion load

Rudder Toe Angle Model
Efficiency of rudders / podded thrusters

Propulsion Power Decomposition
Knows where your power goes with exact breakdown into speed, trim, stabilizers, fouling, draft, sea depth, waves and wind

Engine Model
Creates individual fuel-power (SFOC) curves for different fuels

Hull and Propeller Performance
Extracts the exact impact of fouling, dry-docks and vessel modifications in dollars and tons of fuel

Virtual Boil-Off Sensing
Real-time boil-off rate estimate based on thermo-dynamic modelling (Currently for LNG carriers only)

Gas Management
Breaks down boil-off gas utilization in engines / boilers, gas combustion unit / steam dump & reliquefaction (Currently for LNG carriers only)
Energy Efficiency Management

Performance Monitoring
Normalized fuel curve, speed profile, charter party monitoring, emissions monitoring

Route Benchmarking
Analyzes the route performance

Environmental Forecasts, Hindcasts and Eniram Databases
Incorporates detailed wind, wave, current, temperature and depth information to every decision

Virtual STW Sensing
Gets your key metric right without calibration errors, gaps, or noise

Service Energy Model
Non-propulsion related energy consumption (Currently for cruise ships only)

Optimum Trim Model
Finding optimum trim dynamically in varying conditions
Managing fleet, voyage and vessel energy efficiency

Wärtsilä brings together experts with a unique set of skills – including seafarers, coders, and innovators – to develop solutions for the key issues facing your industry. We are moving beyond retroactive analysis towards proactive management with predictive insights and mobile alerts. Our solutions ensure that the right personnel know when a potential issue needs attention – even before problems happen.
Energy Efficiency Management

Fleet efficiency – Increasing situational awareness
Better situational awareness enables a top-down, fleet-wide approach to improving energy efficiency. In easy-to-digest dashboards you get an overview of your fleet’s activities around the world, including vessel location and KPIs, combined with the latest weather and sea-state information.

Benefits:
- Increase fleet-wide situational awareness and transparency as well as improve communication between onshore and onboard personnel, through a single online interface
- Use independent analytics to improve operational and commercial decision-making and make reporting more efficient via automation
- Take advantage of robust tools for self-service fleet performance analysis.
Energy Efficiency Management

Voyage efficiency – Optimising operational performance

Optimising voyage and operational performance results in concrete savings. You benefit from enriched data and analytics that help you to improve energy efficiency, reduce costs, and improve the planning of future voyages.

Benefits:

- Aggregate voyage performance KPIs that are comparable across your fleet, including fleet ranking by excess consumption and costs
- Improve voyage performance through diagnostics and by reducing the manual workload associated with report consolidation
- Get a fuel-consumption breakdown to realise up to 10% savings per voyage – and a realistic view on areas for improvement, resulting in better budgeting accuracy and target setting.
Vessel efficiency – Optimising technical performance

Improve energy efficiency and reduce costs with more detailed insights into your assets, including hull and propeller condition, speed fuel curves, and engine performance.

Benefits:
- Reduce vessel propulsion/service power and engine SFOC with an optimised maintenance strategy
- Increase transparency and implement best practices for vessels across your fleet with benchmarking
- Enable accurate target setting, vessel commercial description, and equipment/vendor performance verification (e.g. coatings) through fuel-consumption normalisation and removal of external factors.
### Wärtsilä Engines

The design of the Wärtsilä engine range is based on the vast amount of knowledge accumulated over years of successful operation. Robust engines derived from pioneering heavy fuel technology have been engineered to provide unquestionable benefits for the owners and operators of Wärtsilä engines and generating sets:

- **Proven reliability**
- **Low emissions**
- **Low operating costs**
- **Fuel flexibility**

Benefits for the shipyard include installation friendliness, embedded automation systems, and built-on modularised auxiliary systems.

#### Power range for Wärtsilä engines

<table>
<thead>
<tr>
<th>Wärtsilä dual-fuel engines</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wärtsilä 20DF</td>
<td>0-3</td>
</tr>
<tr>
<td>Wärtsilä 34DF</td>
<td>5-15</td>
</tr>
<tr>
<td>Wärtsilä 31DF</td>
<td>7-16</td>
</tr>
<tr>
<td>Wärtsilä 46DF</td>
<td>10-20</td>
</tr>
<tr>
<td>Wärtsilä 50DF</td>
<td>13-20</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Wärtsilä diesel engines</th>
<th>kW</th>
</tr>
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<tbody>
<tr>
<td>Wärtsilä 14</td>
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<tr>
<td>Wärtsilä 20</td>
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<td>Wärtsilä 26</td>
<td>2-6</td>
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<tr>
<td>Wärtsilä 32</td>
<td>3-7</td>
</tr>
<tr>
<td>Wärtsilä 31</td>
<td>4-8</td>
</tr>
<tr>
<td>Wärtsilä 46F</td>
<td>5-11</td>
</tr>
</tbody>
</table>

Engines and Generating Sets

CLICK for more info
Engines and Generating Sets

Fuel flexibility

Wärtsilä is continuously developing its portfolio of gas and multi-fuel engines to suit different marine applications, be they offshore oil and gas installations where gaseous fuel is available from the process, or a merchant vessel operating in environmentally sensitive areas. The Wärtsilä engines offer high efficiency, low exhaust gas emissions and safe operation. The innovative multi-fuel technology allows the flexibility to choose between gas and liquid fuel. When necessary, the engines are capable of switching from one fuel to the other without any interruption in power generation.
Dual-fuel Engines

### Wärtsilä 20DF

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>IMO Tier III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>200 mm</td>
<td>Fuel specification: Fuel oil</td>
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<tr>
<td>Piston stroke</td>
<td>280 mm</td>
<td>700 cSt/50°C 7200 sR1/100°F</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>185 kW/cyl</td>
<td>ISO 8217, category ISO-F-DMX, DMA and DMB</td>
</tr>
<tr>
<td>Speed</td>
<td>1200 rpm</td>
<td></td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>21.0 bar</td>
<td>BSEC 8460 kJ/kWh</td>
</tr>
<tr>
<td>Piston speed</td>
<td>11.2 m/s</td>
<td>BSGC 8290 kJ/kWh</td>
</tr>
</tbody>
</table>

### Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
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<tbody>
<tr>
<td>6L20DF</td>
<td>1 110</td>
</tr>
<tr>
<td>8L20DF</td>
<td>1 480</td>
</tr>
<tr>
<td>9L20DF</td>
<td>1 665</td>
</tr>
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</table>

### Engine dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L20DF</td>
<td>3 254</td>
<td>3 108</td>
<td>1 705</td>
<td>1 690</td>
<td>1 800</td>
<td>624</td>
<td>9.4</td>
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<tr>
<td>8L20DF</td>
<td>3 973</td>
<td>3 783</td>
<td>1 705</td>
<td>1 824</td>
<td>1 800</td>
<td>624</td>
<td>11.1</td>
</tr>
<tr>
<td>9L20DF</td>
<td>4 261</td>
<td>4 076</td>
<td>1 705</td>
<td>1 824</td>
<td>1 800</td>
<td>624</td>
<td>11.7</td>
</tr>
</tbody>
</table>

For definitions see page 67.
Dual-fuel Engines

Wärtsilä 31DF

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>310 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>430 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>550 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>27.2 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.75 m/s</td>
</tr>
</tbody>
</table>

**Fuel specification:**
Fuel oil

**ISO Tier III**

**Cylinder output**
ISO 8217, category ISO-F-DMX, DMA and DMB

**Speed**
BSEC 7230 kJ/kWh
BSGC 7059 kJ/kWh

**Piston speed**
10.75 m/s

**Mean effective pressure**
27.2 bar

**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>8V31DF</td>
<td>4 400</td>
</tr>
<tr>
<td>10V31DF</td>
<td>5 500</td>
</tr>
<tr>
<td>12V31DF</td>
<td>6 600</td>
</tr>
<tr>
<td>14V31DF</td>
<td>7 700</td>
</tr>
<tr>
<td>16V31DF</td>
<td>8 800</td>
</tr>
</tbody>
</table>

**Engine dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>8V31DF</td>
<td>6 180</td>
<td>5 585</td>
<td>3 205</td>
<td>3 100</td>
<td>1 500</td>
<td>57.5</td>
</tr>
<tr>
<td>10V31DF</td>
<td>6 820</td>
<td>6 225</td>
<td>3 205</td>
<td>3 100</td>
<td>1 500</td>
<td>66.1</td>
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<tr>
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<td>7 500</td>
<td>6 905</td>
<td>2 550</td>
<td>3 500</td>
<td>1 500</td>
<td>77.7</td>
</tr>
<tr>
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<td>7 545</td>
<td>2 550</td>
<td>3 500</td>
<td>1 500</td>
<td>85.3</td>
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<tr>
<td>16V31DF</td>
<td>8 780</td>
<td>8 185</td>
<td>2 550</td>
<td>3 500</td>
<td>1 500</td>
<td>94.1</td>
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* Turbocharger at flywheel end
For definitions see page 67.
Dual-fuel Engines

**Wärtsilä 34DF**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>340 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>400 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>500 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>22.0 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.0 m/s</td>
</tr>
</tbody>
</table>

** IMO Tier III, EPA T3**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel specification: Fuel oil</td>
<td></td>
</tr>
<tr>
<td>ISO 8217, category ISO-F-DMX, DMA and DMB</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>22.0 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.0 m/s</td>
</tr>
</tbody>
</table>

**Engine dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L34DF</td>
<td>5 335</td>
<td>2 550</td>
<td>2 380</td>
<td>2 345</td>
<td>1 155</td>
<td>35</td>
</tr>
<tr>
<td>8L34DF</td>
<td>6 315</td>
<td>2 550</td>
<td>2 295</td>
<td>2 345</td>
<td>1 155</td>
<td>44</td>
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<td>9L34DF</td>
<td>6 869</td>
<td>2 550</td>
<td>2 610</td>
<td>2 345</td>
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<td>49</td>
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<td>12V34DF</td>
<td>6 865</td>
<td>2 435</td>
<td>2 900</td>
<td>2 120</td>
<td>1 210</td>
<td>61</td>
</tr>
<tr>
<td>16V34DF</td>
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<td>2 570</td>
<td>3 325</td>
<td>2 120</td>
<td>1 210</td>
<td>77</td>
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For definitions see page 67.
Wärtsilä 46DF

<table>
<thead>
<tr>
<th>Specifications</th>
<th>IMO Tier III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>460 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>580 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>1145 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>600 rpm</td>
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<tr>
<td>Mean effective pressure</td>
<td>23.8 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>11.6 m/s</td>
</tr>
<tr>
<td>Fuel specification: Fuel oil</td>
<td>700 cSt/50°C 7200 sR1/100°F</td>
</tr>
<tr>
<td>ISO 8217, category ISO-F-DMX,</td>
<td>DMA &amp; DMB</td>
</tr>
<tr>
<td>BSEC 7460 kJ/kWh</td>
<td>BSGC 7420 kJ/kWh</td>
</tr>
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</table>

**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
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<tbody>
<tr>
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<td>6 870</td>
</tr>
<tr>
<td>7L46DF</td>
<td>8 015</td>
</tr>
<tr>
<td>8L46DF</td>
<td>9 160</td>
</tr>
<tr>
<td>9L46DF</td>
<td>10 305</td>
</tr>
<tr>
<td>12V46DF</td>
<td>13 740</td>
</tr>
<tr>
<td>14V46DF</td>
<td>16 030</td>
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<tr>
<td>16V46DF</td>
<td>18 320</td>
</tr>
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</table>

**Engine dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>A*</th>
<th>B</th>
<th>C</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L46DF</td>
<td>8 953</td>
<td>8 670</td>
<td>3 255</td>
<td>3 185</td>
<td>1 430</td>
<td>102</td>
</tr>
<tr>
<td>7L46DF</td>
<td>9 773</td>
<td>9 635</td>
<td>3 255</td>
<td>3 185</td>
<td>1 430</td>
<td>118</td>
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<tr>
<td>8L46DF</td>
<td>10 590</td>
<td>10 310</td>
<td>3 445</td>
<td>3 185</td>
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<td>130</td>
</tr>
<tr>
<td>9L46DF</td>
<td>11 413</td>
<td>11 130</td>
<td>3 445</td>
<td>3 185</td>
<td>1 430</td>
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<td>10 350</td>
<td>11 120</td>
<td>3 670</td>
<td>4 555</td>
<td>1 620</td>
<td>184</td>
</tr>
<tr>
<td>14V46DF</td>
<td>11 400</td>
<td>12 170</td>
<td>3 670</td>
<td>4 555</td>
<td>1 620</td>
<td>223</td>
</tr>
<tr>
<td>16V46DF</td>
<td>12 700</td>
<td>13 450</td>
<td>3 860</td>
<td>5 174</td>
<td>1 620</td>
<td>235</td>
</tr>
</tbody>
</table>

For definitions see page 67.
Wärtsilä 50DF

**Cylinder bore** 500 mm
**Piston stroke** 580 mm
**Cylinder output** 975 kW/cyl
**Speed** 514 rpm
**Mean effective pressure** 20.0 bar
**Piston speed** 9.9 m/s

**Fuel specification**: Fuel oil
**Speed** 514 rpm

**ISO 8217, category ISO-F-DMX, DMA and DMB**

**BSEC/BSCG** are given at the following conditions: Values apply for reference conditions ISO 15550 : 2002 (E).

With engine driven pumps (two water pumps, one lubricating oil pump and pilot fuel pump). With 5% tolerance

For definitions see page 67.

### Dual-fuel Engines

#### Engine dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L50DF</td>
<td>8 120</td>
<td>3 475</td>
<td>3 270</td>
<td>1 455</td>
<td>96</td>
</tr>
<tr>
<td>8L50DF</td>
<td>10 270</td>
<td>3 920</td>
<td>3 505</td>
<td>1 455</td>
<td>128</td>
</tr>
<tr>
<td>9L50DF</td>
<td>11 140</td>
<td>3 920</td>
<td>3 505</td>
<td>1 455</td>
<td>138</td>
</tr>
<tr>
<td>12V50DF</td>
<td>10 425</td>
<td>4 240</td>
<td>3 810</td>
<td>1 500</td>
<td>175</td>
</tr>
<tr>
<td>16V50DF</td>
<td>13 830</td>
<td>4 400</td>
<td>4 730</td>
<td>1 500</td>
<td>220</td>
</tr>
</tbody>
</table>

BSEC/BSCG are given at the following conditions: Values apply for reference conditions ISO 15550 : 2002 (E).

With engine driven pumps (two water pumps, one lubricating oil pump and pilot fuel pump). With 5% tolerance

For definitions see page 67.
Diesel Engines

| Cylinder bore | 135 mm |
| Piston stroke | 157 mm |
| Speed         | 1600-1900 rpm |

**Fuel specification:**
Light fuel oil, maximum sulphur content 0.5%
ISO 8217, category ISO-F-DMX, DMA,DMZ
SFOC 205.0 g/kWh at ISO condition

<table>
<thead>
<tr>
<th>Rating</th>
<th>Maximum load</th>
<th>Overall load factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Continuous Duty</td>
<td>Up to 100% of the time</td>
<td>80–100%</td>
</tr>
<tr>
<td>B – Heavy Duty</td>
<td>Up to 10 out of every 12 operating hours</td>
<td>40–80%</td>
</tr>
<tr>
<td>C – Medium Continuous Duty</td>
<td>Up to 6 out of every 12 operating hours</td>
<td>20–80%</td>
</tr>
<tr>
<td>D – Intermittent Duty</td>
<td>Up to 3 out of every 12 operating hours</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

**Wärtsilä 12V14**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Nominal Power</th>
<th>Nominal Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWm</td>
<td>bhp</td>
</tr>
<tr>
<td>A</td>
<td>749</td>
<td>1 004</td>
</tr>
<tr>
<td>B</td>
<td>810</td>
<td>1 086</td>
</tr>
<tr>
<td>C</td>
<td>790</td>
<td>1 059</td>
</tr>
<tr>
<td>D</td>
<td>850</td>
<td>1 139</td>
</tr>
</tbody>
</table>

**Wärtsilä 16V14**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Nominal Power</th>
<th>Nominal Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWm</td>
<td>bhp</td>
</tr>
<tr>
<td>A</td>
<td>1 005</td>
<td>1 347</td>
</tr>
<tr>
<td>B</td>
<td>1 055</td>
<td>1 448</td>
</tr>
<tr>
<td>C</td>
<td>1 135</td>
<td>1 522</td>
</tr>
<tr>
<td>D</td>
<td>1 185</td>
<td>1 642</td>
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**Engine dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V14</td>
<td>2 136</td>
<td>1 480</td>
<td>1 525</td>
<td>2.7</td>
</tr>
<tr>
<td>16V14</td>
<td>2 514</td>
<td>1 540</td>
<td>1 517</td>
<td>3.8</td>
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</table>

CLICK for more info
## Wärtsilä 20

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>200 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>280 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>200/220 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>1000/1200 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>27.3/25 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>9.3/11.2 m/s</td>
</tr>
<tr>
<td><strong>Fuel specification: Fuel oil</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ISO 8217, category ISO-F-RMK 700</strong></td>
<td></td>
</tr>
<tr>
<td><strong>SFOC 189.9 g/kWh at ISO conditions</strong></td>
<td></td>
</tr>
</tbody>
</table>

### Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW/1000 rpm</th>
<th>kW/1200 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4L20</td>
<td>800</td>
<td>–</td>
</tr>
<tr>
<td>6L20</td>
<td>1 200</td>
<td>1 320</td>
</tr>
<tr>
<td>8L20</td>
<td>1 600</td>
<td>1 760</td>
</tr>
<tr>
<td>9L20</td>
<td>1 800</td>
<td>1 980</td>
</tr>
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### Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
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<th>A</th>
<th>B*</th>
<th>B</th>
<th>C*</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4L20</td>
<td>–</td>
<td>2 510</td>
<td>–</td>
<td>1 348</td>
<td>–</td>
<td>1 483</td>
<td>1 800</td>
<td>725</td>
<td>7.2</td>
</tr>
<tr>
<td>6L20</td>
<td>3 254</td>
<td>3 108</td>
<td>1 528</td>
<td>1 348</td>
<td>1 580</td>
<td>1 579</td>
<td>1 800</td>
<td>624</td>
<td>9.3</td>
</tr>
<tr>
<td>8L20</td>
<td>3 973</td>
<td>3 783</td>
<td>1 614</td>
<td>1 465</td>
<td>1 756</td>
<td>1 713</td>
<td>1 800</td>
<td>624</td>
<td>11.0</td>
</tr>
<tr>
<td>9L20</td>
<td>4 261</td>
<td>4 076</td>
<td>1 614</td>
<td>1 449</td>
<td>1 756</td>
<td>1 713</td>
<td>1 800</td>
<td>624</td>
<td>11.6</td>
</tr>
</tbody>
</table>

* Turbocharger at flywheel end.
For definitions see page 67.
Engines and Generating Sets

Diesel Engines

**Wärtsilä 26**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>260 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>320 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>340 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>1000 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>24 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.7 m/s</td>
</tr>
<tr>
<td>Fuel specification</td>
<td>Fuel oil</td>
</tr>
<tr>
<td>ISO 8217, category ISO-F-RMK 700</td>
<td>700 cSt/50°C 7200 sR1/100°F</td>
</tr>
</tbody>
</table>

**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L26</td>
<td>2 040</td>
</tr>
<tr>
<td>8L26</td>
<td>2 720</td>
</tr>
<tr>
<td>9L26</td>
<td>3 060</td>
</tr>
<tr>
<td>12V26</td>
<td>4 080</td>
</tr>
<tr>
<td>16V26</td>
<td>5 440</td>
</tr>
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</table>

**Dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>A</th>
<th>B*</th>
<th>B</th>
<th>C*</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>F</th>
<th>Weight dry sump</th>
<th>Weight wet sump</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L26</td>
<td>4 387</td>
<td>4 130</td>
<td>1 882</td>
<td>1 833</td>
<td>1 960</td>
<td>2 020</td>
<td>2 430</td>
<td>818</td>
<td>950</td>
<td>17.0</td>
<td>17.2</td>
</tr>
<tr>
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<td>5 302</td>
<td>5 059</td>
<td>2 023</td>
<td>1 868</td>
<td>2 010</td>
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<td>2 430</td>
<td>818</td>
<td>950</td>
<td>21.6</td>
<td>21.9</td>
</tr>
<tr>
<td>9L26</td>
<td>5 691</td>
<td>5 449</td>
<td>2 023</td>
<td>1 868</td>
<td>2 016</td>
<td>2 107</td>
<td>2 430</td>
<td>818</td>
<td>950</td>
<td>23.3</td>
<td>23.6</td>
</tr>
<tr>
<td>12V26</td>
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<td>5 314</td>
<td>2 034</td>
<td>2 034</td>
<td>2 552</td>
<td>2 602</td>
<td>2 060</td>
<td>800</td>
<td>1 110</td>
<td>28.7</td>
<td>29.0</td>
</tr>
<tr>
<td>16V26</td>
<td>6 223</td>
<td>6 025</td>
<td>2 151</td>
<td>2 190</td>
<td>2 489</td>
<td>2 763</td>
<td>2 060</td>
<td>800</td>
<td>1 110</td>
<td>36.1</td>
<td>37.9</td>
</tr>
</tbody>
</table>

* Turbocharger at flywheel end.
For definitions see page 67.
## Wärtsilä 31

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>310 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>430 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>610 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>30.1 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.75 m/s</td>
</tr>
<tr>
<td>Fuel specification</td>
<td>Fuel oil</td>
</tr>
<tr>
<td>SFOC</td>
<td>167.7 g/kWh at ISO conditions</td>
</tr>
<tr>
<td>ISO 8217, category ISO-F-RMK 700</td>
<td></td>
</tr>
</tbody>
</table>

### Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>8V31</td>
<td>4 880</td>
</tr>
<tr>
<td>10V31</td>
<td>6 100</td>
</tr>
<tr>
<td>12V31</td>
<td>7 320</td>
</tr>
<tr>
<td>14V31</td>
<td>8 540</td>
</tr>
<tr>
<td>16V31</td>
<td>9 760</td>
</tr>
</tbody>
</table>

### Engine dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>F</th>
<th>Weight</th>
</tr>
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<tbody>
<tr>
<td>8V31</td>
<td>6 175</td>
<td>6 114</td>
<td>3 205</td>
<td>3 113</td>
<td>1 496</td>
<td>57.0</td>
</tr>
<tr>
<td>10V31</td>
<td>6 813</td>
<td>6 754</td>
<td>3 205</td>
<td>3 113</td>
<td>1 496</td>
<td>65.6</td>
</tr>
<tr>
<td>12V31</td>
<td>7 900</td>
<td>7 840</td>
<td>2 628</td>
<td>3 500</td>
<td>1 496</td>
<td>77.1</td>
</tr>
<tr>
<td>14V31</td>
<td>8 540</td>
<td>8 480</td>
<td>2 660</td>
<td>3 500</td>
<td>1 496</td>
<td>84.6</td>
</tr>
<tr>
<td>16V31</td>
<td>9 130</td>
<td>9 070</td>
<td>2 660</td>
<td>3 500</td>
<td>1 496</td>
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* Turbocharger at flywheel end
For definitions see page 67.
Wärtsilä 32

<table>
<thead>
<tr>
<th>Cylinder bore</th>
<th>320 mm</th>
<th>IMO Tier II or III</th>
</tr>
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<tbody>
<tr>
<td>Piston stroke</td>
<td>400 mm</td>
<td>700 cSt/50°C</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>580 kW/cyl</td>
<td>7200 sR1/100°F</td>
</tr>
<tr>
<td>Speed</td>
<td>750 rpm</td>
<td>ISO 8217, category ISO-F-RMK 700</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>28.9 bar</td>
<td>SFOC 178.8 g/kWh at ISO conditions</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.0 m/s</td>
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**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
</tr>
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<tbody>
<tr>
<td>6L32</td>
<td>3 480</td>
</tr>
<tr>
<td>8L32</td>
<td>4 640</td>
</tr>
<tr>
<td>9L32</td>
<td>5 220</td>
</tr>
<tr>
<td>12V32</td>
<td>6 960</td>
</tr>
<tr>
<td>16V32</td>
<td>9 280</td>
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**Dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>A</th>
<th>B*</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>F</th>
<th>Weight</th>
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<tr>
<td>6L32</td>
<td>5 570</td>
<td>5 130</td>
<td>2 432</td>
<td>2 295</td>
<td>2 380</td>
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<td>8L32</td>
<td>6 400</td>
<td>6 379</td>
<td>2 457</td>
<td>2 375</td>
<td>2 610</td>
<td>2 345</td>
<td>1 155</td>
<td>44</td>
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<td>9L32</td>
<td>6 885</td>
<td>6 869</td>
<td>2 455</td>
<td>2 375</td>
<td>2 610</td>
<td>2 345</td>
<td>1 155</td>
<td>49</td>
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<tr>
<td>12V32</td>
<td>7 098</td>
<td>6 865</td>
<td>2 516</td>
<td>2 430</td>
<td>2 900</td>
<td>2 120</td>
<td>1 210</td>
<td>57</td>
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<tr>
<td>16V32</td>
<td>8 041</td>
<td>7 905</td>
<td>2 516</td>
<td>2 595</td>
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<td>2 120</td>
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* Turbocharger at flywheel end.
For definitions see page 67.
### Wärtsilä 46F

<table>
<thead>
<tr>
<th>Specification</th>
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<tr>
<td>Cylinder bore</td>
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<tr>
<td>Piston stroke</td>
<td>580 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>1200 kW/cyl</td>
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<tr>
<td>Speed</td>
<td>600 rpm</td>
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<tr>
<td>Mean effective pressure</td>
<td>24.9 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>11.6 m/s</td>
</tr>
<tr>
<td>Fuel specification</td>
<td>ISO 8217, category ISO-F-RMK 700</td>
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<tr>
<td>SFOC at ISO conditions</td>
<td>175 g/kWh at ISO conditions</td>
</tr>
<tr>
<td>ISO Tier II or III</td>
<td></td>
</tr>
<tr>
<td>Option: Lubricating oil module</td>
<td>integrated on engine.</td>
</tr>
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**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>kW</th>
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<tbody>
<tr>
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<td>7 200</td>
</tr>
<tr>
<td>7L46F</td>
<td>8 400</td>
</tr>
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<td>8L46F</td>
<td>9 600</td>
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<tr>
<td>9L46F</td>
<td>10 800</td>
</tr>
<tr>
<td>12V46F</td>
<td>14 400</td>
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<tr>
<td>14V46F</td>
<td>16 800</td>
</tr>
<tr>
<td>16V46F</td>
<td>19 200</td>
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**Dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A</th>
<th>A*</th>
<th>B</th>
<th>C</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L46F</td>
<td>8 470</td>
<td>8 620</td>
<td>3 500</td>
<td>2 905</td>
<td>1 480</td>
<td>97</td>
</tr>
<tr>
<td>7L46F</td>
<td>9 465</td>
<td>9 440</td>
<td>3 800</td>
<td>3 130</td>
<td>1 480</td>
<td>113</td>
</tr>
<tr>
<td>8L46F</td>
<td>10 255</td>
<td>10 260</td>
<td>3 800</td>
<td>3 130</td>
<td>1 480</td>
<td>124</td>
</tr>
<tr>
<td>9L46F</td>
<td>11 075</td>
<td>11 080</td>
<td>3 800</td>
<td>3 130</td>
<td>1 480</td>
<td>140</td>
</tr>
<tr>
<td>12V46F</td>
<td>10 950</td>
<td>10 280</td>
<td>3 770</td>
<td>4 050</td>
<td>1 820</td>
<td>177</td>
</tr>
<tr>
<td>14V46F</td>
<td>11 650</td>
<td>11 729</td>
<td>4 243</td>
<td>4 678</td>
<td>1 820</td>
<td>216</td>
</tr>
<tr>
<td>16V46F</td>
<td>12 700</td>
<td>12 880</td>
<td>4 243</td>
<td>4 678</td>
<td>1 820</td>
<td>233</td>
</tr>
</tbody>
</table>

* Turbocharger at flywheel end.

For definitions see page 67.
Diesel Engines

Definitions and notes for Wärtsilä engines

Engine dimensions

A* Total length of the engine when the turbocharger is located at the flywheel end.
A Total length of the engine when the turbocharger is located at the free end.
B Height from the crankshaft centreline to the highest point.
B* Height from the crankshaft centreline to the highest point when the turbocharger is located at the flywheel end.
C Total width of the engine.
C* Total width of the engine when the turbocharger is located at the flywheel end.
D Minimum height from the crankshaft centreline when removing a piston.
F Distance from the crankshaft centreline to the bottom of the oil sump.

Dimensions and weights

- Dimensions are in millimetres and weights are in metric tonnes. Indicated values are for guidance only and are not binding.
- Cylinder configurations: L = in-line and V = v-form.

Specific fuel energy consumption

- At ISO standard reference conditions at 85% load
- Lower calorific value of fuel 42 700 kJ/kg
- Tolerance 5%
- With engine driven pumps
- Natural gas
- Methane number min. 80
- Lower heating value min. 28 MJ/Nm³

ISO standard reference conditions

Total barometric pressure .................................................. 1.0 bar
Suction air temperature ..................................................... 25°C
Charge air cooling water temperature ................................. 25°C
Relative humidity ................................................................ 30%
Wärtsilä Auxpac generating sets are available in a selected range as pre-engineered and pre-commissioned auxiliary generating sets. The common baseframe is optimised for the package, which together with the compact design of the engine and the selected generator, offers unmatched power-to-space and power-to-weight ratios. Auxpac generating sets are offered as 400 V / 690 V / 6600 V – 50 Hz and 400 V / 690 V / 6600 V – 60 Hz in the power range 500 kW to 4300 kW.

### Main data of generators

<table>
<thead>
<tr>
<th></th>
<th>60 Hz</th>
<th>50 Hz</th>
<th>IMO Tier II or III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltage</strong></td>
<td>450</td>
<td>400</td>
<td>Fuel specification:</td>
</tr>
<tr>
<td><strong>Protection class</strong></td>
<td>IP 23, IP 44 *</td>
<td>IP 23, IP 44 *</td>
<td>Fuel oil</td>
</tr>
<tr>
<td><strong>Temperature rise and isolation</strong></td>
<td>Class F</td>
<td>Class F</td>
<td>ISO 8217, category ISO-F-RMK 55</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Air, water *</td>
<td>Air, water *</td>
<td>* Option</td>
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</table>
### A20 – Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Output kW</th>
<th>A</th>
<th>E</th>
<th>L</th>
<th>Weight</th>
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<td>520W4L20</td>
<td>520</td>
<td>5 113</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>685W4L20</td>
<td>685</td>
<td>5 113</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>760W6L20</td>
<td>760</td>
<td>5 783</td>
<td>1 860</td>
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</tr>
<tr>
<td>875W6L20</td>
<td>875</td>
<td>5 783</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>1040W6L20</td>
<td>1 040</td>
<td>5 783</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>1200W8L20</td>
<td>1 200</td>
<td>6 508</td>
<td>2 010</td>
<td>2 462</td>
</tr>
<tr>
<td>1400W8L20</td>
<td>1 400</td>
<td>6 508</td>
<td>2 010</td>
<td>2 462</td>
</tr>
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<td>1600W9L20</td>
<td>1 600</td>
<td>6 784</td>
<td>2 010</td>
<td>2 457</td>
</tr>
<tr>
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<td>1 150</td>
<td>5 783</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>1260W6L20</td>
<td>1 260</td>
<td>5 783</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>1325W8L20</td>
<td>1 325</td>
<td>6 503</td>
<td>2 010</td>
<td>2 462</td>
</tr>
<tr>
<td>1500W8L20</td>
<td>1 500</td>
<td>6 503</td>
<td>2 010</td>
<td>2 462</td>
</tr>
<tr>
<td>1680W8L20</td>
<td>1 680</td>
<td>6 503</td>
<td>2 010</td>
<td>2 462</td>
</tr>
<tr>
<td>1760W9L20</td>
<td>1 760</td>
<td>6 784</td>
<td>2 010</td>
<td>2 457</td>
</tr>
<tr>
<td>1880W9L20</td>
<td>1 880</td>
<td>6 784</td>
<td>2 010</td>
<td>2 457</td>
</tr>
<tr>
<td>520W4L20</td>
<td>520</td>
<td>5 133</td>
<td>1 860</td>
<td>2 275</td>
</tr>
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<tr>
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<td>760</td>
<td>5 133</td>
<td>1 860</td>
<td>2 275</td>
</tr>
<tr>
<td>1000W6L20</td>
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<td>1 860</td>
<td>2 275</td>
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<td>1 860</td>
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</tr>
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<td>1350W8L20</td>
<td>1 350</td>
<td>6 508</td>
<td>2 010</td>
<td>2 462</td>
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<tr>
<td>1520W8L20</td>
<td>1 520</td>
<td>6 508</td>
<td>2 010</td>
<td>2 462</td>
</tr>
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<td>1700W9L20</td>
<td>1 700</td>
<td>6 784</td>
<td>2 010</td>
<td>2 457</td>
</tr>
</tbody>
</table>
Engines and Generating Sets

Generating Sets

Wärtsilä Gensets

A wide range of generating sets, comprising the generator and diesel engine mounted on a common baseframe, are available for both service power generation and for diesel-electric propulsion. All generating sets listed in this section are based on medium-speed diesel engines designed for operating on heavy fuel oil. These generating sets are resiliently mounted and the generator voltage can be selected in all cases, except for the Auxpac generating sets, which are Low Voltage only. Larger diesel generators are delivered for separate mounting of the diesel engine and generator.

Power Range for Wärtsilä Gensets

<table>
<thead>
<tr>
<th>Wärtsilä Genset 20DF</th>
<th>2000</th>
<th>4000</th>
<th>6000</th>
<th>8000</th>
<th>10,000</th>
<th>12,000</th>
</tr>
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<tbody>
<tr>
<td>Wärtsilä Genset 34DF</td>
<td></td>
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<td>8000</td>
<td>6000</td>
<td>4000</td>
<td>2000</td>
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<tr>
<td>Wärtsilä Genset 31DF</td>
<td></td>
<td></td>
<td>6000</td>
<td>8000</td>
<td>10,000</td>
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<td>Wärtsilä Genset 14</td>
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<td>4000</td>
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<td>Wärtsilä Genset 26</td>
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<td>6000</td>
<td>8000</td>
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<td>6000</td>
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Engines and Generating Sets

Generating Sets

<table>
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<tr>
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<th>IMO Tier III</th>
</tr>
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<tr>
<td>Cylinder bore</td>
<td>200 mm</td>
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<td>Piston stroke</td>
<td>280 mm</td>
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<tr>
<td>Cylinder output</td>
<td>160/185 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>1000/1200 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>22.0, 21.0 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>9.3, 11.2 m/s</td>
</tr>
<tr>
<td>Generator voltage</td>
<td>0.4–13.8 kV</td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95–0.96</td>
</tr>
</tbody>
</table>

| Fuel specification: Fuel oil | ISO 8217, category ISO-F-DMX, DMA and DMB |
| 700 cSt/50°C | 7200 sR1/100°F |
| BSEC 8390 kJ/kWh | BSGC 8220 kJ/kWh |

<table>
<thead>
<tr>
<th>Rated power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
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<td>8L20DF</td>
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<tr>
<td>9L20DF</td>
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</table>

<table>
<thead>
<tr>
<th>Dimensions (mm) and weights (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>6L20DF</td>
</tr>
<tr>
<td>8L20DF</td>
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<tr>
<td>9L20DF</td>
</tr>
</tbody>
</table>

For definitions see page 79.


### Wärtsilä Genset 31DF

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>310 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>430 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>530, 550 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>720, 750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>27.1, 27.2 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.3, 10.75 m/s</td>
</tr>
<tr>
<td>Generator voltage</td>
<td>0.4-13.8 kV</td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95-0.97</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuel specification:</th>
<th>ISO 8217, category ISO-F-RMK 700</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 8217</td>
<td>ISO-F-RMK 700</td>
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### Rated power

<table>
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<th>Engine type</th>
<th>60 Hz</th>
<th>50 Hz</th>
</tr>
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<td></td>
<td>530 kW/cyl, 720 rpm</td>
<td>550 kW/cyl, 750 rpm</td>
</tr>
<tr>
<td></td>
<td>Engine kW</td>
<td>Gen. kW</td>
</tr>
<tr>
<td>8V31DF</td>
<td>4 240</td>
<td>4 070</td>
</tr>
<tr>
<td>10V31DF</td>
<td>5 300</td>
<td>5 090</td>
</tr>
<tr>
<td>12V31DF</td>
<td>6 360</td>
<td>6 100</td>
</tr>
<tr>
<td>14V31DF</td>
<td>7 420</td>
<td>7 120</td>
</tr>
<tr>
<td>16V31DF</td>
<td>8 480</td>
<td>8 140</td>
</tr>
</tbody>
</table>

### Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>E*</th>
<th>I*</th>
<th>K</th>
<th>L*</th>
<th>Weight*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8V31DF</td>
<td>9 100</td>
<td>3 110</td>
<td>1 700</td>
<td>2 390</td>
<td>4 880</td>
<td>94.3</td>
</tr>
<tr>
<td>10V31DF</td>
<td>9 750</td>
<td>3 110</td>
<td>1 700</td>
<td>2 390</td>
<td>4 880</td>
<td>107.2</td>
</tr>
<tr>
<td>12V31DF</td>
<td>10 150</td>
<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>122.3</td>
</tr>
<tr>
<td>14V31DF</td>
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<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>138.4</td>
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<tr>
<td>16V31DF</td>
<td>11 400</td>
<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>150.4</td>
</tr>
</tbody>
</table>

* Dependent on generator type and size. For definitions see page 79.
**Wärtsilä Genset 34DF**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>Cylinder bore</td>
<td>340 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>400 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>480, 500 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>720, 750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>22.0 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>9.6, 10.0 m/s</td>
</tr>
<tr>
<td>Generator voltage</td>
<td>0.4–13.8 kV</td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95–0.97</td>
</tr>
</tbody>
</table>

**Rated power**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>60 Hz 480 kW/cyl, 720 rpm</th>
<th>50 Hz 500 kW/cyl, 750 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engine kW</td>
<td>Gen. kW</td>
</tr>
<tr>
<td>6L34DF</td>
<td>2 880</td>
<td>2 770</td>
</tr>
<tr>
<td>8L34DF</td>
<td>3 840</td>
<td>3 690</td>
</tr>
<tr>
<td>9L34DF</td>
<td>4 320</td>
<td>4 150</td>
</tr>
<tr>
<td>12V34DF</td>
<td>5 760</td>
<td>5 530</td>
</tr>
<tr>
<td>16V34DF</td>
<td>7 680</td>
<td>7 370</td>
</tr>
</tbody>
</table>

**Dimensions (mm) and weights (tonnes)**

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>E*</th>
<th>I*</th>
<th>K</th>
<th>L*</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6L34DF</td>
<td>8 700</td>
<td>2 290</td>
<td>1 450</td>
<td>2 345</td>
<td>4 000</td>
<td>57</td>
</tr>
<tr>
<td>8L34DF</td>
<td>10 410</td>
<td>2 690</td>
<td>1 630</td>
<td>2 345</td>
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<td>76</td>
</tr>
<tr>
<td>9L34DF</td>
<td>10 475</td>
<td>2 890</td>
<td>1 630</td>
<td>2 345</td>
<td>4 180</td>
<td>87</td>
</tr>
<tr>
<td>12V34DF</td>
<td>10 075</td>
<td>3 060</td>
<td>1 700</td>
<td>2 120</td>
<td>4 365</td>
<td>96</td>
</tr>
<tr>
<td>16V34DF</td>
<td>11 175</td>
<td>3 060</td>
<td>1 850</td>
<td>2 120</td>
<td>4 515</td>
<td>121</td>
</tr>
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</table>

* Dependent on generator type.
Generator output based on a generator efficiency of 96%.
For definitions see page 79.
Wärtsilä Genset 14

| Cylinder bore | 135 mm |
| Piston stroke | 157 mm |
| Speed         | 1500, 1800 rpm |
| Generator voltage | 0.4 - 0.69 kV |
| Generator efficiency | 0.95 - 0.96 |

Fuel specification: Light fuel oil, maximum sulphur content 0.5%
ISO 8217, category ISO-F-DMX, DMA,DMZ
SFOC 205,0 g/kWh at ISO condition

<table>
<thead>
<tr>
<th>Engine type</th>
<th>Engine kW</th>
<th>Gen. kW</th>
<th>Engine kW</th>
<th>Gen. kW</th>
<th>Engine kW</th>
<th>Gen. kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V14</td>
<td>710</td>
<td>675</td>
<td>790</td>
<td>750</td>
<td>910</td>
<td>865</td>
</tr>
<tr>
<td>16V14</td>
<td>945</td>
<td>900</td>
<td>1 055</td>
<td>1 000</td>
<td>1 215</td>
<td>1 155</td>
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<table>
<thead>
<tr>
<th>Engine type</th>
<th>Engine kW</th>
<th>Gen. kW</th>
<th>Engine kW</th>
<th>Gen. kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V14</td>
<td>710</td>
<td>675</td>
<td>790</td>
<td>750</td>
</tr>
<tr>
<td>16V14</td>
<td>945</td>
<td>900</td>
<td>1 055</td>
<td>1 000</td>
</tr>
</tbody>
</table>

Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>E*</th>
<th>L*</th>
<th>Weight*</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V14</td>
<td>3 800</td>
<td>1 480</td>
<td>1 600</td>
<td>5.5</td>
</tr>
<tr>
<td>16V14</td>
<td>4 600</td>
<td>1 540</td>
<td>1 600</td>
<td>7.5</td>
</tr>
</tbody>
</table>

* Dependent on generator type and size.
For definitions see page 79.
Wärtsilä Genset 20

<table>
<thead>
<tr>
<th>Cylinder bore</th>
<th>200 mm</th>
<th>Generator voltage</th>
<th>0.4–13.8 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston stroke</td>
<td>280 mm</td>
<td>Generator efficiency</td>
<td>0.95–0.96</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>185, 200, 220 kW/cyl</td>
<td>Fuel specification: Fuel oil</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>900, 1000, 1200 rpm</td>
<td>700 cSt/50°C, 7200 sR1/100°F</td>
<td></td>
</tr>
<tr>
<td>Piston speed</td>
<td>8.4, 9.3, 11.2 m/s</td>
<td>ISO 8217, category ISO-F-RMK 700</td>
<td></td>
</tr>
</tbody>
</table>

### Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>60 Hz</th>
<th>50 Hz</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Engine kW</td>
<td>Gen. kW</td>
</tr>
<tr>
<td>4L20</td>
<td>740</td>
<td>700</td>
</tr>
<tr>
<td>6L20</td>
<td>1 110</td>
<td>1 055</td>
</tr>
<tr>
<td>8L20</td>
<td>1 480</td>
<td>1 405</td>
</tr>
<tr>
<td>9L20</td>
<td>1 665</td>
<td>1 580</td>
</tr>
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### Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>E*</th>
<th>I*</th>
<th>K</th>
<th>L*</th>
<th>Weight*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4L20</td>
<td>5 113</td>
<td>1 860</td>
<td>895</td>
<td>1 800</td>
<td>2 275</td>
<td>15.9</td>
</tr>
<tr>
<td>6L20</td>
<td>5 783</td>
<td>1 860</td>
<td>895</td>
<td>1 800</td>
<td>2 275</td>
<td>18.7</td>
</tr>
<tr>
<td>8L20</td>
<td>6 508</td>
<td>2 010</td>
<td>1 225</td>
<td>1 800</td>
<td>2 462</td>
<td>22.8</td>
</tr>
<tr>
<td>9L20</td>
<td>6 784</td>
<td>2 010</td>
<td>1 225</td>
<td>1 800</td>
<td>2 457</td>
<td>23.3</td>
</tr>
</tbody>
</table>

* Dependent on generator type and size. For definitions see page 79.
<table>
<thead>
<tr>
<th>Engine type</th>
<th>Cylinder bore</th>
<th>Generator voltage</th>
<th>IMO Tier II or III</th>
</tr>
</thead>
<tbody>
<tr>
<td>26L26</td>
<td>260 mm</td>
<td>0.4–13.8 kV</td>
<td></td>
</tr>
<tr>
<td>8L32</td>
<td>320 mm</td>
<td>0.95–0.96</td>
<td></td>
</tr>
<tr>
<td>9L32</td>
<td>325, 340 kW/cyl</td>
<td>700 cSt/50°C</td>
<td></td>
</tr>
<tr>
<td>12L32</td>
<td>320 mm</td>
<td>7200 sR1/100°F</td>
<td></td>
</tr>
<tr>
<td>16L32</td>
<td>320 mm</td>
<td>ISO 8217, category ISO-F-RMK 700</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rated power</th>
<th>60 Hz</th>
<th>50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
<td>325 kW/cyl, 900 rpm</td>
<td>340 kW/cyl, 1000 rpm</td>
</tr>
<tr>
<td>Engine kW</td>
<td>Gen. kW</td>
<td>Engine kW</td>
</tr>
<tr>
<td>6L26</td>
<td>1 950</td>
<td>1 870</td>
</tr>
<tr>
<td>8L26</td>
<td>2 600</td>
<td>2 495</td>
</tr>
<tr>
<td>9L26</td>
<td>2 925</td>
<td>2 810</td>
</tr>
<tr>
<td>12V26</td>
<td>3 900</td>
<td>3 745</td>
</tr>
<tr>
<td>16V26</td>
<td>5 200</td>
<td>4 990</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions (mm) and weights (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>6L26</td>
</tr>
<tr>
<td>8L26</td>
</tr>
<tr>
<td>9L26</td>
</tr>
<tr>
<td>12V26</td>
</tr>
<tr>
<td>16V26</td>
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</table>

* Dependent on generator type and size.
For definitions see page 79.
### Engines and Generating Sets

#### Wärtsilä Genset 31

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>310 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>430 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>590, 610 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>720, 750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>30.3, 30.1 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>10.3, 10.75 m/s</td>
</tr>
</tbody>
</table>

**IMO Tier II or III**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator voltage</td>
<td>0.4–13.8 kV</td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95–0.97</td>
</tr>
<tr>
<td>Fuel specification</td>
<td>Fuel oil</td>
</tr>
<tr>
<td>Speed</td>
<td>700 cSt/50°C, 7200 sR1/100°F</td>
</tr>
<tr>
<td>ISO 8217, category</td>
<td>ISO-F-RMK 700</td>
</tr>
<tr>
<td>SFOC</td>
<td>167.7 g/kWh at ISO conditions</td>
</tr>
</tbody>
</table>

#### Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>60 Hz</th>
<th>50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>590 kW/cyl, 720 rpm</td>
<td>610 kW/cyl, 750 rpm</td>
</tr>
<tr>
<td>Engine kW</td>
<td>Gen. kW</td>
<td>Engine kW</td>
</tr>
<tr>
<td>8V31</td>
<td>4 720</td>
<td>4 530</td>
</tr>
<tr>
<td>10V31</td>
<td>5 900</td>
<td>5 665</td>
</tr>
<tr>
<td>12V31</td>
<td>7 080</td>
<td>6 800</td>
</tr>
<tr>
<td>14V31</td>
<td>8 260</td>
<td>7 930</td>
</tr>
<tr>
<td>16V31</td>
<td>9 440</td>
<td>9 060</td>
</tr>
</tbody>
</table>

#### Dimensions (mm) and weights (tonnes)

<table>
<thead>
<tr>
<th>Engine type</th>
<th>A*</th>
<th>E*</th>
<th>I*</th>
<th>K</th>
<th>L*</th>
<th>Weight*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8V31</td>
<td>9 100</td>
<td>3 110</td>
<td>1 700</td>
<td>2 390</td>
<td>4 880</td>
<td>93.8</td>
</tr>
<tr>
<td>10V31</td>
<td>9 750</td>
<td>3 110</td>
<td>1 700</td>
<td>2 390</td>
<td>4 880</td>
<td>106.7</td>
</tr>
<tr>
<td>12V31</td>
<td>10 150</td>
<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>121.7</td>
</tr>
<tr>
<td>14V31</td>
<td>10 800</td>
<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>137.7</td>
</tr>
<tr>
<td>16V31</td>
<td>11 400</td>
<td>3 500</td>
<td>1 700</td>
<td>2 390</td>
<td>4 350</td>
<td>149.6</td>
</tr>
</tbody>
</table>

* Dependent on generator type and size.
For definitions see page 79.
Generating Sets

<table>
<thead>
<tr>
<th>Wärtsilä Genset 32</th>
<th>IMO Tier II or III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder bore</td>
<td>320 mm</td>
</tr>
<tr>
<td>Piston stroke</td>
<td>400 mm</td>
</tr>
<tr>
<td>Cylinder output</td>
<td>560, 580 kW/cyl</td>
</tr>
<tr>
<td>Speed</td>
<td>720, 750 rpm</td>
</tr>
<tr>
<td>Mean effective pressure</td>
<td>28.9 bar</td>
</tr>
<tr>
<td>Piston speed</td>
<td>9.6, 10.0 m/s</td>
</tr>
<tr>
<td>Generator voltage</td>
<td>0.4–13.8 kV</td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95–0.97</td>
</tr>
<tr>
<td>Fuel specification: Fuel oil</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>700 cSt/50°C</td>
</tr>
<tr>
<td>7200 sR1/100°F</td>
<td></td>
</tr>
<tr>
<td>Generator efficiency</td>
<td>0.95–0.97</td>
</tr>
</tbody>
</table>
| Rated power

<table>
<thead>
<tr>
<th>Engine type</th>
<th>60 Hz/720 rpm</th>
<th>50 Hz/750 rpm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>560 kW/cyl</td>
<td>580 kW/cyl</td>
</tr>
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<td>Gen. kW</td>
<td>Engine kW</td>
</tr>
<tr>
<td>Gen. kW</td>
<td></td>
<td>Gen. kW</td>
</tr>
<tr>
<td>6L32</td>
<td>3 360</td>
<td>3 480</td>
</tr>
<tr>
<td>3 230</td>
<td>3 340</td>
<td></td>
</tr>
<tr>
<td>7L32</td>
<td>3 920</td>
<td>4 060</td>
</tr>
<tr>
<td>3 770</td>
<td>3 900</td>
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<td>4 480</td>
<td>4 640</td>
</tr>
<tr>
<td>4 300</td>
<td>4 450</td>
<td></td>
</tr>
<tr>
<td>9L32</td>
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<td>5 220</td>
</tr>
<tr>
<td>4 840</td>
<td>5 010</td>
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<td>6 960</td>
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<td>6 450</td>
<td>6 680</td>
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<td>9 280</td>
</tr>
<tr>
<td>8 600</td>
<td>8 910</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions (mm) and weights (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine type</td>
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<tr>
<td>6L32</td>
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<tr>
<td>7L32</td>
</tr>
<tr>
<td>8L32</td>
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<tr>
<td>9L32</td>
</tr>
<tr>
<td>12V32</td>
</tr>
<tr>
<td>16V32</td>
</tr>
</tbody>
</table>

* Dependent on generator type and size.
Generator output based on a generator efficiency of 96%.
Final measurements might differ depending on selected turbocharger execution.
For definitions see page 79.
Engines and Generating Sets

Defining Notes for Generating Sets

Generating set dimensions

A  Total length of the generating set
E  Total width of the generating set
I  Distance from the bottom of the common baseframe to the crankshaft centreline
K  Minimum height from the crankshaft centreline when removing a piston
L  Total height of the generating set.

Dimensions and weights

Dimensions are in millimetres and weights are in metric tonnes. Indicated values are for guidance only and are not binding. Cylinder configurations: L = in-line, and V = V-form.

Specific fuel energy consumption

- At ISO standard reference conditions at 85% load
- Lower calorific value of fuel 42 700 kJ/kg
- Tolerance 5%
- With engine driven pumps
- Natural gas
- Methane number min. 80
- Lower heating value min. 28 MJ/Nm³

ISO standard reference conditions

Total barometric pressure .......................................................... 1.0 bar
Suction air temperature ............................................................. 25°C
Charge air cooling water temperature ........................................ 25°C
Relative humidity ................................................................. 30%
Auxiliary Systems

**Engine Auxiliary Systems**

All auxiliary equipment needed for the engines can be delivered by Wärtsilä. Some equipment can be built onto the engine, and the rest can be delivered separately or grouped in modules.

Depending on the engine type and application, a lubricating oil pump, HT- and LT-cooling water pumps, fuel pump, oil filters and coolers, prelubricating oil pump and thermostatic valves can be added to the engine.

Stand-by pumps, seawater pumps, central coolers, starting air vessels, lubricating oil automatic filters, exhaust gas silencers and boilers are typically delivered for separate mounting.

**Standardised modular auxiliary units**

- Fuel oil booster
- Fuel oil separating
- Lubricating oil separating
- Cooling water preheating
- Starting air compressors
- Oil mist separator
- Oily water bilge separator

Maximum compatibility is ensured when auxiliary systems are delivered together with the main propulsion engines and generator sets. Whenever necessary, the auxiliary systems are tailored to optimise the operating performance for a specific trade. The systems are specified to minimise building costs and operating costs for a specific combination of main and auxiliary engines.

Customised modular auxiliary units are available on request.
Engines and Generating Sets

Auxiliary Systems

Preheating unit

Oil mist separator module.

Fuel oil transfer pump module with heater.
**Scrubber System Design**

In order to better meet the demands of their customers, Wärtsilä has developed and is proud to offer three standard scrubber designs: the conventional V-\(\text{SO}_X\) with up to four venturi, the I-\(\text{SO}_X\) with its reduced footprint and installation ease, and lastly the Q-\(\text{SO}_X\) boasting a hefty power range.

Each scrubber design have benefits dependent on vessel type and layout, making it important for owners to consider the specific requirements for each project.

All three designs accommodate open loop, closed loop and hybrid running. Systems configured for open loop may also be delivered with the option of hybrid ready.

CLICK for more info
Wärtsilä exhaust gas cleaning technology provides an economical and environmentally friendly solution for your vessel. All of this while acting in compliance with new and existing regulations laid forth by the IMO and EU. This is true not only regarding sulphur oxide reduction and particulate capture, but also regarding water treatment and discharge.

All three systems are compatible with new builds and retrofits – for vessels fitted with either 2-stroke or 4-stroke engines, as well as oil-fired boilers.

Wärtsilä’s history of expertise within the EGC market has provided them the opportunity to continually optimize performance through customer feedback and experience – thus building up a robust system portfolio composed of equipment that is reliable, easy to operate and easy to install.
Exhaust Gas Cleaning

**SO\textsubscript{X} Abatement**

- **Wärtsilä Open Loop Scrubber System**
  The Wärtsilä open loop system is designed to remove \( \text{SO}_x \) from exhaust gas through the utilization of seawater alone.

  In this method the natural alkalinity of the seawater does the work, therefore eliminating the need for chemicals. Open loop scrubbing is possible anywhere in the world where seawater alkalinity levels are high enough to support the system.

  Running in open loop, exhaust gas enters the scrubber and is then sprayed with seawater. This blending process forces the \( \text{SO}_x \) in the exhaust to mix with the seawater, thus forming sulphuric acid. No chemicals are needed during this process as the high alkalinity of the seawater neutralizes the acid in a natural process.

  With the Wärtsilä system the wash water from the scrubber is continuously monitored in order to ensure both compliance with criteria from MEPC, and to guarantee that it can safely be discharged back into the sea – with no harm to the surrounding environment.

- **Wärtsilä Closed Loop Scrubber System**
  In the Wärtsilä closed loop system, the scrubber is designed to use wash water to remove \( \text{SO}_x \) from the exhaust gas.

  As the name indicates, the system operates continuously in a closed loop, eliminating dependency on seawater alkalinity. This type of system is ideal in situations of full-time operation in areas of low alkalinity, for example the Great Lakes.

  During operation, exhaust gas enters the scrubber and is blended with seawater which has been treated with sodium hydroxide, i.e. caustic soda. The \( \text{SO}_x \) in the exhaust react with this mixture and the acids are neutralized.

  The system is designed in such a way that a small amount of bleed-off is then extracted from the closed loop and treated, in order to fulfil IMO requirements. The ‘washed’ effluents may then be safely discharged overboard – with no harm to the surrounding environment.

  In the case that zero discharge mode is requested or required, the effluent is simply routed to a holding tank until a scheduled discharge is carried out.

- **Wärtsilä Hybrid Scrubber System**
  Wärtsilä provides the option of ultimate system flexibility to their customers – through allowing controlled variation from open and closed loop, in one and the same scrubbing system. The hybrid scrubber solution.

  This hybrid solution provides maximum efficiency, allowing safe and compliant operation in both low alkaline waters as well as in the open ocean.
Exhaust Gas Cleaning

SO$_X$ Abatement
Wärtsilä NO\textsubscript{X} Reducer (NOR)

A marine diesel engine installed on a ship constructed on or after 1 January 2016, and operating in the North American ECA and the United States Caribbean Sea ECA, must comply with the Tier III NO\textsubscript{X} standards. The same rule applies in the North Sea and Baltic Sea for ships with keel laying on or after 1 January 2021.

The Wärtsilä NO\textsubscript{X} Reducer (NOR) is an emission after-treatment system based on the Selective Catalytic Reduction (SCR) technology for Nitrogen Oxide (NO\textsubscript{X}) reduction. The NOR is optimized and validated for Wärtsilä medium speed engines in terms of reliability, flexibility, size and easy installation and maintenance onboard. It is available for both new build and retrofits. Wärtsilä engines delivered with NOR are equipped with exhaust gas temperature control to ensure the correct temperature for SCR.
operation (ON/OFF). The NOR can be used for various applications and different fuel qualities (HFO/MDO/MGO) and can be operated together with other exhaust gas equipment including scrubbers, silencers, and exhaust gas boilers. Wärtsilä provides IMO and EPA Tier III EIAPP certificates for a complete package of engine and SCR. The Wärtsilä NOx Reducer ensures you can operate with different fuels globally and reduces emission based operation fees.

The main component of the NOR installation is the Reactor with a soot blowing unit and the catalyst elements. Other modular essential parts of the NOR system are the power distribution unit, urea pump unit, urea dosing unit, which controls the SCR functionality, and the urea mixing and injection unit.
Fleet Operations Solutions (FOS) create a platform for collaborative decision-making and are designed to achieve the highest level of safety at sea, increase fleet efficiency and simplify everyday tasks both ashore and on board.

FOS unites all navigational processes and voyage data on a single platform making the crew and the operations center work as one. Along the entire route, vessel and shore are exchanging the information in a
secure environment to make sure that the ship arrives to the destination point safely and in time.

Advanced software applications facilitate routine tasks and decrease the workload allowing people to focus on their main objectives.

**With FOS it is possible to:**

- Track the fleet in real-time mode and receive detailed information on each vessel
- Access the operational data anytime from anywhere on multiple devices
- Select the most efficient route optimised automatically in accordance with weather conditions
- Always have the latest and most recent charts and voyage data at hand for planning
- Ensure uptime of the navigational equipment and get timely support
- Get alarms and quickly respond to unusual ship behaviour and anomalies
- Help the crew to perform safe manoeuvres in situation of high stress or overwhelming traffic
- Constantly maintain the competence of the crew
All tools and data are connected in one operating system with the ECDIS kernel at its core, building the basis for improved operational efficiency and safe processes, with all stakeholders having access to and relying on the same information.

**Access**
FOS provides centralised access for decision support, notifications and planning processes onshore and on-board.

**A-Suite**
A set of connected intelligent applications inside FOS using artificial intelligence to improve situational awareness and provide decision support on bridge and ashore.

**Advanced Intelligent Routing**
AIR optimises vessel route according to a variety of metocean data, as well as traffic separation schemes and regional regulations on acceptable fuel types, using artificial intelligence technologies.

**Advanced Data Delivery**
ADD automatically keeps the charts and planning tools updated and therefore compliant.

**Advanced Intelligent Diagnostics**
AID detects anomalies, i.e. abnormal, unusual and/or dangerous patterns in ship behaviour, real-time and post voyage, in order to increase situational awareness, eliminate the possibility of human error and eventually, reduce risk.

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**Building Blocks of Fleet Operations Solution**

- **Access**
- **A-Suite**
- **Advanced Intelligent Routing**
- **Advanced Data Delivery**
- **Advanced Intelligent Diagnostics**

**Enablers**
- VSAT
- Database
- ECDIS Data Server Router
- Other Sensors
Advanced Remote Maintenance
ARM provides remote support, diagnostics and preventive maintenance for the navigational bridge and satellite communication equipment.

Advanced Intelligent Manoeuvring
AIM is a track prediction designed to improve situational awareness and reduce the probability of officer in-attention or poor judgment leading to an incident.

Advanced Remote Training for Seafarers
ARTS is an advanced e-learning solution. It provides online access to manufacturer approved type-specific training course featuring the original Transas ECDIS software.

Enablers
- A complete connected Dual ECDIS solution as required by the IMO regulations compliant with the latest requirements.
- Comprehensive VSAT network coverage with reliable backup.
Wärtsilä Multi Stage Flash Evaporators

The Wärtsilä multi-stage flash (MSF) evaporator is utilised for producing fresh water from seawater, well water or industrial water.

A special advantage of the multi-stage flash technology is that the specific heat consumption (or thermal efficiency) can be continuously adapted to the individual requirements of each application.

The produced distillate has a very low salt content which makes it suitable as technical water (e.g. boiler feed water). The distillate quality and quantity are independent from the seawater temperature which makes the MSF technology a reliable source for freshwater.

Characteristics

- Capacity up to 1500 t/d.
- Salt content of the distillate ≤ 4 ppm NaCl.
- Steady production of freshwater at seawater temperatures between 0–32°C
- Either steam, engine jacket water or a combination of these can be utilised for heating
- Corrosion resistant materials (e.g. copper-nickel) for components in contact with seawater
Fresh Water Generation

Key benefits
- Flexible dimensions
- Full-automatic operation
- High availability due to low maintenance requirements
- Technology with the lowest lifecycle costs
- Efficiency gained by the use of frequency converter for pumps
- Minimised risk of scaling because heat transfer and evaporation are taking place in different areas

Wärtsilä Single Stage Desalination Systems

The Wärtsilä Single Stage Desalination (SSD) fresh water generator uses the process of vacuum distillation to remove the salt and other impurities from seawater and convert it into high quality distillate.

The system uses a vacuum distillation process that enables the use of the waste heat from the main diesel engine or other alternative heat sources to evaporate the seawater.

The technology is simple and has a modular design. The automated operation and low maintenance requirements enable continuous and user friendly handling.

Wärtsilä has developed an efficient and cost-effective technology for seawater desalination, with a capacity up to 50 t/d, for marine and offshore applications.

Key benefits
- High distillate quality
- Easy maintenance
- Easy operation
- Compact

Options
- Booster heater
- Steam injector
- Rehardening filter
- Hot water loop

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Gas Solutions

Gas Recovery

Wärtsilä Gas Solutions offers innovative and energy efficient systems and solutions related to a number of oil & gas segments. The scope includes marine LNG and LPG cargo systems, fuel gas systems for marine vessels, onshore gas terminals, biogas systems, flare gas ignition and tank control systems.

■ Wärtsilä Ballistic Flare Gas Ignition System

The Wärtsilä Ballistic Flare Gas Ignition system is designed to handle gas that is normally flared in oil, gas, and petrochemical applications.

The Wärtsilä Ballistic Flare Gas Ignition system has been developed to guarantee safe and reliable ignition of the flare whenever required.

The system combines high reliability and availability throughout the lifetime of the facility. It features low maintenance requirements and is easily retrofitted into existing installations.

More than one hundred low pressure ballistic pellet ignition systems have been supplied by Wärtsilä worldwide for both offshore and onshore projects.
Gas Solutions

Gas Recovery

Wärtsilä VOC Recovery

Our field proven system is self-supplied with energy and results in zero VOC emissions.

These emissions from the global sea transportation of crude oil and associated products, account for a total of more than 5 million tonnes per year. The Wärtsilä VOC plant ensures that cargo tank pressures are maintained low enough to keep the vent valve closed. This prevents VOC from being emitted to the atmosphere, and the gas is instead fed to the VOC recovery module, where it is treated by compression and condensation. The liquefied gas mix is then fed to the 2-stroke and 4-stroke VOC fuel tank.

We have also developed a system for VOC recovery in offshore oil loading applications. It exceeds the Norwegian authorities’ requirements for Non-Methane Volatile Organic Compounds (NMVOCs) by reducing VOC emissions by 100%, including methane, which is not currently specified in the regulatory requirements.

The first VOC condensation system with zero emissions was installed on the shuttle tanker Stena Alexita, operated by ExxonMobil in the North Sea oil fields.
Wärtsilä Voyage Emissions Reduction System

The Wärtsilä Voyage Emissions Reduction (VER) system is a means for increasing oil tanker revenues, while also significantly aiding the environment through reduced emissions. The system effectively eliminates the problem of volatile organic compound (VOC) emissions from tankers during laden voyages.

VOC’s are organic chemicals having a high vapour pressure resulting from their low boiling point, which leads to extensive evaporation. On average, an oil tanker will emit 0.085 percent of its contained cargo per each week. For a 320,000 DWT Very Large Crude Carrier (VLCC), this amounts to 270 tons of lost cargo per week.

The Wärtsilä VER system meets all the regulation 15 requirements of the International Maritime Organization’s (IMO) MARPOL Annex VI protocol. It also fulfills port specific requirements for terminals with regards to VOC emission reductions.
Wärtsilä Cargo Handling for Small LNG Carriers and LNG Bunker vessels

There is a growing demand for small-scale transportation of LNG to end users that are located in areas where pipelines are not feasible or economically viable. Typically such end users are power generation plants, land based industries and suppliers of LNG as fuel for vehicles or ships. Wärtsilä has developed a Cargo Handling System that is designed on basis of the extensive experience that Wärtsilä Gas Solutions has accumulated in delivering such systems for LPG, LEG and LNG carriers. The available scope includes:

- Cargo handling system
- Boil-off gas handling
- Cargo tank design and complete tank delivery
- Ship design
- LNG fuel supply system

We provide designs for small size LNG Carriers carrying LNG only, or Multi Gas Carriers able to carry all types of gas cargo. Typically these ships are between 4000 and 40,000 m$^3$. 

Wärtsilä Cargo Handling System for Ethylene/Multi Gas Carriers

The ethylene carrier segment has grown during the last years, from small size vessels to handy size, and now also includes a large-scale carrier purpose built for ethane trading.

Wärtsilä has become the largest supplier of complete cargo handling systems for vessels in this segment, covering the whole range of sizes requested in the market today. These vessels are known for their flexibility and can trade multiple types of cargoes from gas to chemicals. Deliveries also include carriers with LNG capacity and dual-fuel propulsion.

An increasing supply of ethane has created a new segment of shipping, namely the trade of ethane as feedstock to the petrochemical industry on a large scale. Wärtsilä is also delivering complete cargo handling system to these very large ethane carriers.
Gas Carrier Cargo Handling Systems

**Wärtsilä Cargo Handling System for Semi-refrigerated Gas Carriers**

The semi-refrigerated segment covers the range from 4000 m$^3$ to 30,000 m$^3$. Wärtsilä Gas Solutions offers a cargo handling system including the design and delivery of C-type cargo tanks designed in either cylindrical or bilobe format.

Recent cargo handling design developments include the capability of handling propane cargo with high ethane content.

**Wärtsilä Cargo Handling System for Fully Pressurized Gas Carriers**

Most of the vessels in the Gas Carrier fleet are fully pressurized with cargo tank volumes typically in the range of 1000 m$^3$ to 13,000 m$^3$. Wärtsilä Gas Solutions offers modern and advanced solutions for such vessels.

Fully pressurized vessels carry LPG at ambient temperatures and with corresponding saturated gas pressures. The design pressure for fully pressurized Cargo tanks is typically 18 bar(g).

Wärtsilä Gas Solutions has developed the new and alternative QiCool design concept, which utilizes the best aspects of both fully pressurized and semi-refrigerated designs. With this approach, the cargo tank design pressure is reduced and cargo chiller units are installed.

The QiCool design allows an increased cargo loading rate up to 98% with design figures for SW and air temperatures. The QiCool design enables the achievement of cost savings and higher revenues.

**Wärtsilä Cargo Handling System for Fully Refrigerated Gas Carriers**

Wärtsilä Gas Solutions has for a long time been the preferred cargo handling system supplier to the leading owners of fully refrigerated vessels. When transported, LPG is normally kept at its coldest temperature and the required equipment has to be extremely reliable.

Our broad portfolio of innovative and energy efficient solutions has given Wärtsilä a leading position in the market. This extensive offering is supported by Wärtsilä’s unmatched global service network.
Gas Solutions

Gas Carrier Cargo Handling Systems

**Wärtsilä Ship and Cargo Tank Design**

Wärtsilä Ship Design offer a ship design portfolio that is among the most extensive in the industry. This portfolio includes the Design of Gas Carriers, for which we have focused on small to handy size vessels with the possibility to tailor the appropriate final design in cooperation with the owner and shipyard. Our services cover the spectrum from conceptual studies to class approved designs and yard workshop drawings.

Having the in-house resources to design C-type cargo tanks allows us to be a complete partner for the building of Gas Carriers. Our IMO C-type cargo tank designs include the cylindrical tanks, bilobe tanks, and tanks for LPG FP (−10 °C), ethylene (−104 °C) and LNG (−163 °C).

Read more about Wärtsilä Ship Design on pages 178-183.
Inert Gas Systems

Wärtsilä is a market leader in the development, design, manufacture and servicing of advanced inert gas and nitrogen solutions for marine and offshore oil and gas applications.

Our leading-edge, customised solutions ensure high quality and advanced levels of safety for vessels operating in regulated areas. We are certified by ISO 9001:2000, ISO 14001:2004 and OHSAS 18001:2007.

Our strong reputation in inert gas solutions is based on over 50 years’ experience and unique full-scale R&D facilities located in Moss, Norway. Our references include over 2,500 vessels installed with our inert gas equipment. Performance testing of inert gas systems can be executed in the company’s own test hall in Moss, the only facility tailor-made for this purpose in the world today.

Wärtsilä systems are vital systems to ensure a high level of safety for vessels where they are installed. Consequently, product quality is always the number one priority. All our systems are designed based on compact modules, offering important savings in space and installation cost both for newbuildings and for retrofit on existing vessels.

Wärtsilä ensures our customers a global network for lifetime support. This is vital to secure uninterrupted operation. Furthermore, we also offer Service Agreements, product training (from our facilities in Moss) and system upgrades to support our customers in their efforts to optimize operational performance as well as cost. Our in-house spare parts department will provide anticipated spares on short notice.

Inert Gas Generators are advantageous compared to other competitive makes on the following important areas:

- Less space requirement/burner design.
- Cleanness of gas with regard to water, salt, SO\textsubscript{X} and NO\textsubscript{X} content.
- Better cooling efficiency.
- Independence of orientation and ship’s motions.
- High graded materials in critical areas exposed to corrosion.
- Lower emissions (Best Available Technique) and lower operational costs
- Interoperable control system(s)
Inert Gas Systems

Wärtsilä Inert Gas Generators for Tankers

Our inert gas generator system, specialised for Tankers, ensures the correct atmosphere in the cargo tanks to minimize the risk of explosion.

Our systems are designed to a high level of safety and are based on compact modules, offering important savings in space and installation cost both for newbuildings and retrofitting existing vessels.

Our most recent developments include automatic regulation based on deck pressure setting. During off-loading the system optimizes the inert gas production to only produce the necessary quantum of Inert Gas to maintain the tank pressure. This system reduces oil consumption providing cost efficiency up to 40% savings, as well as an environmental benefit.

Benefits:
- Unique turbulent burner design based on more than 50 years of experience
- Concentric vertical combustion chamber fitted inside the scrubber unit provide compact units, minimum space requirement and independence of ship’s motion
- High grade steel for heat/corrosion resistance
- Low maintenance cost

Wärtsilä Mult-Inert™ System

The Wärtsilä Mult-Inert system combines a flue gas system and an inert gas generator to offer maximum flexibility onboard product tankers transporting petroleum products.

Wärtsilä Mult-Inert™ systems are vital systems ensuring a high level of safety for use onboard tankers intended to carry both crude oil and refined products, and combine into one compact unit where quality is the number one priority.

The Wärtsilä Mult-Inert™ system can run as an inert gas generator or, when the boilers are in use, as a flue gas system. They are
Inert Gas Systems
designed based on compact modules, offering important savings in space and installation cost for newbuild and retrofit vessels.

When discharging crude oil or less refined petroleum products, our Mult-Inert™ Generator System can be run in flue gas mode as the boilers are run to heat the cargo. The cargo is less sensitive to contamination. When discharging more sensitive cargo, the system can be switched to inert gas generator mode burning marine fuel.

Wärtsilä Flue Gas

Flue gas systems are used to channel exhaust gases from a ships boiler uptake.

Wärtsilä flue gas systems are vital systems to ensure a high level of safety for the vessels where they are installed. Consequently, product quality is always the number one priority.

They are tailor made for use on board crude oil carriers and are designed based on compact modules, offering important savings in space and installation cost both for newbuildings and for retrofit on existing vessels.

The system also uses a topping up generator making high inert gas quality possible by a purposeful designed combustion chamber.

Benefits of the Wärtsilä design:

- Unique concentric venturi scrubber design based on more than 50 years’ experience
- Minimum space requirement
- High efficiency
- Low maintenance costs
- Safe and easy operation
- Scrubber unit
- Combining three scrubbing principles for high efficiency cooling and cleaning: venturi scrubbing, wet filter and spray section
- Concentric arrangement independent of ships pitching and rolling
- Internally coated with GRE and venturi tube in corrosion and heat resistant steel
Inert Gas Systems

Wärtsilä Inert Gas Generators for Gas Carriers

Our inert gas generator system, specialised for Gas Carriers, ensures the correct atmosphere in the cargo tanks to minimize the risk of explosion. Our system offers a high level of safety and are designed based on compact modules, offering important savings in space and installation cost for both newbuildings and retrofitting existing vessels.

Our most recent developments include higher capacity Wärtsilä inert gas generator systems for new and larger LNG carriers requiring dry inert gas on-board, plus a combined inert gas system and gas combustion unit (GCU). Our newly developed integrated solution eliminates the need for a separate GCU and a safe and reliable gas combustion mode is implemented using the same equipment as the Wärtsilä inert gas generator system.
Inert Gas Systems

**Wärtsilä Inert Gas System and Gas Combustion Unit (IGG/GCU)**

Wärtsilä have supplied combined IGG-GCU systems since its introduction in 2013 as of now a number of 50 vessels. IGG-GCU uses an existing Wärtsilä inert gas generator to burn the boil-off gas, thereby eliminating the need for a conventional gas combustion unit. This results in space and capital expenditure savings. At the same time, by using the boil-off gas as fuel for creating inert gas, the combined system also provides notable operating cost savings. The combined system is burning the BOG in a controlled burning chamber, making correct measurement of methane slippage possible.

The combined IGG-GCU system has a minimal environmental footprint. This is achieved through the replacement of a separate onboard system, and by using the boil-off gas for inert gas generation, which together minimise the extra use of marine diesel oil (MDO) fuel.
Gas Solutions

Inert Gas Systems

■ Wärtsilä Nitrogen Generators

Wärtsilä Nitrogen Generators are dependable outlets for nitrogen. As the name implies, these systems are designed to generate, or create, a dry, clean inert gas. The use of nitrogen generators eliminates the problems associated with handling gas cylinders. Our nitrogen generators are designed for their flexibility and efficiency.

Wärtsilä Nitrogen Generators are also designed to deliver various purities in the same system, giving our customers even greater flexibility. We supply niche, supplementary, small volume systems with capacities from 10 to 6 000 Nm³/h at purities from 95 to 97.5% nitrogen.

The system is particularly suited for marine and offshore applications, where the demand for high quality and challenging specifications is present. We always adapt to our customer’s needs, and are capable of installing our systems into the most challenging locations.

■ Wärtsilä Offshore Inert Gas Systems

Representing more than 50 years of experience, the Wärtsilä Offshore Inert Gas Systems are known as the ultimate choice for quality and reliability. The systems fulfil requirements for 20-40 years of design life in demanding offshore environments and apply to stringent HSE legislations, with use of the best available techniques for high efficiency, low maintenance and safe operation in combination with minimum space requirements, low noise and near zero emissions.

Uniqueness and modularity are important features of the design to ensure the correct quality for each facility. The Wärtsilä Offshore Inert Gas Systems can be installed on new builds or be retrofitted onboard existing vessels, and provided as loose items, containers or plug-and-play skids.
LNG Solutions

Floating Storage and Regasification Barges (FSRBs)

The smallest FSRUs today are around 120,000 m³. There are no small LNG carriers available that can be converted to FSRUs. Wärtsilä has created a solution for this problem by designing a barge containing storage tanks (7500-30,000 m³) and regasification systems. These can be an attractive alternative to onshore satellite and bunkering terminals. The LNG barge can be equipped with the similar processes as the land-based solution. The process can also be split between the barge and land. This can be done, for example, by locating the LNG storage on the barge and process equipment and support facilities onshore.

Wärtsilä prefers to deliver the barge and necessary infrastructure onshore as a complete EPC. Wärtsilä can also provide services and maintenance solutions for the total solution.

- Ideal for providing fast and flexible access to gas in new areas
- For land unsuitable for onshore LNG tanks or difficult to permit
- Where there is a lack of skilled labour and local construction material
- A mobile asset, possible to relocate or trade – ideal for temporary demand and uncertain market conditions.

FSRB with a 15,000 m³ LNG storage

1. Unloading system
2. LNG storage
3. Regasification
4. Electrical and control system
5. Gas send out
An LNG terminal is a liquid gas processing plant which main purpose is to receive, store and further distribute natural gas. Many terminals nowadays also having facilities for loading small scale bunkering vessels and shuttle tankers. The storage tank is usually the most expensive part of a terminal unless marine facilities are part of the scope, and the terminals are usually defined according to the size of the tanks. Wärtsilä’s portfolio consists of terminals with various functions combined with a storage capacity in the range of 100 to 160,000 m$^3$.

- Specifically adapted for the requirements of small-scale LNG through elimination of complexity and increase of flexibility
- Single use (e.g. providing fuel for a power plant) or multi-use (e.g. gas send-out, ship bunkering, truck loading)
- Onshore and near shore (barge) concepts
- Stringent safety regulations during both construction and operation.
LNG Plants – Small Scale Liquefaction Technology

REVERSED BRAYTON CYCLE – THE RELIABLE SOLUTION FOR SMALL SCALE LIQUEFACTION

Wärtsilä’s larger liquefaction plants are easy to operate, reliable, and fully automated. They represent a low lifecycle cost solution in the small to medium size liquefaction capacity range.

These liquefaction plants are based on the Reversed Brayton cycle. Nitrogen is the sole refrigeration medium, and is used in a process of compressing and expanding the nitrogen to obtain the required cryogenic temperature.

Main technical data:
- Energy consumption: ~ 0.38 kWh/kg LNG
- Capacities between 60–800 tons/day (3–41 MMSCFD)
- Based on proprietary reversed Brayton technology
- Simple process and less equipment needed because the refrigerant (Nitrogen) is always in gas phase
- Smaller plants designed for unmanned operation
- Delivery time: 18–22 months.

Small scale liquefaction plants open new market opportunities for the development of local or regional gas distribution networks, where gases did not previously exist as an alternative environmentally friendly and competitive energy source.
LNG Plants – Mini Scale Liquefaction Technology

Wärtsilä offers the energy efficient Mixed Refrigerant (MR) liquefaction technology for low liquefaction capacities. Together with our fast track engineering model, this technology results in low investment costs and short manufacturing time.

The liquefier system uses mixed refrigerant technology, where one single MR compressor and one aluminium plate-fin heat exchanger (PFX) are the main components in the system. A standard chiller (pre-cooling unit) is incorporated to improve energy efficiency and to ensure stable operation of the MR process.

Main technical data:
- Energy consumption: ~ 0.7 kWh/kg LNG
- Capacities up to 50 tons/day (2.6 MMSCFD)
- Based on Mixed Refrigerant technology
- Designed for unmanned operation
- Space requirement for liquefaction system: 15 x 15 m²
- Delivery time: 12 months
- Standard capacities: 10, 17 and 25 ton LNG/day
- Using standard and robust components.

Wärtsilä provides the complete process plant, which can also be supplied as an EPC delivery. Once installed, Wärtsilä further offers Operation & Maintenance agreements that are tailored to the customer’s specific needs.

CLICK for more info
LNG Solutions

■ Biogas Upgrading

All human activity creates waste. However, waste can also be a valuable resource. Excess agricultural produce, manure, wastewater sludge, household and restaurant waste are perfect raw materials for biogas production. Biogas can be upgraded to pure biomethane, or Renewable Natural Gas, which is compressed and used as a low carbon vehicle fuel (CNG, RNG) or injected into the natural gas grid providing renewable energy to both homes and businesses.

Wärtsilä Puregas Solutions deliver several options for treating biogas, ranging from upgrading to biomethane (Renewable Natural Gas) for grid injection, compression for bioCNG, to liquefaction for bioLNG and fuelling infrastructure.

Wärtsilä Puregas Solutions is a Swedish based company, delivering highly efficient biogas upgrading solutions. As global market leader, Puregas has subsidiaries in the UK, Denmark, Germany and the USA.

With over 20 years of experience Puregas manufactures and supplies Biogas Upgrading Plants. The unique CApure upgrading process recovers over 99.9% of the available methane from the raw biogas, maximising biomethane / Renewable Natural Gas yields and revenues with exceptionally low operational costs. Puregas provides fully integrated solutions for biogas upgrading and have over 30 plants already operating.

The CApure process recovers over 99.9% of the biomethane present in the raw biogas by separating the CO2 from the biogas through a process of chemical adsorption. The selective organic solvents used in this process are so efficient that the product gas can contain over 99% biomethane. The biomethane can be directly injected into the gas grid, compressed to produce bioCNG or liquefied for bioLNG. It’s also possible to capture the CO2 from the plant and use this for commercial purposes.

■ Wärtsilä LNG Regasification

Our portfolio of LNG regasification technologies represents an industry benchmark in terms of energy efficiency, robustness, and operational flexibility.

Wärtsilä has delivered and commissioned numerous floating LNG regasification plants based on either closed loop regasification technology, using steam with water/glycol as the intermediate heating medium, or open loop regasification technology using seawater with propane as the intermediate heating medium. An open seawater solution using glycol as intermediate medium is also under development.

We have also delivered modularised regasification plants for jetty installations. These facilitate a much shorter construction time compared to conventional land based LNG regasification terminal projects.
Gas Solutions

Wärtsilä LNG Reliquefaction

Wärtsilä is a leading designer, developer and supplier of energy efficient LNG Boil-Off Gas (BOG) reliquefaction plants. These systems are designed to be efficient, reliable, safe, robust and flexible.

With 35 systems in operation and an additional 8 plants under construction, Wärtsilä has the highest number of BOG reliquefaction plants installed in the global LNG carrier, LBV and LNG shuttle fleet. Similar solutions could also be installed with onshore LNG terminals.

We work closely with our customers to develop technological solutions that meet their needs for increased fuel flexibility, energy efficiency, and environmental performance in today’s fast changing LNG market.
Wärtsilä LNGPac™

Wärtsilä LNGPac™ is a complete fuel gas handling system for LNG-fuelled ships consisting of the bunkering station, the LNG Fuel Gas Supply and fuel gas processing as well as the control and monitoring system. The LNG fuel system can be offered as a standalone product or as part of a complete propulsion system. Besides, the customized package can be equipped with cold recovery, gas detection, nitrogen generators and other optional features. Wärtsilä can deliver LNG systems for propulsion and power generation for any applicable type of ship or low-pressure (6/16 barg) dual fuel or gas engine.

Complete Solution

The Wärtsilä LNGPac™ system is based on an IMO C-type LNG-storage tank with either double-walled vacuum or single-walled polyurethane (PUR) insulation. All LNG pipelines, e.g. from the bunker station to the tank are insulated. All necessary process equipment is installed in a separate unit, which can be either mounted directly to the LNG tank or placed remotely. The fuel gas process equipment vaporizes the liquid LNG to natural gas and ensures correct fuel gas temperature and pressure for the engines and other gas consumers. The LNGPac operations, such as bunkering, BOG management, and fuel gas supply to consumers is fully automated and controlled with an HMI adopted to customer needs. The LNGPac control system can be delivered integrated with the vessel automation system (IAS) and with monitoring & remote access or diagnostics (CBM) of Wärtsilä Life Cycle Services.

The LNGPac™ is designed always in compliance with international safety requirement and operational standards specific to a gas processing plant. The NG pipelines are ventilated and hazardous zones are separated from the non-hazardous space with an integrated airlock. Dedicated engineering is conducted from the beginning of the project to match the specific operational requirements, safety and classification requirements.
LNG Fuel Gas Supply Systems

Features
Our innovative features have made the LNGPac™ a simple plug and play solution with the following benefits:

The INTEGRATED AIRLOCK reduces the footprint, improves safety by minimizing hazardous zones, and makes the installation for the yard much easier.

The INTEGRATED CONTROL CABINET results in a dramatic reduction of interfaces since the electrical cabling from the LNGPac™ to the external switchboards can be reduced to only a few cables. LNGPac™ automation can be connected to the Wärtsilä engine digital ecosystem for global maintenance support throughout the complete vessel lifecycle. Besides, one supplier for automation design, project execution, commissioning work and services will reduce project risk and minimize delays in communication.

The INTEGRATED GAS VALVE UNIT (GVU) shifts the functional components of the GVU as part of the LNGPac™. This single system solution will not only save space, but also save in installation time and costs for the yard.

A new evaporator type with a REFRIGERANT CIRCUIT allows the engine LT-water to be directly connected to the LNGPac™ without the need of an intermediate heating media circuit skid. This leads to fewer interfaces and equipment and less installation work is required.

The cold released from LNG vaporisation can be recovered and utilized for HVAC and cold store with Wärtsilä’s patented COLD RECOVERY.

If not taken advantage of the Type-C LNG tank pressure built-up to control the LNG supply, the LNGPac™ can alternatively be equipped with a Wärtsilä Svanehøj ECA fuel pump. With single-shell tanks the LNG pump is assembled as a deep-well installation and with vacuum-insulated tanks the pump is placed in a cryosump located in the adjacent tank connection space. With this seamless integration of the pump, heat ingress to the LNG-storage tank is minimized.

Maintenance oriented design
LNGPac™ design focuses on enabling safe service and maintenance of all core equipment related to the operational functionality of LNG bunkering and gas consumption without any need for emptying the tank.
LNG Fuel Gas Supply Systems

<table>
<thead>
<tr>
<th>IMO C-type LNG-tank</th>
<th>Double-wall tank</th>
<th>Single-wall tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG Volume</td>
<td>25 – 500 cbm</td>
<td>300 – 5000 cbm</td>
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<tr>
<td>Dmax (2 &lt; L/D &lt; 7)</td>
<td>6.5 m</td>
<td>10 m</td>
</tr>
<tr>
<td>Design pressure</td>
<td>4 – 9 barg</td>
<td>4 – 7 barg</td>
</tr>
<tr>
<td>Insulation</td>
<td>Vacuum</td>
<td>PUR</td>
</tr>
<tr>
<td>Tank type</td>
<td>Single-lobe</td>
<td>Single-/Bi-lobe</td>
</tr>
<tr>
<td>Positioning</td>
<td>Horizontal or Vertical, Top- or Below-deck</td>
<td></td>
</tr>
<tr>
<td>Secondary barrier</td>
<td>Not required</td>
<td></td>
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<tr>
<td>Bunkering capacity</td>
<td>40 – 1000 cbm/h</td>
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</tbody>
</table>

**Multi-Lobe LNGPac**

Wärtsilä’s Multi-Lobe LNGPac is a fuel-gas-supply system for large LNG volumes of fuel. The system provides adequate storage and supply capabilities for gas-fuelled ships involved in extended voyages between port calls, such as cruise vessels, container ships, and large feeder vessels.

Wärtsilä offers the Multi-Lobe LNGPac as a full ‘one-stop-shop’ supply and service package that includes the onboard design, the system classification formalities, manufacturing, delivery, commissioning, and lifecycle maintenance.
If your product is LNG, LPG or ammonia, Wärtsilä Tank Control Systems can provide an application-specific solution for your business needs. Today, the liquid gas industry is driven by the economics of operational scale. In order to apply efficient business management, while adhering to stringent safety regulations, operations personnel must have access to correct information.

Throughout the production cycle, from storage to distribution, the availability of precise data is essential, and it needs to be relayed to the control room in real time.

Whether your operation is large or small, our solutions are custom designed to suit your requirements. They can operate independently, or be interconnected within a plant-wide system. Our vast experience, research, instrumentation technology, and service support will add value to your business.

Marine Gauging

LNG secondary tank gauging systems
- World leaders in LNG marine gauging, more than 320 vessels supplied worldwide
- FLIV isolation valves.

Product and chemical carriers
- LPG level gauging
- Alarm systems
- Supervisory control and data acquisition system.
Liquefied Natural Gas (LNG)

Total LNG tank gauging system

Our total LNG storage tank instrumentation solution comprises the following, fully integrated system components:

- SIL-3 certified servo level gauges
- High/high level alarm gauges
- Product temperature probes
- Fully automatic LTD gauges
- Leak detection and cooling temperature transmitter system
- PC based SCADA package
- Roll-over predictive alarm software
- LNG sampling system.

The entire system communicates via a redundant communication link.

Liquefied Petroleum Gas (LPG)

Wärtsilä Tank Control Systems lead the industry in liquefied gas storage instrumentation and safety systems. We offer complete pressurised tank solutions for LPG and liquefied chemical gases (vinyl chloride, ethylene, propylene, butadiene, ammonia, etc.). These include level gauging or safety shut-off valves systems with hydraulic panel remote, that enable the full protection, control, and supervision of the storage plant.

Wärtsilä Tank Control Systems is a key player in LPG cavern storage applications. We have developed, in close collaboration with key customers, a unique and dedicated range of products that meet the specific needs of this type of storage.
## LNG Quantity Converter

<table>
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<tr>
<td>kg/hr</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lbs/hr</td>
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<td></td>
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<tr>
<td>Am³/hr</td>
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<tr>
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<td>Sm³/hr</td>
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<tr>
<td>Scf/hr</td>
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<td>100,000</td>
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<tr>
<td>lbs/day</td>
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<tr>
<td>Am³/day</td>
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<td>US gal/day</td>
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<td>tons/yr</td>
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<td>MMSm³/yr</td>
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<td>MMScf/yr</td>
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**Note:** Volumetric values are based on saturated LNG of approximately 96.2% C1, 3.7% C2, 0.4% C3, 0.15% C4 and 0.55% N2 (at -161.8 °C, 1.1 bara)
<table>
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<th>7000</th>
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<td>3000</td>
<td>3500</td>
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</table>
Wärtsilä Gears

Wärtsilä gears have been designed to meet the highest standards of operational efficiency, reliability and low noise and vibration.

**Gear configurations:**

- 1-speed gearboxes, for installations with a single engine and propeller operating at a constant propeller speed. The Wärtsilä SCV designation indicates a vertical offset, while SCH represents a horizontal offset.
- 2-speed gearboxes, for installations with a single engine and propeller able to operate at two selectable propeller speeds. The Wärtslä SCV/2 designation indicates a vertical offset, while SCH/2 represents a horizontal offset.
- Double gearboxes, for installations with two engines and one propeller operating at a constant rotational speed. “Twin-in single-out” gears with Wärtsilä designation TCH.
- Special gearboxes, for instance gearboxes with both horizontal and vertical offsets, are available upon request and are customised for the specific application.
- All Wärtsilä gears can be supplied with built-in multi-disc clutches for engaging the propeller.

**Power take-off (PTO)**

All Wärtsilä gears can be equipped with one or more PTOs for driving shaft alternators, compressors or pumps. A clutch is optionally available for the PTO.

**Power take-in (PTI)**

Most Wärtsilä gears can be supplied with a combined PTO/PTI. In PTI mode the shaft alternator can be used as an electric motor to enable additional power for demanding operations via the ‘PTI booster’. This functionality does not require any additional clutch.

- “PTI take me home” – an electrical drive mode used for emergencies if the prime mover is out of operation. This functionality requires two clutches: one to disconnect the prime mover and one to engage the propeller in PTI mode.

**Hydraulic system for the gear & controllable pitch (CP) propeller can be integrated or separate**

Most Wärtsilä gears are designed with an integrated propeller hydraulic system. This provides a space efficient and highly reliable solution since the hydraulic pump is driven mechanically by the gearbox. Optionally, all gears can be interfaced to a separate hydraulic power unit as well.
Wärtsilä 2-speed Gear

The Wärtsilä 2-speed gear is designed to serve vessels having multiple operational modes or reduced transit speeds. In particular, RoPax ferries, offshore support vessels, tug boats and fishing vessels can gain notable economic and environmental benefits. Single screw vessels with redundant propulsion system (“take me home system”) will also benefit from this type of gear.

The key feature of the 2-speed gearbox is the possibility to reduce the propeller speed while the speed of the vessel remains constant in operating conditions where vessel speed is below maximum. This results in fuel savings of up to 15% when compared to a single speed mechanical propulsion system. At the same time, nitrogen oxide (NO\textsubscript{X}) and sulphur oxide (SO\textsubscript{X}) emissions are reduced accordingly.

The reduction in fuel consumption and emissions is the result of the propeller being able to run at close to its optimal design point.

When switching between propeller speeds, both the engine speed and PTO speed are kept constant, enabling uninterrupted electrical power generation at any time.

Benefits

- Fuel consumption and exhaust gas emissions reduced
- Reliable performance with low transmission losses
- Acts as a systems enabler for vessels with variable operational modes and/or a need for a redundant propulsion system
- Two selectable propeller speeds at 100% engine speed
- Provides efficient utilisation of the main engine
- PTO power at 100% of the engine power
- PTO power uninterrupted when changing propeller speed
- Reliable and simple to operate with mode changes from the bridge
- Lower noise levels for on-board comfort and ecological friendliness
## Single Input Gears

### Single input gears, vertical offset, dimensions (mm)

<table>
<thead>
<tr>
<th>Gear type/size</th>
<th>A</th>
<th>B Std-Max</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>L</th>
<th>N</th>
<th>O SCV/SV</th>
<th>Weight tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCV38</td>
<td>380</td>
<td>290</td>
<td>1305</td>
<td>115</td>
<td>465</td>
<td>1000</td>
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<td>340</td>
<td>538</td>
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<td>830</td>
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<td>530</td>
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</tr>
<tr>
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<td>700</td>
<td>4040</td>
<td>300</td>
<td>1390</td>
<td>3084</td>
<td>2516</td>
<td>2018</td>
<td>1630</td>
<td>850</td>
<td>610</td>
<td>2020</td>
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</tr>
<tr>
<td>SV140</td>
<td>1400</td>
<td>600</td>
<td>4250</td>
<td>350</td>
<td>1500</td>
<td>3250</td>
<td>2600</td>
<td>2150</td>
<td>1700</td>
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<td>720</td>
<td>920</td>
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<td>680</td>
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* Not binding
Single Input Gears

**Single input gears, power range**

<table>
<thead>
<tr>
<th>Power range (MW)</th>
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<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>25</td>
</tr>
<tr>
<td>132</td>
</tr>
<tr>
<td>125</td>
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<td>46</td>
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<td>38</td>
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**Single input gears, horizontal offset, dimensions (mm)**

<table>
<thead>
<tr>
<th>Gear type/ size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>N</th>
<th>O SCH/ SH</th>
<th>Weight tonnes</th>
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<tbody>
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<td>1095</td>
<td>730</td>
<td>500</td>
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<td>SCH75</td>
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<td>280</td>
<td>885</td>
<td>2230</td>
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<td>11.5</td>
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<tr>
<td>SCH85</td>
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<td>320</td>
<td>1000</td>
<td>2495</td>
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<td>970</td>
<td>830</td>
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<td>750</td>
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<td>1520</td>
<td>2250</td>
<td>830</td>
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<td>910</td>
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<td>750</td>
<td>1700/1510</td>
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<td>1715</td>
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<td>830</td>
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* Not binding
Wärtsilä gear type SCV132

Wärtsilä gear type TCH370-S63
Double Input Gears

Double input gears, dimensions (mm)

<table>
<thead>
<tr>
<th>Gear type/size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>J</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>Weight tonnes*</th>
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</thead>
<tbody>
<tr>
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<td>1900</td>
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<td>555</td>
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<td>360</td>
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<td>15.0</td>
</tr>
<tr>
<td>TCH240</td>
<td>2400</td>
<td>490</td>
<td>20</td>
<td>450</td>
<td>1315</td>
<td>3580</td>
<td>1455</td>
<td>730</td>
<td>3135</td>
<td>570</td>
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<td>570</td>
<td>1290</td>
<td>28.0</td>
</tr>
<tr>
<td>TCH270</td>
<td>2700</td>
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<td>10</td>
<td>500</td>
<td>1330</td>
<td>3900</td>
<td>1690</td>
<td>880</td>
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</tr>
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<td>5370</td>
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<td>790</td>
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<td>5565</td>
<td>1645</td>
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<td>880</td>
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<tr>
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* Not binding

TCH type

Double input gears vs Wärtsilä engines

<table>
<thead>
<tr>
<th>Gear type</th>
<th>Engine offset (mm)</th>
<th>Engine type</th>
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<tbody>
<tr>
<td>TCH190</td>
<td>1900</td>
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<tr>
<td>TCH240</td>
<td>2400</td>
<td>Electric motors</td>
</tr>
<tr>
<td>TCH250</td>
<td>2500</td>
<td>W26 (L-version)</td>
</tr>
<tr>
<td>TCH270</td>
<td>2700</td>
<td>W32 (L-version) and W34DF (L-version)</td>
</tr>
<tr>
<td>TCH350</td>
<td>3500</td>
<td>W12V32, W6L46F, W6L50DF</td>
</tr>
<tr>
<td>TCH370</td>
<td>3700</td>
<td>W16V32, W16V33, W8L46F, W9L46F, W8L50DF, W9L50DF, W12V34DF, W16V34DF, W46DF (L-version)</td>
</tr>
<tr>
<td>TCH380</td>
<td>3800</td>
<td>W8V31, W10V31</td>
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</table>
## 2-speed Gears

### 2-speed gears, vertical offset, dimensions (mm)

<table>
<thead>
<tr>
<th>Gear type/size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>L</th>
<th>N</th>
<th>O</th>
<th>Weight tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCV80/2-P54</td>
<td>800</td>
<td>540</td>
<td>2680</td>
<td>220</td>
<td>880</td>
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<td>2210</td>
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<td>1350</td>
<td>17.0</td>
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<td>260</td>
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<td>2500</td>
<td>2000</td>
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### 2-speed gears, horizontal offset, dimensions (mm)

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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>J</th>
<th>L</th>
<th>N</th>
<th>O</th>
<th>Weight tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCH80/2-P54</td>
<td>800</td>
<td>540</td>
<td>15</td>
<td>220</td>
<td>700</td>
<td>2450</td>
<td>1050</td>
<td>950</td>
<td>660</td>
<td>800</td>
<td>580</td>
<td>1325</td>
<td>15.0</td>
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<td>SCH90/2-P58</td>
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<td>580</td>
<td>15</td>
<td>260</td>
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<tr>
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<td>260</td>
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<td>3200</td>
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<td>3500</td>
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<td>2000</td>
<td>1520</td>
<td>715</td>
<td>1050</td>
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**Vertical offset**

**Horizontal offset**
2-speed Gears

2-speed gears, power range

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<th>Model</th>
<th>Power Range (MW)</th>
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<tr>
<td>SCV/SCH118/2</td>
<td>12-14</td>
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<td>SCV/SCH112/2</td>
<td>10-12</td>
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<td>SCV/SCH100/2</td>
<td>8-10</td>
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<td>SCV/SCH90/2</td>
<td>6-8</td>
</tr>
<tr>
<td>SCV/SCH80/2</td>
<td>4-6</td>
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</tbody>
</table>

Wärtsilä gear type SCV90/2-PDC58
Wärtsilä Controllable Pitch (WCP) propeller systems provide excellent performance and manoeuvrability, and are recommended for vessels with frequent sailing routes that involve multiple operating conditions. These can be, for example, vessels requiring full power in both bollard pull and free-sailing conditions, or that make frequent port calls. WCP propeller systems can also be applicable for vessels that encounter varying weather conditions or demanding operational requirements, such as dynamic positioning. A controllable pitch propeller can be the optimal choice for installations with a shaft generator operating at constant rotational speed. Full propulsion power is available in both heavy and light conditions through an automatic pitch adjustment. Engine overload is avoided regardless of the conditions.

The WCP propeller system is the ideal choice for diesel-mechanic propulsion with both medium-speed and low-speed diesel engines. By integrating a suitable gearbox and Power Take Off/In, the WCP propeller system can be transformed into a hybrid propulsion system that enables:

- High operational efficiency and flexibility
- A power boost mode
- Emergency propulsion power.
WCP Propeller Systems

A Wärtsilä Controllable Pitch (WCP) propeller system comprises a hub, propeller blades, shafting, hydraulics, control system and any further accessories required. The system is fully customised to meet the specific needs of the customer. Wärtsilä’s hydrodynamic experts tailor the propeller for each application to achieve the optimum balance between fuel consumption and comfort levels, according to the customer’s wishes.

**Technical data**

Power range starting from 500 kW, no upper limit
- 4- or 5-bladed propellers starting at a diameter of 1200 mm
- Bronze or stainless steel propellers
- Various hub types, depending on the application
- Compliant with all ice classes.

**Options**
- US EPA Vessel General Permit 2013 compliance
- Zero pollution sterntube
- Under water replacement of propeller blades
- Trailing propellers or full blade feathering
- Navy/research/fishing requirements for low noise signature
- EnergoPac rudder or EnergoProFin hub cap for increased efficiency
- Continuous oil monitoring for increased reliability
- Wärtsilä High Performance (HP) Nozzle
- Shaft withdrawal interval reduction
- Cruise control and fuel savings with EcoControl functionality.
Wärtsilä is uniquely positioned to select various controllable pitch hub principles up to 16 MW. The WCP hub type D is the right solution for light and moderately loaded propellers. The WCP hub type G is selected for vessels requiring high power or having a highly loaded propeller. With these two hub types, Wärtsilä successfully covers all applications requiring controllable pitch propellers. Stainless steel propellers are also included in our portfolio.
Wärtsilä Propulsion Package

Wärtsilä offers an unrivalled range of products, systems and solutions, including ship machinery, propulsion equipment and control systems, for all types of marine vessels. The offering is based on technological expertise and close customer support. Our customer support extends throughout the entire process, from initial design to construction and operation.

The benefits of integrated packages comprising a WCP system include:

- In-house design, manufacturing and project management
- Matching components and integrated design to ensure functionality and efficiency
- Easy installation and commissioning
- Simple mechanical and automation interfaces to shipyard systems.

Wärtsilä integrated propulsion package for a cargo vessel. WCP-1190 propeller system, SCV 95 gearbox, Wärtsilä 10V31 engine and control system.

WCP propeller systems – Application base

- Gas Tankers
- Passenger Vessels
- RoRo Vessels
- Container Vessels
- Passenger & Cargo Vessels
- Tankers
- Service Vessels
- Navy & Coast Guard Vessels
- Bulk Carriers
- Cruise Vessels
- Cargo Vessels
- Offshore Vessels
- Fishing Vessels
Wärtsilä’s Hydrodynamic Design

The hydrodynamic design covers propellers for vessels ranging from heavy-duty ships, such as AHTS to high-speed passenger ferries, and from small fishing boats to enormous ice classed container vessels. Wärtsilä’s extensive hydrodynamic know-how is based upon the company’s long history and vast experience in the design of propellers. Our design tools are continuously developed and validated by a large number of model test results, full-scale measurements, and research and development efforts. The latest addition to Wärtsilä’s design capability is the OPTI Design methodology.

OPTI Design

With OPTI Design the focus is on the vessel’s total propulsive efficiency, which in the end determines its fuel consumption. This propulsive efficiency depends in turn on the efficiency of the propeller and the interaction between the propeller and the vessel. With modern Computational Fluid Dynamics (CFD) it is possible to make a flow simulation of the complete vessel and propulsion unit. With such simulation, paying attention to both the propeller design and the details, such as brackets and nozzle connections and the propulsion unit to the vessel, the overall performance can be determined. Design features that can be further improved are also revealed, thus improving the vessel’s overall performance.
WCP Propeller Systems

Polar Logistics Vessel for Terre Australes et Antarctiques Françaises (TAAF) and the French Polar Institute (IPEV)
WCP-1080 propeller system, DNV Polar Class 5

Passenger ferry for Rederi AB Gotland
WCP-1540 propeller system, Energopac rudder
28.5 knots, DNV ice 1A

Chemical tankers for Gothia Tanker Alliance
WCP-1415 propeller system, HP Nozzle, Energopac rudder, OPTI Design and ProTouch
Fixed Pitch Propellers

**Wärtsilä Fixed Pitch Propellers**

Wärtsilä fixed pitch propellers are manufactured by the Wärtsilä CME Zhenjiang Propeller Co., Ltd joint venture company. At this facility fixed pitch propellers with diameters from 1 to 12 meters and up to 120 tons in weight can be produced. Since the joint venture company was established in 2004, more than 2000 propellers have been produced. Furthermore, Wärtsilä CME is able to take advantage of the extensive experience and databases of LIPS and Wärtsilä with regard to propeller design and production technology.

The propeller and shaft line design tools are based upon long experience with calculations, model test results, Computational Fluid Dynamics (CFD), and full scale results.
Fixed Pitch Propellers

Propeller efficiency, noise, and vibration requirements are the main considerations for propeller designs that can be applied for a wide variety of speeds and power densities, and for any type of ship. The unique Wärtsilä Cunial® propeller material provides excellent casting, machining and fatigue properties.

Replacement Propellers

By re-designing and replacing existing propellers using Wärtsilä state-of-the-art design tools, notable efficiency improvements can be achieved. For example, by designing a Fixed Pitch Propeller to accommodate slow steaming at reduced vessel speed and power levels, efficiency improvements of up to 15% are possible.

Redesigning and replacing propellers is not restricted to Wärtsilä Propulsion products only!
Fixed Pitch Propellers

- **Wärtsilä Built-Up Propellers**

The Wärtsilä Built-Up Propeller (BUP) is an attractive alternative for a monobloc propeller. The easily (de)mountable blades and the possibility of under water (de)mounting enable the propeller blades to be replaced or repaired with minimum interruption to the normal operating service.

The BUPs are supplied in stainless steel or bronze. Connections to the propeller shaft are made using a flange and fit bolts. Most BUPs are delivered with 4- and 5-blade propellers, but 6-bladed propellers can also be delivered on request. There are no propeller diameter or weight limits. The flush and compact hub design in combination with efficiency optimised propeller blades makes the BUP fit for applications where low fuel consumption is important.

Built-up propellers are typically installed on ice-breakers and offshore patrol vessels operating in heavy ice conditions, or conditions where there is an increased risk of damage to the propeller. Extended scheduling interruptions are avoided thanks to rapid (underwater) replacement of the blades.

The short replacement time needed also benefits vessels with a fixed operating schedule, such as cruise and ferries.
Coastal and Inland Waterway Propellers

Coastal and inland propulsion systems are specialized for vessels operating on local waterways, and for coastal and fishing vessels. Wärtsilä has considerable expertise in designing propulsion systems for large, fast luxury yachts and government-owned ships as well as a variety of special vessels, all with their own characteristics. Wärtsilä supplies fixed pitch propellers, nozzles, and propeller shaft assemblies complete with sterntube systems as part of the propulsion equipment for such vessels.

Coastal and Inland Waterway Propellers are available in bronze or stainless steel. They are tailor-made with 3, 4, 5, 6 or 7 blades. The accuracy can be according to ISO class II, I or S. Wärtsilä has the capability to deliver fixed pitch propellers for any diameter above 1000 mm, although for the coastal and inland waterway segment they are seldom larger than 3500 mm.
Wärtsilä High Performance Nozzle
Fitting a nozzle increases the thrust at relatively low ship speeds. This allows for significant savings to be achieved in terms of fuel consumption, depending on the number of revolutions and the capacity of the engine. The improved Wärtsilä High Performance nozzle, the type HP nozzle, when combined with Wärtsilä propellers, can provide up to 5% more thrust than conventional nozzles in bollard pull conditions. The nozzle profile offers a double profiled cross section at the inlet side of the nozzle.

Wärtsilä EnergoPac
EnergoPac is the optimised propulsion and manoeuvring solution for coastal and ocean going vessels. The key objective is to reduce the vessel’s fuel consumption by integrating the design of both the propeller and rudder. Each EnergoPac is designed to fit the intended vessel and to meet its specific requirements; this allows EnergoPac to be optimised fully for energy efficiency, whilst not compromising on either manoeuvrability or comfort levels.

- Improved propulsive energy efficiency
- Reduced fuel consumption
- Excellent maneuverability
- Lower vibration levels and higher on-board comfort
- Reduced levels of emissions
- Integrated propeller and rudder design.
**Fuel savings**
EnergoPac reduces fuel consumption because it effectively reduces the flow separation behind the propeller hub. Extended studies show that for the same course-keeping capabilities, EnergoPac will create less drag than conventional rudder systems.

**Typical applications**
EnergoPac can effectively reduce the operational costs for any vessel with a considerable share of free sailing time in its operational profile. It works very well for propellers with a relatively large propeller hub. The potential savings are large for vessels with highly loaded controllable pitch propeller systems, such as Ro-Ro vessels, ferries, container/multipurpose vessels, and vessels with an ice class notation. In addition to controllable pitch propeller applications, EnergoPac can also be applied on vessels with fixed pitch propellers.

**Cost savings**
The reduction in fuel consumption depends very much on the vessel type, its operational profile, and on the reference propeller and rudder. For any application, the power savings can be estimated by Wärtsilä. The estimate is based on the vessel design, its operational profile and other factors. Proven savings in the power required for a vessel’s trial speed vary between 2 and 9% with EnergoPac.
EnergoProFin
The Wärtsilä EnergoProFin is an energy saving propeller cap with fins that rotate together with the propeller. It improves propulsive efficiency by weakening the hub vortex, and by recovering kinetic energy from the rotating flow aft of the propeller blades. This solution provides average fuel savings of 2%, with a payback time of less than one year. The Wärtsilä EnergoProFin can be applied for both Controllable and Fixed Pitch Propellers. Vessels utilising EnergoProFin receive 23 percent discount on harbour dues at Port of Vancouver.

EnergoFlow
The Wärtsilä EnergoFlow is an innovative and cost-effective pre-swirl stator, that creates optimal inflow for the propeller by guiding one side of the stern flow in the opposite direction to the propeller rotation, generating pre-swirl. The EnergoFlow consists of multiple curved fins and a ring attached to the ship’s hull to prevent the power losses that typically occur in a propeller’s slipstream. The curved fins enhance the propeller’s efficiency while keeping resistance at acceptable levels. Hence, optimal total efficiency is achieved by combined design of the Wärtsilä propeller and EnergoFlow shape.

The power savings that can be achieved with EnergoFlow varies,
depending on the specifics of each case. Nevertheless, indications are depicted in the illustration above, based on ship type. Bulk carriers can achieve the highest fuel savings, in the range of 10%. Faster vessels which are already relatively efficient in propulsion terms, could still see a respectable 4% improvement. Regardless of ship type, Wärtsilä EnergoFlow typically pays for itself within one to two years.
Wärtsilä Steerable Thrusters

Wärtsilä steerable thrusters are available in different series covering a wide range of customer needs.

Specific configurations, such as the retractable thruster and underwater mountable thruster series, are based on the reliable designs of the standard steerable thruster series. Together they form a steerable thruster range that covers the most advanced ship design options.

The Wärtsilä Thruster series:

Wärtsilä Steerable Thrusters

The Wärtsilä Steerable Thruster (WST) series is intended for tug or offshore support vessel applications, and for river/inland waterway vessels. These thrusters have a light ice class capability and can be combined with high-speed engines of up to 1800 rpm. Two nozzle types can be selected depending on customer requirements: a bollard pull nozzle or a nozzle optimised for free-sailing. Configurations with open propellers are available on request.

Wärtsilä Retractable Thrusters

Wärtsilä Retractable Thrusters are available at power ratings up to 6500 kW. Retractable thrusters up to 4500 kW are available in L- and Z-drive configuration. WST-24R features an 8° tilted propeller gearbox design to minimize thruster-hull and thruster-thruster interactions. LMT types are equipped with 3° or 5° tilted nozzle. All retractable types can be fitted with a hull closing plate.

The upper part of the retractable range is covered by the WST-65RU retractable underwater mountable thruster, whereby the outboard part can be exchanged under water to optimise maintenance when docking of the vessel is not possible. Like WST-24R, the WST-65RU features an 8° tilted propeller gearbox.

Wärtsilä Underwater Mountable Thrusters

The Wärtsilä WST-U designated underwater mountable thrusters belong to a series with several added features, such as an increased power range, an 8° tilted propeller gearbox, and the Wärtsilä Thruster Nozzle to provide superior and reliable DP performance. The underwater mountable thrusters from the LMT series are available for the lower end of the power range.

Special Thruster Designs

Based on the above mentioned thruster series, special thruster designs are available, such as inboard demountables, icepods and containerized (retractable) thrusters.
Steerable Thrusters
Steerable Thrusters

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Engine power (2) (kW)</th>
<th>Input speed (rpm)</th>
<th>Propeller diameter (mm)</th>
<th>Bollard pull (1) (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST-11</td>
<td>900</td>
<td></td>
<td>1600</td>
<td>30</td>
</tr>
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<td></td>
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<td>69</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td></td>
<td>2400</td>
<td>73</td>
</tr>
<tr>
<td>WST-18</td>
<td>2050</td>
<td></td>
<td>2600</td>
<td>80</td>
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<tr>
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<tr>
<td></td>
<td>2800</td>
<td>1000</td>
<td>3000</td>
<td>107</td>
</tr>
<tr>
<td>WST-21</td>
<td>2400</td>
<td></td>
<td>3000</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>1200</td>
<td>3000</td>
<td>111</td>
</tr>
<tr>
<td>WST-24</td>
<td>3200</td>
<td></td>
<td>3200</td>
<td>144</td>
</tr>
<tr>
<td></td>
<td>3200</td>
<td>1200</td>
<td>3200</td>
<td>144</td>
</tr>
</tbody>
</table>

1) Based on two installations, 100% power, FP propeller in nozzle designed for bollard pull, thrust deduction included
2) In case of ice class notation, maximum power level is reduced

Key benefits
• Superior hydrodynamic performance for high bollard pull or maximum propulsion efficiency.
• Compatible with high speed engines (up to 1800 rpm).
• Compact dimensions with a high level of integration.
• Reliable propeller shaft and steering seals with monitoring.
• Robust design for reliable operations.
• Maintenance friendly design to minimize downtime.
• Reduced number of external connections and field bus technology for ease of installation.
• Wärtsilä ProTouch controls with ergonomic levers and intuitive touch screen displays.

Options
• Diesel-mechanical Z-drive configuration compatible with engine speeds ranging from 750 rpm to 1800 rpm (intermediate ratio’s available on request)
• Diesel-mechanical configurations have an integrated power take off for steering, lubrication, clutch and pitch hydraulics
• Diesel-electric Z-drive configuration with electric steering and auxiliary systems
• 2 propeller diameters per size (3 diameters for WST-14)
• FP propeller and integrated medium duty hydraulic clutch (slipping range up to 50% engine rpm) or CP propeller with hydraulic on/off clutch
• Two nozzle types: optimized for bollard pull or free sailing (FP propeller only)
• Finnish-Swedish (Baltic) ice class up to 1B, Russian (RMRS) ice class up to Ice-3 or equivalent Russian river register (RRR) ice class
• EPA VGP 2013 compliance
• Mounting method: bolt-in, weld-in, can-mounted or split installation
• L-drive versions are available on request.
# Wärtsilä Steerable Thrusters range

<table>
<thead>
<tr>
<th>Thruster Type</th>
<th>Power range (kW)</th>
<th>WST-11</th>
<th>WST-14</th>
<th>WST-16</th>
<th>WST-18</th>
<th>WST-21</th>
<th>WST-24</th>
<th>WST-28</th>
<th>WST-32</th>
</tr>
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<tr>
<td></td>
<td>500</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
<td>3000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Wärtsilä Steerable Thrusters dimensions (mm)

<table>
<thead>
<tr>
<th>Thruster Type</th>
<th>Dimensions</th>
<th>Weld-in (well diameter [mm])</th>
<th>Bolt-in (well diameter [mm])</th>
<th>PAL options D [mm]</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST-16</td>
<td></td>
<td>2342 (2400)</td>
<td>2326 (2400)</td>
<td>2800</td>
<td>17050/20400</td>
</tr>
<tr>
<td>WST-18</td>
<td></td>
<td>2342 (2400)</td>
<td>2326 (2400)</td>
<td>2900</td>
<td>18600/21950</td>
</tr>
<tr>
<td>WST-21</td>
<td></td>
<td>2542 (2600)</td>
<td>2512 (2600)</td>
<td>3200</td>
<td>24800/27500</td>
</tr>
<tr>
<td>WST-24</td>
<td></td>
<td>2692 (2750)</td>
<td>2660 (2750)</td>
<td>3500</td>
<td>28500/31500</td>
</tr>
<tr>
<td>WST-28</td>
<td></td>
<td>2862 (2920)</td>
<td>2825 (2920)</td>
<td>3900</td>
<td>32800/36100</td>
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<tr>
<td>WST-32</td>
<td></td>
<td>3042 (3100)</td>
<td>3000 (3100)</td>
<td>4000</td>
<td>37000/41000</td>
</tr>
</tbody>
</table>

1) Estimated minimum (FPP and smallest prop / nozzle / propeller arm length (PAL)) and maximum (CPP and biggest prop / nozzle / PAL) weights.
Retractable Thrusters

**Wärtsilä Retractable Thrusters**

**Benefits**
- Fast retraction and deployment
- Fully retracted during transit; optional hull closing plate
- High thrust performance
- 3° tilted Wärtsilä HR Nozzle (LMT type)
- WTN type nozzle in combination with 8° tilted propeller shaft (WST-R and WST-RU types)
- L- and Z-drive options enable integration in a wide range of vessel types and sizes
- Outboard part exchangeable under water for maintenance or overhaul (WST-65RU)

**Options**
- 2 propeller diameter options (WST-24R and LMT type FS2510/3500)
- L- and Z-drive with horizontal floating shaft and quick connect clutch (except WST-65RU type)
- Fixed pitch (FP) or controllable pitch (CP) propeller (LMT types CS/FS 175/200/225/250)
- 3° tilted nozzle (standard), 5° tilted nozzle or straight execution (LMT type)
- Hull closing plate

<table>
<thead>
<tr>
<th>Type</th>
<th>Power (max.)</th>
<th>Input speed (rpm)</th>
<th>Propeller type</th>
<th>Propeller diameter (A) [mm]</th>
<th>Depth (B) [mm]</th>
<th>Width (C) [mm]</th>
<th>Retraction (F) [mm]</th>
<th>Layout</th>
<th>Height without E-motor (H1) [mm]</th>
<th>Overall height (H2) [mm]</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMT CS/FS175MNR</td>
<td>1000</td>
<td>1200</td>
<td>FP or CP</td>
<td>1700</td>
<td>2836</td>
<td>2900</td>
<td>2220</td>
<td>L-drive</td>
<td>6120</td>
<td>7700</td>
<td>20000</td>
</tr>
<tr>
<td>LMT CS/FS200MNR</td>
<td>1200</td>
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<td>FP or CP</td>
<td>1900</td>
<td>2865</td>
<td>3020</td>
<td>2400</td>
<td>L-drive</td>
<td>7490</td>
<td>8600</td>
<td>27750</td>
</tr>
<tr>
<td>LMT CS/FS225MNR</td>
<td>1600</td>
<td>1200</td>
<td>FP or CP</td>
<td>2100</td>
<td>3435</td>
<td>3590</td>
<td>2655</td>
<td>L-drive</td>
<td>7280</td>
<td>8950</td>
<td>31200</td>
</tr>
<tr>
<td>LMT CS/FS250MNR</td>
<td>2000</td>
<td>900</td>
<td>FP or CP</td>
<td>2400</td>
<td>3710</td>
<td>3666</td>
<td>3000</td>
<td>L-drive</td>
<td>8100</td>
<td>10500</td>
<td>34750</td>
</tr>
<tr>
<td>LMT CS/FS250MNR</td>
<td>2000</td>
<td>900</td>
<td>Z-drive</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>WST-24R</td>
<td>2400</td>
<td>900</td>
<td>FP</td>
<td>2600 / 2800</td>
<td>4090</td>
<td>4410</td>
<td>3580</td>
<td>L-drive</td>
<td>9750</td>
<td>11690</td>
<td>48500</td>
</tr>
<tr>
<td>LMT FS2510MNR</td>
<td>3500</td>
<td>720</td>
<td>FP</td>
<td>3000 / 3200</td>
<td>4900</td>
<td>4500</td>
<td>4105</td>
<td>L-drive</td>
<td>11300</td>
<td>14460</td>
<td>105000</td>
</tr>
<tr>
<td>LMT FS2500MNR</td>
<td>4500</td>
<td>720</td>
<td>FP</td>
<td>3400 / 3600</td>
<td>5845</td>
<td>4770</td>
<td>4720</td>
<td>L-drive</td>
<td>14560</td>
<td>16750</td>
<td>132000</td>
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<tr>
<td>WST-65RU</td>
<td>6500</td>
<td>600</td>
<td>FP</td>
<td>4200</td>
<td>5550</td>
<td>5980</td>
<td>7200</td>
<td>L-drive</td>
<td>16850</td>
<td>20100</td>
<td>212500</td>
</tr>
</tbody>
</table>

**Remarks**
- Other input speed / power level combinations are available on request.
- Maximum power level depends on classification society.
- Selections are not valid for classification with ice class.
- Values for dimensions and weight are indicative.
- Dimensions and weights can vary depending on propeller type, propeller size and project specific customizations.
- 1) Height indication H2 is for L-drive execution, including generic E-motor
- 2) Indicative weights without auxiliaries and oil
Retractable Thrusters

Power Range for Wärtsilä Retractable Thrusters

<table>
<thead>
<tr>
<th>Thruster Model</th>
<th>Power Range (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST-65RU</td>
<td>500 - 6500</td>
</tr>
<tr>
<td>LMT FS3500MNR</td>
<td>2500 - 5500</td>
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<tr>
<td>LMT FS2510MNR</td>
<td>3500 - 5500</td>
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<tr>
<td>WST-24R</td>
<td>3500 - 5500</td>
</tr>
<tr>
<td>LMT CS/FS250MNR</td>
<td>2500 - 5500</td>
</tr>
<tr>
<td>LMT CS/FS225MNR</td>
<td>2500 - 5500</td>
</tr>
<tr>
<td>LMT CS/FS200MNR</td>
<td>1500 - 5500</td>
</tr>
<tr>
<td>LMT CS/FS175MNR</td>
<td>500 - 4500</td>
</tr>
</tbody>
</table>

Propulsors & Gears
Underwater Mountable Thrusters

### Wärtsilä Underwater Mountable Thrusters

#### Key benefits
- Maintenance or overhaul without the need for dry docking the vessel
- High bollard thrust and propulsion efficiency
- Effective DP operations thanks to the $8^\circ$ tilted propeller shaft or $3^\circ$ tilted nozzle
- Electric L-drive up to 6500 kW
- High reliability
- Wide power range
- Easy installation

#### Options
- Condition monitoring (PCMS)
- Oil condition monitoring
- Redundant lubrication and steering hydraulic systems
- Face type propeller shaft seals
- Seal monitoring
- Extended time between overhauls (TBO)
- Diver-less underwater mounting (WST-U type)

### Main technical data

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Power $(^1)$ (kW)</th>
<th>Input speed (rpm)</th>
<th>Propeller diameter (mm)</th>
<th>Tilt</th>
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<tbody>
<tr>
<td>LMT FS1510NU</td>
<td>2435</td>
<td>720</td>
<td>2600</td>
<td>$3^\circ$ $(^2)$</td>
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<td>LMT FS2510NU</td>
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<td>539</td>
<td>3200</td>
<td>$3^\circ$ $(^2)$</td>
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<td>720</td>
<td>3600</td>
<td>$8^\circ$</td>
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<td>WST-45U</td>
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<td>600</td>
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</tr>
<tr>
<td>WST-55U</td>
<td>4500</td>
<td>720</td>
<td>3900</td>
<td>$8^\circ$</td>
</tr>
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<td>WST-55U</td>
<td>5500</td>
<td>600</td>
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</tr>
<tr>
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<td>720</td>
<td>4200</td>
<td>$8^\circ$</td>
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<td>600</td>
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1) The power level is for dynamic positioning (DP) operation
2) Tilted nozzle

### Dimensions (mm)

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H $(^1)$</th>
<th>R</th>
<th>Outboard part $(^2)$</th>
<th>Receptacle $(^3)$</th>
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</thead>
<tbody>
<tr>
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<td>2600</td>
<td>1936</td>
<td>1045</td>
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<td>900</td>
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<td>1000</td>
<td>1350</td>
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<td>LMT FS2510NU</td>
<td>3000</td>
<td>2123</td>
<td>1266</td>
<td>1911</td>
<td>2220</td>
<td>900</td>
<td>1347</td>
<td>1000</td>
<td>1550</td>
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<td>2194</td>
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<td>WST-65U</td>
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<td>2719</td>
<td>3025</td>
<td>1390</td>
<td></td>
<td></td>
<td></td>
<td>77500</td>
<td>49500</td>
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</table>

1) Options: 1200, 1600, 2000, 2400; project specific lengths on request
2) Indicative weight, with oil
3) Including pipe covers and valve
4) Including top cover, bottom cover, pipe covers, valves and position sensor

All weights and dimensions for $3^\circ$ tilted nozzle (1510 through 2510 type) or $8^\circ$ tilted propeller shaft (WST-45/55/65U type)
## Wärtsilä Underwater Mountable Thrusters range

<table>
<thead>
<tr>
<th>Thruster Model</th>
<th>Power Range (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST-65U</td>
<td>1500 - 6500</td>
</tr>
<tr>
<td>WST-55U</td>
<td>1500 - 5500</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>LMT1510NU</td>
<td>1500 - 1500</td>
</tr>
</tbody>
</table>

![Propulsors & Gears](149)
Transverse Thrusters

Wärtsilä Transverse Thrusters

Benefits

- Superior hydrodynamic performance for high thrust - diameter ratio
- Robust, reliable and maintenance friendly design
- Easy installation; high level of integration
- Maintenance friendly design
- Ergonomic controls with intuitive touch screen displays

Options

- CP or FP propeller upto WTT-40 type; CP propeller for WTT-45 and -55 types
- Manoeuvring (AUX) or Dynamic positioning application
- Redundant pumps and/or lubrication filters
- Compatible with environmentally acceptable lubricant (EAL) for EPA VGP 2013 compliance
- Face type seal or Air barrier seal for WTT-16 and bigger types
- Tailor-made tunnel with tunnel ends cut according to hull form and additional circular or longitudinal stiffeners
- L-drive with intermediate shaft and separate E-motor foundation
- De-mountable, low noise, horizontal drive variants
- Package with electric motor and starter

Wärtsilä Transverse Thrusters dimensions

<table>
<thead>
<tr>
<th>Thruster type</th>
<th>Maximum power</th>
<th>Propeller diameter (D) (mm)</th>
<th>Length (L) (mm)</th>
<th>Weight</th>
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<tbody>
<tr>
<td></td>
<td>Manoeuvring AUX (kW)</td>
<td>Dynamic positioning (kW)</td>
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<tr>
<td>CT/FT 125 H</td>
<td>614</td>
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<td>1550</td>
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<tr>
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<td>789</td>
<td>1500</td>
<td>1800</td>
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<td>1000</td>
<td>1750</td>
<td>1970</td>
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<td>4800</td>
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<td>3600</td>
<td>3660</td>
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<td>WTT-55(^3)</td>
<td>5500</td>
<td>5000</td>
<td>4000</td>
<td>4300</td>
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</tbody>
</table>

1 Maximum power level is valid for uni-directional rotation (CPP). Depending on propeller type and class society, lower power levels may apply.

2 Version with CP propeller including a standard tunnel with E-motor support, excluding E-motor.

3 Available on request.

Values in italics are preliminary.
Transverse Thrusters

Wärtsilä Transverse Thrusters range

<table>
<thead>
<tr>
<th>Model</th>
<th>Power range (kW)</th>
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<tbody>
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<td>WTT-55</td>
<td>250</td>
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<tr>
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<td></td>
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<tr>
<td>CT/FT150</td>
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</tr>
<tr>
<td>CT/FT125</td>
<td></td>
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</table>

Power range (kW)
Wärtsilä Midsize Waterjets

- A compactly designed axial pump with excellent efficiency, cavitation and noise characteristics.
- The waterjet unit is completely pre-assembled, thereby reducing installation time.
- High performance components in stainless steel to prevent wear and corrosion.
- The water lubricated bearing in the stator bowl provides an environmentally friendly solution.
- Water lubricated Face type sterntube seal with an optional inflatable emergency seal.
- Inboard mounted thrust bearing block, for increased life and easy maintenance.
- Inboard hydraulics provide an environmental friendly solution, increased life and easy maintenance.
- Machinery controls integrated within the unit.

Key benefits

A Plug and Play waterjet concept, with all auxiliary systems pre-installed on the skid. The waterjet package is welded into the hull and the yard connections are reduced to a minimum.
## Waterjets

### Weight & dimensions table

<table>
<thead>
<tr>
<th>Size</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>C (mm)</th>
<th>D (mm)</th>
<th>E (mm)</th>
<th>F (mm)</th>
<th>Weight steering (kg)</th>
<th>Weight booster (kg)</th>
<th>Entrained water (l)</th>
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<tr>
<td>510</td>
<td>1 540</td>
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<td>450</td>
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<td>570</td>
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<tr>
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<td>3 220</td>
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<td>1 400</td>
<td>810</td>
<td>3 600</td>
<td>3 000</td>
<td>1 750</td>
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</tbody>
</table>

### Wärtsilä Midsize 510–810 sizes

![Diagram of Wärtsilä Midsize 510–810 sizes](image_url)

- **Engine power (b kW)**
- **Vessel speed (knots)**

- **510 size**
- **570 size**
- **640 size**
- **720 size**
- **810 size**
Propulsors & Gears

Waterjets

**Wärtsilä Modular Waterjets**

The Wärtsilä WXJ modular waterjets represent the state-of-the-art in this field, delivering outstanding benefits and performance and offering a high-level of customisation with a wide variety of options available depending on the vessel type.

The Wärtsilä WXJ series features an improved axial pump design, which boosts performance with an increased thrust of as much as 3 percent, while the improved cavitation margins help reduce the environmental impact by lowering noise levels. This axial pump design comes with a 25% reduction in mounting flange diameter, 10% overall weight reduction and a 35% increase in cavitation margin compared to its predecessor, the “LJ type” with a mixed flow pump design, while the small transom interface dimensions, and best in class weight are unchanged.

**Key benefits**

Wärtsilä axial waterjets are single stage, compact, high performance systems that combine mixed flow properties with an axial construction.
Waterjets

This results in much less space being needed on the vessel’s transom, and greatly increased waterjet cavitation margins for optimum vessel operational flexibility. For naval architects, the axial jet technology creates the possibility to apply a larger power density onto narrower hulls in order to achieve top vessel performance.

- Lowest size to weight ratio in the market
- Axial pump design means less space on the transom
- Worldwide availability, including China, Japan, Korea, etc.
- Inboard mounted thrust bearing block, for increased life and easy maintenance
- Best performance in the market based on more than 35 years of waterjet experience
- High-performance components in Duplex stainless steel to prevent wear and corrosion
- Impeller tip clearance guaranteed due to axial shape and no risk of impeller housing collisions.

The upgraded Wärtsilä WXJ series of waterjets features increased thrust and lower noise levels
Propulsors & Gears

Waterjets

Express 4 – A high-speed RoPax ferry with a compact axial flow jet solution
## Weight and dimension table

<table>
<thead>
<tr>
<th>Size</th>
<th>Outboard length SR (mm)</th>
<th>Outboard length B (mm)</th>
<th>Inboard length (mm)</th>
<th>Transom Flange (mm)</th>
<th>Mass Steerable (kg)</th>
<th>Mass Booster (kg)</th>
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<tr>
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<td>3 005</td>
<td>52 500</td>
<td>34 400</td>
</tr>
</tbody>
</table>

Photo courtesy of Molslinjen
Propulsors & Gears

Waterjets

**Waterjet size selection**

The selection graphs indicate the jet size required based on the relation between the vessel’s engine power and design speed. For instance, a ship with four 1250 kW engines and a corresponding vessel speed of 33 knots will need four 510 size waterjets. A ship with a design speed of 40 knots at 1250 kW power can use 450 size waterjets. The correct jet size is thus indicated by the line above the intersection of the power and the corresponding vessel speed.

To ensure an optimised propulsion system for your vessel, we recommend that you contact Wärtsilä during the early stages of the design work. Please contact us for an optimised jet selection based on specific vessel design parameters, the operational profile, or for details of waterjets above 50 knots or 30 000 kW. DXF/DWG format general arrangement drawings of the most often used sizes are available.

**Application**

The characteristics of a waterjet make it a good propulsor for several types of applications.

- **High speed vessels**: waterjets have better propulsion efficiency at ship speeds over 25–30 knots.
- **Shallow draft vessels**: the integrated steering function provides benefits for rescue vessels, inshore passenger ferries, landing crafts & special work boats.
- **High power density**: the pressure built-up in the waterjet inlet allows small dimensions.
- **Maneuverability**: waterjets have integrated steering and reversing with quick response capability.
Propulsors & Gears

Waterjets

Wärtsilä WXJ 910–1400 sizes

- Engine power (bW)
- Vessel speed (knots)

Wärtsilä WXJ 1500–2180 sizes

- Engine power (bW)
- Vessel speed (knots)
Wärtsilä ProTouch Propulsion Control System

The Wärtsilä Propulsion Control System (PCS) is a comprehensive system of levers and touch-screen interfaces, designed to suit all the possible propulsion configurations of a modern ship.

Wärtsilä ProTouch represents the state-of-the-art answer to demands for safe, intuitive and compact design controls. ProTouch gives the power to the user.

**Key benefits**

**Compact design:** The entire footprint of the system is significantly reduced to allow ergonomic optimisation, and to meet functional requirements.

**Modularity/flexibility:** The extended modularity of the hardware and graphic user interfaces provides a flexible solution for any vessel layout. The system fits all the propulsion products and, as a result, all types of vessels.
Safety: the system improves safety, both at sea and in port, by removing the visual challenge of finding critical information. It provides the user the relevant information when needed.

User friendly, intuitive operations: Thanks to the modern displays with touchscreen technology, the operator has handy access to all functions and information. The system will guide the user when a more complex sequence or action is required. Furthermore, the system can support any language.

Simpler installation and maintenance: The system minimizes installation time and costs, simplifies commissioning, and reduces maintenance needs. This is because the PCS is fully pre-configurable and the components communicate by a redundant field bus with a minimal number of cables.

Integration with other systems: The system enables easy integration via serial interfaces with, for example, VDR, IAMCS and DP/AP systems.
Valves

Wärtsilä Valves Limited is a European based valve manufacturing group with over 80 years’ experience supplying a wide range of manual and actuated valves in non-ferrous, high alloy, steel and composite materials for the global energy industries:

- Offshore Oil and Gas
- Floating Production Systems
- Petro-Chemical
- Power Generation

- LNG
- Naval Marine
- Marine Services
- Pipelines.

We are recognised around the world for our engineering excellence, superb customer service and high-performing products, and are the chosen valve supply partners of a growing and enviable list of global blue chip clients.

The World’s Preferred Valve Solutions Partner

Wärtsilä Shipham Valves manufactures non-ferrous, high alloy and composite valve solutions for handling sea water and other corrosive media. For 80 years a key supplier to the British Royal Navy and Ministry of Defence, Shipham is now widely recognised as a global leader in the design and manufacture of valves used in severe service applications, handling sea water and other corrosive media.
Valves

Wärtsilä Shipham Valves offers a diverse range of valves by type, material, and size, providing gate, globe, check (swing and wafer style), ball, Y-type strainers and butterfly valves, in sizes from 1/4” to 48” in non-ferrous, composite and high alloy materials.

Speciality materials – ‘our standard’


Bespoke Valve Solutions for Offshore, Marine & Industrial Applications

Focused on short lead-times, Wärtsilä John Mills Valves manufactures bronze and nickel aluminium bronze gate, globe, check, strainers and storm valves for sea water service in the marine, oil & gas, Naval, water treatment and chemical industries.

In addition to our standard valve range we also manufacture specialty valves such as mud boxes, gland cocks, sight glasses, sounding cocks and storm valves.

Our complete in-house capabilities include design, pattern manufacture, casting production, machining and assembly & test which allows Wärtsilä John Mills to produce both standard and bespoke designed valves within industry leading timescales.

Pipeline Ball & Gate Valves

Wärtsilä Cort Valves has over 70 years’ experience in the design and manufacture of API-6D trunnion mounted ball valves & through conduit gate valves for the global oil and gas industry. Manufactured to order with reduced lead-times, the Wärtsilä CORT range of pipeline valves are available in sizes 2”–60” diameter and in pressure classes from ANSI 150–2 500.

With an enviable product population installed worldwide by major oil and gas end users, Wärtsilä Cort continue to support our clients assets from our extensive records with servicing, repairs and spares availability.
Shaft line products and services

In an increasingly dynamic and unpredictable market, ship owners and operators are looking for new ways to reduce maintenance costs and extend the lifecycle of their shaft line equipment.

With our fully-integrated product portfolio and global service network offering around-the-clock support, we can make this happen and ensure our customers are equipped for the modern world.

Lifecycle efficiency
Access to our global service network together with our diverse product range reassures customers that their vessel is being looked after and reaching its full potential.

Risk reduction
From risk exposure to systematic mapping and monitoring, our risk management programme is fully comprehensive and shaped by current legislation.

Environmental leadership
Years of experience, global manufacturing facilities and a strong understanding of the regulatory environments in which our customers operate allow us to reimagine the future of shipping and keep our customers compliant in sensitive areas around the world.
Seals

**Wärtsilä oil lubricated seals**

**Wärtsilä Airguard**

A hard-wearing environmentally-friendly lip seal designed to eliminate oil leakage, the Wärtsilä Airguard delivers on reliability and compliance with current anti-pollution regulations.

**Wärtsilä Sternguard OLS**

A unique and versatile sealing solution with a track record for excelling in harsh weather conditions, the Wärtsilä Sternguard Oil-Lubricated-Seal (OLS) can optimise the performance of a wide range of vessels and thrusters regardless of the environment.

**Wärtsilä Sternguard IWSS**

Running on Environmentally Acceptable Lubricants (EALs) and designed to operate in abrasive waters, the Wärtsilä Sternguard In-Water-Serviceable-Seal (IWSS) is an environmentally-friendly as well as adaptable outboard face sealing solution for vessels.

**Wärtsilä Sternguard EJ**

Technologically-advanced and built to endure tough conditions, the Wärtsilä Sternguard EJ face seal provides a dependable inboard sealing solution for small to medium sized vessels ranging from trawlers to tugs and offshore supply vessels.

CLICK for more info
Seals

Wärtsilä Sternguard EK
A robust, reliable and cost-effective alternative to traditional lip seals, the Wärtsilä Sternguard EK Face Seal has the capabilities to support small to medium oil lubricated vessels operating in abrasive waters.

Wärtsilä Sandguard
Engineered to last, Wärtsilä Sandguard excels in abrasive and silty waters and provides a dependable lip sealing solution for dredgers.

Wärtsilä Oceanguard
Using the latest technology and superior materials, the Wärtsilä Oceanguard, a high performing propeller shaft sealing system, has been designed to prevent both oil pollution and lubricant contamination, and keep customers compliant with current legislation.

Wärtsilä Steerguard E
Made of hard-wearing abrasion-resistant materials, Wärtsilä Steerguard E provides a reliable sealing solution on the rudder stocks of small to medium-sized vessels.

Wärtsilä water lubricated seals

Wärtsilä Enviroguard M
Minimal leakage, low lifecycle costs and exceptional performance in tough water conditions make Wärtsilä Enviroguard M fundamental to military, cruise and merchant vessels. This fully or partially split face seal comes with a double inflatable seal to facilitate in-the-water maintenance.

Wärtsilä Enviroguard MG4
Designed to endure challenging environments, Wärtsilä Enviroguard MG4 delivers a dependable face sealing solution for vessels operating in abrasive waters.

Wärtsilä Enviroguard MB
Fitted with robust omega bellows and split wearing components, Wärtsilä Enviroguard MB is a hardwearing face seal designed to withstand aggressive environments and undergo repair or replacement in-situ.
Seals

**Wärtsilä Enviroguard M4**
Capable of withstanding high shaft movements, the Wärtsilä Enviroguard M4 face seal (outboard) is well-suited to icebreaker applications. This water-lubricated stern-tube system also has split wearing components to allow for in-situ repair or replacement.

**Wärtsilä Enviroguard PSE and FSE**
It is now over 15 years since Wärtsilä launched the Wärtsilä Enviroguard PSE/FSE face seal (inboard). This fully or partially split seal with hard-wearing interfaces and an inflatable membrane is designed to work in both blue-water (open ocean) and brown-water (sediment-rich) conditions and withstand extreme pressure.

**Wärtsilä Diveguard AD**
Wärtsilä Diveguard AD is a hard-wearing watertight face seal used on the most demanding marine applications in the most unforgiving environments.

**Wärtsilä Jetguard**
Designed with commercial and military operations in mind, Wärtsilä Jetguard PSE is a long-lasting waterjet face seal with high axial and radial shaft movement potential and proven capabilities in aggressive environments.

**Wärtsilä Floodguard**
Maintaining vessel integrity in both military and commercial operations, we’ve developed the Wärtsilä Floodguard seal – a self-activating bulkhead seal designed to prevent inter-compartmental flooding.
Bearings, couplings and stern tubes

Bearings

**Wärtsilä Sternsafe white metal stern tube bearing**
Coated with white metal using our latest laser technology, the Wärtsilä Sternsafe white metal stern tube bearing is reliable, robust and brings unparalleled tribological benefits to our customers worldwide.

**Wärtsilä Sternsafe stern tube composite bearing**
Vital for large oil lubricated vessels operating in rough seas, the Wärtsilä Sternsafe stern tube composite bearing can withstand high shaft deflections and operate for prolonged periods of time in oil with a higher water content.

**Wärtsilä Envirosafe stern tube composite bearing**
A durable seawater lubricated composite bearing made for stern tubes, the Wärtsilä Envirosafe stern tube composite bearing is environmentally-friendly, cost-efficient and capable of optimising performance.

**Wärtsilä intermediate linesafe bearing**
With modular cast iron housing and cast aluminium components, Wärtsilä Linesafe facilitates both self-lubrication and in-water servicing and brings significant improvements to the performance of intermediate line shaft bearing solutions.

**Wärtsilä thrust bearing**
An exceptionally high thrust load capacity enables the Wärtsilä thrust bearing to reduce pressure and maximise vessel performance in aggressive environments. Its remote temperature and oil monitoring systems also simplify product management.
Bearings, couplings and stern tubes

Wärtsilä Steersafe E
Adept at withstanding intense pressure, Wärtsilä Steersafe E can be used on rudders and stabilisers submerged in abrasive waters. This seawater lubricated, rudder bearing is also fully compliant with US Environmental Protection Agency (EPA) regulations and approved by major Classification Societies.

Wärtsilä generator bearing
Capable of generating thrust and supporting axial and radial loads, the Wärtsilä generator bearing can optimise the performance of a wide range of marine and industrial applications. It can also be fitted with remote monitoring systems to control temperature and oil flow.

Couplings and stern tubes

Wärtsilä High Friction Couplings
Developed using the latest technology, the Wärtsilä High Friction Coupling is an innovative piece of equipment offering significant benefits for marine propulsion systems.

Wärtsilä stern tubes
Wärtsilä’s stern tube packages offer outstanding performance capabilities covering both high and standard load requirements. Together with Wärtsilä-compatible packages, we offer stand-alone supplies ranging from seals and bearings to ancillary lubrication systems.
Ancillary systems

**Ancillary Systems**

**Wärtsilä Water Quality System**

Supplying open lubricated stern tube setups with clean, abrasive-free water, our advanced Wärtsilä Water Quality System extends the life cycle of equipment and optimises vessel performance.

**Wärtsilä Sea-Master monitoring system**

Through the generation of data, the Wärtsilä Sea-Master system transforms tail shaft asset management and enables ship owners and operators to monitor the performance of their equipment.
Services

Wärtsilä Shaft Line Repair Services
With our Shaft Line Repair Services, ship owners and operators gain access to a wide-range of expertise and around-the-clock support.

Wärtsilä Alignment and Measurement Services
From providing accurate measurements to detecting vertical or horizontal misalignment, our shaft line alignment and measurement services are fully comprehensive and ensure vessels are working at their optimal.

Wärtsilä Field Services
From technical surveys and repairs to complete overhauls, our experts are available around-the-clock to perform onboard and underwater maintenance jobs.

Wärtsilä Underwater Services
From inspections to overhauls and maintenance procedures, our qualified diver technicians carry out a range of underwater services to ensure customers get the most out of their vessel.
Ship Design Portfolio & Services

Wärtsilä Ship Design offers innovative designs with the emphasis on cost efficiency. Our designs are initiated from detailed discussions with the ship owner to attain a deep understanding of the company’s business model, and from this basis we develop the specific type of vessel needed. In this attention to detail we differentiate from the majority of our competitors. All of our designs are optimized to achieve higher energy efficiency, lower operating costs, and enhanced environmental performance. They also ensure optimal construction at the shipyard.

Our unique expertise, knowledge, and global footprint allow us to turn our customers’ vision into reality and maximize their profits and asset values. With more than 4000 vessels built to our designs, including the
most advanced LNG powered ships, the competitive edge we bring our customers is a well established fact.

We cover the full range of ship design disciplines, including naval architecture, hull optimization, stability calculations, hull and structural engineering, machinery- and piping engineering, and outfitting.

We offer a broad range of options, from basic designs including classification drawings, to detail designs and optimized 3D production drawings. We also offer a comprehensive range of marine consultancy services for shipyards, or owners undertaking newbuilding, conversion, and retrofit projects.
For more info, click on corresponding vessel picture.

<table>
<thead>
<tr>
<th>Offshore Vessels</th>
<th>Merchant Vessels</th>
<th>Fishing Vessels</th>
</tr>
</thead>
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<tr>
<td>AHTS</td>
<td>Gas carriers</td>
<td>Pelagic Vessels</td>
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<tr>
<td>Specialised Offshore Vessels</td>
<td>Container feeders</td>
<td>Stem Trawlers</td>
</tr>
<tr>
<td>PSV</td>
<td>Tankers</td>
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</table>
Our people
The design process in Wärtsilä Ship Design is dedicated to delivering the very best solutions for each of our customers. We believe that a ship design is not merely a product – but a process. For this reason, we begin all our projects by asking our customers about their specific needs, and how best we can meet them. Through this we are able to ensure that the customer’s precise challenges and objectives – both now and in the future – have been truly understood and will be met.
Today, Wärtsilä Ship Design has operations in 6 countries, with local project development and project delivery capabilities in Europe and Asia, and more than 200 dedicated and experienced designers and engineers. Their global ship design competence is the result of thousands of successfully completed projects.
Ship Traffic Control Solutions

Ship Traffic Control provides tools for a coordinated, global approach to maritime traffic control, monitoring and decision support shared amongst relevant stakeholders according to their needs and access level.

Connected through one central operating system, Ship Traffic Control Solutions collect information from various data sources, process this information and integrate it into a common operational picture available across the whole operational ecosystem.
Ship Traffic Control Solutions

- Vessel Traffic Services: Coordination of vessel traffic and port calls
- Coastal Surveillance Systems: Creation of a common operational picture
- Offshore Solutions: Effective monitoring and tracking of activity at offshore installations
- Search & Rescue Solutions: Helping conduct SAR operations with optimal resource allocation
- River Information Systems: Safe and secure navigation along rivers
- Pilot Management Solutions: Safe and efficient pilotage
- VTS Simulation & Training: Scalable and flexible training solutions
Wärtsilä Simulation & Training Business connects maritime stakeholders by providing integrated solutions and high-quality content that bridges the gap between STCW and required level of competency.

We step up to the challenges of providing training in a digital world characterised by increased emphasis on learning methods that accommodate flexibility and collaboration.
Simulation & Training solutions offer micro-learning, enabling education anytime anywhere, personalized training and e-learning supported by remote tutoring.

They offer gamification of training, drawn from real-life situations and virtually recreated, to make it more engaging for individual learning or for building team skills in multi-player mode.
Simulation Technologies

Wärtsilä simulation solutions cover practically every aspect of modern ship operations and enable various levels of training – from familiarization, standard operation and watch-keeping, to advanced operations, troubleshooting and vessel resource management.

- Navigational & GMDSS Simulators
  - ECDIS
  - Offshore simulation
  - DP Simulator
  - Tug, Mooring and Inland operations
  - Ice Navigation Simulator
  - Fishing Simulator
- SAR Operations
- Small Craft Simulator
- Oil Spill Response Simulator
- Naval Applications
- R&D Applications
- VTS Simulation and Training Solutions
Simulation and Training

- Technological Simulators
  - Engine Room Simulator
  - High Voltage Training Breaker
  - Ship Energy Management Simulator
  - Liquid Cargo Handling Simulator
  - Safety Management and Control Simulation

- Simulator Development Tools
  - Ship model toolkit
  - Virtual shipyard
  - 3D visualization toolkit
  - Sailing area library
Wärtsilä Oily Water Separators

The Wärtsilä Oily Water Separator (OWS) manages bilge water with minimum impact for operating personnel, with results that surpasses current and proposed legislative requirements.

The technology behind the Wärtsilä OWS is a combination of optimised traditional methods and innovative new solutions. The separator consists of a four-stage, emulsion-breaking unit, where each stage handles one key component of the sludge and bilge mix. It can handle input flows with an oil content of between 0 and 100%, making it the most versatile separator on the market.

The Wärtsilä OWS units are IMO and US Coast Guard approved and gives the operator effective control over all bilge media as well as over any discharges made into the sea. The amount of oil in water after treatment is less than 5 ppm.

Wärtsilä Bilge Water Guard

Wärtsilä Bilge Water Guard is a fully automated bilge discharge monitoring system which continually monitors the oil content for all bilge discharges overboard.

Should the oil content rise above the set limit, the flow will be rerouted back to the bilge tank. The system logs the discharge quantity and oil content as well as time and location of the ship. All data is stored in memory for later retrieval.
Oily Water Systems

The system is enclosed in a locked, tamper-proof cabinet, with all accesses being logged to internal memory. For both crew members and ship management, the Wärtsilä Bilge Water Guard provides a vital safety net, with the availability to make evident the compliance with applicable regulations.

■ Wärtsilä Slop Water Treatment System

The Wärtsilä slop water treatment system is designed to clean water (deck washing water or rain) – contaminated with oil or drilling mud produced by off shore operational activity – enabling it to be discharged without further treatment.

The system consists of two units – a MWD (Mud Water Decanter) and SWC (Slop Water Cleaning) unit. In the first stage the MWD separates the mud and oil from the water emulsion, in the second the SWC treats and discharges the emulsified water.

Slop water/mud is a waste stream, produced when an oil/synthetic/diesel drilling fluid becomes contaminated with water. It is amongst the most significant of waste streams from exploration and exploitation activities.

The system will significantly reduce drill slop sent onshore by as much as 80–90%.
Wärtisilä Sewage Treatment Plants

The Wärtisilä Super Trident sewage treatment plant is the cost-effective and safe answer to disposing of wastewater at sea, maintaining the quality of the world’s oceans.

Our sewage treatment plants are certified to meet IMO MEPC 227(64) guidelines, which came into effect 1 January 2016.

Optimised for the treatment of black and grey wastewater flows, and suitable for conventional gravity and vacuum fed collection systems, all plants are controlled automatically. This allows unattended operation, with reduced maintenance requirements and lower long-term operating costs.

The systems are compact and modular in design, suitable for between-deck installations, and are adaptable to customer new build specifications.
Waste Water Processing

**Wärtsilä Retrofit RTC-14**

**Sewage Treatment Plants**

The Wärtsilä retrofit RTC-14 range has been specifically designed to reduce the cost of installing sewage treatment equipment into existing vessels. Each size in the retrofit range is built up from three separate water tight tanks connected by external piping, aiding installation. The dimensions of each component has been arranged to permit its transportation through standard vessel access ways.

The dimensions below indicate the size of aperture through which unit will pass with tanks separated when the control panel, transfer tubes & studs, dosing skid, vent tubes, flow meter and covers are also removed.

<table>
<thead>
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<th>Model No.</th>
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<th>Length (mm)</th>
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<tbody>
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<tr>
<td>RTC80-14</td>
<td>880</td>
<td>1870</td>
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</table>
Wärtsilä MBR technology is based on biological degradation and membrane separation and allows for the treatment of grey and black water to satisfy the most stringent standards.

The process produces the highest quality discharge without requiring any addition or generation of chemicals that are hazardous to the environment or ship operation.

Effluent quality tests conducted by the US National Sanitary Foundation on Wärtsilä MBR produced results exceeding the most stringent future legislative pollutant standards envisaged. The technology also achieved outstanding performance in Alaska under the scrutiny of the local authority, USCG and USEPA studies over the past seasons.

We also supply smaller, more compact versions of our MBR systems. Wärtsilä miniMBR’s are ideal for use on smaller cruise and naval vessels, plus ferries with up to a 200 complement, as well as FPSOs and accommodation platforms.

Key benefits
- Ease of installation with modular designs
- Simple design compared to submerged membrane or hybrid systems
- Lower operational man hours required
- Complete flexibility with newbuild, conversion and retrofit options MED and IMO certified
- Reduced operational costs
Dry Waste

Vessels can be fitted with Wärtsilä’s dry waste disposal system for food waste collection and treatment, bio-sludge dewatering, food waste and bio-sludge drying, incineration, recycling equipment, and innovative waste to energy products. Procuring the complete wet & dry solution from a single source streamlines the coordination and integration, making for an easier and efficient project delivery with a single reliable source of after sales.

The cruise market is changing and shipyards now require complete waste treatment packages. In addition to vacuum toilets, collection systems and the advanced waste water treatment plant, Wärtsilä now also offers:

Food waste collection & treatment

Wärtsilä Water Systems has designed highly efficient vacuum food waste systems to cope with all needs of managing this waste on board. Feeding hoppers with integrated macerators are designed to be integrated into table tops which are connected to the main vacuum pipes, where food waste will be fed directly into the food waste holding tanks. Allowing for smaller pipes due to vacuum generation, decentralized macerating in galleys and pantries at point of origin, safe operation with no risk of cutlery entering system, easier thermal food waste drying, low water consumption. The food waste collected has several options for being treated. From using food waste digesters that convert particulate matter to treatable waste water,
Dry Waste

to dewatering where removal of surface water is key. This reduces the volume and increases the concentrations of solids by use of centrifuges or decanters. Solids are then fed into the de-watered bio waste tanks and the liquid directed to food waste reject water tanks and AWP. This solid waste will then be dried and sent to the dried bio waste silo which is then transported via a screw conveyor to the incinerator and wet ash bagged to be taken ashore. During this process the bio sludge taken from the MBR will also be de-watered, dried and fed into the same silo for dried biowaste.

Drying

The dryer in the Wärtsilä Bio-Sludge Treatment system can process all sludge from the wastewater treatment process and food waste before incineration. The drying process increases the dryness of the waste to a high level of dry solids, ready for incineration. Dried sludge is stored in the bio-sludge silo before incineration. In addition, the design of the agitators/blades within our dryer, crushes "potatoes" during the drying/mixing process, which prevents the sticky phase effect, and the creation of large stones, reducing any unplanned maintenance.

Incineration

The Wärtsilä incinerator incorporates a number of unique features. The wet de-ashing system eliminates airborne ash in the dry waste compartments, resulting in a cleaner and healthier working environment for personnel. In addition, it is easy to handle ash bags and reduces maintenance on other equipment installed nearby. The paddle technology (water cooled paddle
Dry Waste

system) requires only a short combustion chamber, thanks to the forward and backward movement, which results in an optimal mixing of waste during the incinerating process.

Since the combustion process takes place on the bottom of the incinerator, the air supply is above the burning waste resulting in reduced airborne ash. The paddle system has water cooled shafts and paddles made from Inconel, a material used in extreme environments, and thus, cannot be overheated.

Wärtsilä incinerator

Recycling Equipment

The accumulation of recyclable wastes on board vessels must be managed correctly on board, our systems take advantage of any storage and working spaces, reducing handling time, as well as maximizing the off-loadable efficiency.

All fork lifts and lifting devices for transport of ash bags and recycling equipment can also be supplied by Wärtsilä.

Wärtsilä recycling equipment consists of:

- Shredders
- Densifiers
- Glass crushers
- Bale compactors
- Briquetting
Wärtsilä Vacuum Collection Systems

The Wärtsilä vacuum collection system uses differential air pressure to transport sewage from the toilet bowls, and other sanitary fittings, to the Sewage Treatment Plant (STP) or independent collection tank. Ejectors can be mounted direct to the STP for modular construction without the need for a separate collection tank, and only a small amount of flush water is needed compared to conventional gravity systems.

Features

- Ejectors can be mounted direct to the STP for modular construction without the need for a separate collection tank
- Only a small amount of flush water is needed compared to conventional gravity systems
- Vertical Lift capability
- Smaller diameter piping, independent of slope
- Reduced peak loadings allow use of smaller sewage treatment plant than for gravity systems
- Ejector performance optimised using Computational Fluid Dynamics (CFD)

Additional optional features

- Grey water vacuum collection to separate grey water collection tank(s)
- Retrofit to existing tanks
- Foam suppressant
- PLC interface with data logger
- Overboard discharge from vacuum circulation pump
- Controlled feed/transfer equipment
Wärtsilä Vacuum Toilets

The Wärtsilä vacuum flush toilet has been designed to be mechanically simple, operationally reliable, and stylish in appearance. Wärtsilä vacuum toilets use air to drive waste from the toilet to the treatment tank or intermediate collection tank. This contemporarily styled toilet has a built-in vacuum breaker and flush memory, is simple to install, and is supplied ready to connect. The control mechanism can be accessed without removing the bowl. By using only approximately 1 litre of water, the amount of wastewater is dramatically reduced.

Wärtsilä also offers a Vacuum Interface Valve, which provides an interface between the sewage collection system and conventional grey water drains and urinals. The valve enables an easy connection to gravity-based appliances, enabling cost savings and effective integration with the vacuum system piping. The valve is reliable, easy to maintain, and has been installed in USN/USCG ships and merchant marine vessels throughout the world.

Features
- Contemporary styling
- Minimum space requirements
- Low water consumption
- Simple to install – supplied complete, ready to connect
- Quiet operation
- Maintenance in-situ
Lifecycle solutions

With the industry’s most complete global network of services and workshop facilities, Wärtsilä supports its marine customers wherever they are located, and whenever help is needed.

Our comprehensive range of services includes everything from OEM parts supply, product support comprising field services, technical advice, performance optimization, environmental solutions and crew training, to full lifecycle solutions.

QuantiParts trades OEM engine parts for Wärtsilä classic engine types such as Deutz, Deutz MWM, Stork Werkspoor Diesel, Bolnes, Sulzer A/S 4 stroke, Poyaud, SACM, Vasa 14/24, GMT and Crepelle. Our stock consists of nearly 5.5 million components for more than 40 different engine types.

Wärtsilä Lifecycle solutions optimise the efficiency and performance of your marine assets. We predict your maintenance needs, ensure your assets operate in the most energy-efficient way and ensure that your vessel operates in accordance with all relevant regulations. But our holistic approach goes beyond maintenance and operations: we combine digital innovations and advanced data to help match activities with your operations. Our performance targets are agreed based on measured data and then guaranteed to be reached and maintained.

Wärtsilä Guaranteed asset performance ensures the operational reliability, performance and availability of your assets. Performance
Lifecycle solutions

targets are determined based on business demands and quantifiable performance indicators are set, we then guarantee that those targets are reached and maintained.

Wärtsilä Optimised operations offer real-time monitoring and advisory services that maximise efficiency. You are provided with a ship energy efficiency management plan that follows IMO guidelines. Our onboard advisory services allow for continuous improvement of operations by identifying areas in which performance can be enhanced and recommending possible system efficiency upgrades.

Wärtsilä Optimised Maintenance involves planning and scheduling maintenance procedures to suit your business operations, and in doing so improving long-term cost predictability and availability. Optimised Maintenance provides remote operational and technical advisory services, whenever and wherever needed. It identifies optimal maintenance intervals according to actual needs instead of having to rely on a rigidly fixed maintenance schedule.

Wärtsilä is an experienced lifecycle solution provider, with a proven track record in operation and maintenance services. Globally, more than 850 installations are covered by Wärtsilä Lifecycle solutions. Our extensive global service network and efficient spare parts logistics ensure that you can focus on your core business, resting assured that your maintenance needs can be optimally met around the clock.
INDIA
Wärtsilä India Private Limited
Marine Business Office
Kesar Solitaire, 21st Floor, Plot No. 5,
Sector No. 19, Palm Beach Road, Sanpada,
400 705 Navi Mumbai, India
Tel. +91 22 2781 8300/8550
Fax Marine Business +91 22 2781 4732

INDONESIA
P.T. Wärtsilä Indonesia
Marine Business
Pergudangan Cardig
Airport Halim Perdanakusumah
Jakarta 13610
Tel. +62 21 2966 7820
Fax +62 21 2966 7821

P.T. Wärtsilä Indonesia
Marine Business
Tempo Scan Tower Bldg. 19th Floor.
Jl. H.R. Rasuna Said Kav. 3 – 4
Jakarta 12950
Tel. +62 21 5793 0515
Fax +62 21 5793 0516

ITALY
Wärtsilä Italia S.p.A.
Marine Business Office Genova
Tel. +39 010 599 5800
Fax, Sales +39 010 247 2341

Marine Business Office Trieste
Bagnoli della Rosandra, 334, San Dorligo
della Valle, IT-34018 Trieste, Italy
Tel. +39 040 319 5000
Fax +39 040 827 371

Wärtsilä APSS Srl
Via S. Sebastiano 16
12055 Diano d’Alba, Italy
Tel. +39 0173 468 468
E-mail sales.apss.it@wartsila.com

JAPAN
Wärtsilä Japan Ltd.
Marine Business
6-7-2, Minatojima, Chuo-ku,
Kobe 650-0045, Japan
Tel. +81 78 304 7501
Fax +81 78 303 6171

Marine Business
fabbit Otemachi, Asahi Life Otemachi
Building 3F, 2-6-1 Otemachi,
Chiyoda-ku, 100-0004 Tokyo, Japan
Tel. +81 3 6631 7670
Fax +81 3 6631 7676

Imabari Office
1-3-3 Kyouei-chou Imabari
794-0024 Ehime, Japan
Tel. +81 898 35 4822
Fax +81 898 35 4821

KENYA
Wärtsilä Eastern Africa Ltd
ABC Towers - 7A, ABC Place Waiyaki Way
P.O.Box 66782 - 00800. NAIROBI, Kenya.
Tel. +254 20 7602 400 (Pilot)
E-mail info.wea@wartsila.com

KOREA
Wärtsilä Korea Ltd.
Marine Business
Busan
15-36, Gangbyeon-daero 456 beon-gil,
Sasang-gu, Busan, 47033, Korea
Tel. +82 51 329 0500
Fax +82 51 324 4349

Seoul
503-1ho, Gwanghwamun Officia Bldg.,
92, Saemunan-ro, Jongno-gu,
Seoul, 03186, Korea
Tel. +82 2 723 0524
Fax +82 2 723 0508

MALAYSIA
Wärtsilä Malaysia Sdn Bhd
Kuala Lumpur
Menara Standard Chartered
Level 35, Unit 35.1No. 30 Jalan Sultan Ismail
50250 Kuala Lumpur, Malaysia
Tel. +603-21485072
Fax +603-21485064

Johor Bahru
PLO 3 Jalan Pekellung
81700 Pasir Gudang, Johor, Malaysia
Tel. +607-2567746
Fax +607-2513455
Email: MYservicessalessupport@wartsila.com
Email: SGmarine@wartsila.com

MEXICO
Wärtsilä de México S.A de C.V
Av. 1o de Mayo, 120
Suite 304, Forum Naucalpan
Col. San Andrés Atoto.
Naucalpan de Juárez, Estado de México,
México C.P. 53500
Tel. +521 938 138 1500
Wärtsilä Marine Solutions Worldwide

MOROCCO
Société Salva
Marine Business Office
93 Boulevard de la Résistance ,
21700 Casablanca, Morocco
Tel. +212 5 2230 4038
Fax +212 5 2230 5717

NETHERLANDS
Wärtsilä Netherlands B.V.
Local businesses for maritime & energy sales, parts and services
Havenstraat 21, 3115 HD, Schiedam
Tel. +31 (0) 88 980 2000
Wärtsilä Netherlands B.V.
Global Technology & Services Centre and Global Wärtsilä Land & Sea Academy
James Wattlaan 23, 5151 DM Drunen
P.O. Box 6, 5150 BB Drunen
Tel. +31 (0) 88 980 4000
Wärtsilä Netherlands B.V.
Global Energy Business sales
Hanzelaan 95, 8017 JE, Zwolle
Tel. +31 (0) 88 980 3000
Wärtsilä Netherlands B.V.
QuantiParts BV - A Wärtsilä Company - Trading OEM spare parts mature Wärtsilä engine brands like Stork, Werkspoor, Diesel, Deutz MWM, Bolnes
Hanzelaan 95, 8017 JE, Zwolle
Tel. +31 (0) 88 980 2500
www.quantiparts.com
Wärtsilä Netherlands B.V.
Local businesses for fishery, coast guard, parts & services
Nieuwe Vissershaven 17, 8861 NX, Harlingen
Tel. +31 (0) 88 980 2900
Wärtsilä Netherlands B.V.
QuantiServ - A Wärtsilä Company - Reconditioning centre
Stationsweg 6A, 4416 PJ, Kruiningen
Tel. +31 (0) 88 980 2700
www.quantiserv.com
Wärtsilä Nederland B.V.
Local businesses for maritime navigation, communication entertainment systems
IJzerwerkerkade 36 (Harbour 1093)
3077 MC, Rotterdam
Tel. +31 10 479 54 44
Wärtsilä Nederland B.V.
Local businesses for maritime navigation, communication entertainment systems
Meester Snijderweg 29, 3251 LJ Stellendam
Tel. +31 187 493 826

Wärtsilä Global Logistics Services
Global distribution centre for spare parts
Genuakade 8, 8263 CG, Kampen
Tel. +31 (0) 88 980 1200

Trident BV – underwater services
Mr. F.J. Haarmanweg 75
4538 AN Terneuzen
Tel. +31 115 61 2872
Email: info@trident-diving.com

NIGERIA
Wärtsilä Marine & Power Services Nigeria Ltd
23, Oba Akinjobi Street, 2th floor
GRA Ikeja, Lagos, Nigeria
Tel. +234 (0) 1-4548 828
E-mail: west.africa@wartsila.com

NORWAY
Wärtsilä Norway AS
Marine Business
• Rubbestadneset,
  N-5420 Rubbestadneset, Norway
• Meatjonnsvegen 74
  N-5412 Stord, Norway
• Stiklestadveien 1,
  N-7041 Trondheim, Norway
• Dalhaugane 2,
  N-5489 Boenes, Norway
• Karmsundsgaten 77,
  N-5531 Haugesund, Norway
Tel. +47 53 42 25 00
Fax +47 53 42 25 01
Wärtsilä Moss AS
Vaerftsgata 9A,
P.O. Box 1053, N-1510 Moss, Norway
Tel. +47 69 27 99 00
E-mail: moss@wartsila.com
Wärtsilä Gas Business AS
Solbraaveien 10, 1383 Asker, Norway
Tel. +47 815 48 500
E-mail: Gas Business .gasinfo@wartsila.com
Service support .... support.wgs@wartsila.com
Spares..................spares.wgs@wartsila.com
Wärtsilä Ship Design Norway AS
Havnavegen 90, N-5419 Fitjar, Norway
Tel. +47 53 42 25 00
Fax +47 53 42 25 01
E-mail: shipdesign@wartsila.com
Wärtsilä Valmarine AS
Ingenior Rybergs gate 99, 3027 Drammen
P.O. Box 881, 3007 Drammen, Norway
Tel. +47 32 21 81 00
E-mail: sales.valmarine.no@wartsila.com

Wärtsilä Gas Business
Solbraavn 10, 1383 Asker, Norway

200
PAKISTAN
Wärtsilä Pakistan (Pvt) Ltd.
Marine Business Office, Lahore Pakistan
16 km Raewind Road Lahore, Pakistan
Tel. .................................... +92 42 35905900
Fax .................................... +92 42 35905922
Marine Business Office Karachi Pakistan
F-8 KDA Scheme 1, Tipu Sultan Road,
Karachi Pakistan
Tel. .................................... +92 21 34375830
Fax .................................... +92 21 34375822

PAKISTAN
Wärtsilä Pakistan Services, S.A.
Panama Pacifico Flex #2 – Local #3,
Edif. 3870 Brujas Ave.,
Former Howard Air Force Base
Corregimiento de Veracruz
Distrito de Arraiján, Panama
Rep. of Panama
Tel. .................................... +507 304 7400
Fax .................................... +507 304 7494

PAPUA NEW GUINEA
Wärtsilä PNG Ltd
Marine Business Office Papua New Guinea
Warehouse 5, Unit 9, Section 36
Allotment 5 Kitty Hawk Street
6 Mile, Port Moresby NCD 121
Papua New Guinea
Tel. .................................... +675 323 7375
Fax .................................... +675 323 7540
Postal address: P.O. Box 379,
Port Moresby NCD 121, Papua New Guinea

PARAGUAY
Wärtsilä Marine Business
Luiz Morales 746 y Luis de Granada
Asuncion, Paraguay
Tel. .................................... +595 21 220874

PERU
Wärtsilä Peru S.A.C.
Marine Business Office Lima
Av. Ricardo Palma 341,
Centro Empresarial Platino, Piso 6,
Oficina 604, Miraflores, Lima 18, Peru
Tel. .................................... +51 1 241 7030

PHILIPPINES
Wärtsilä Philippines Inc.
Marine Business Office Laguna
No 6, Diode Street, Light Industry and
Science Park, Bo. Diezmo, Cabuyao, 4025
Laguna, Philippines
Tel. .................................... +63 2 843 7301
Fax .................................... +63 49 543 0381

POLAND
Wärtsilä Polska Sp. z o.o.
Marine Business
Ul. Twarda 12, 80-871 Gdansk, Poland
Tel. .................................... +48 58 347 85 00
Fax .................................... +48 58 347 85 20
E-mail.......................... contact.poland@wartsila.com

Wartsilä Ship Design
Poland Sp.z.o.o.
Ul. Luzycka 2, 81-537 Gdynia, Poland
Tel. .................................... +48 58 622 63 13
E-mail...... shipdesign.poland@wartsila.com

Wärtsilä Baltic Design
Centre Sp. z o.o.
Ul. Luzycka 3c, 81-537 Gdynia, Poland
Tel./Fax .................................... +48 58 718 61 50
E-mail.......................... wbdc@wartsila.com

PORTUGAL
Wärtsilä Portugal, S.A.
Rua Dr. Francisco Sá Carneiro, no. 251
4740 – 473 Esposende
Tel. .................................... +351 253 724 400
Fax .................................... +351 253 724 409

ROMANIA
Wärtsilä Hungary Kft. Budaors Sucursala Constanta
Santierul Naval Constanta,
Cladirea Administrativa TA, Cam 2, ETJ 2,
Incinta Port Constanta 900900, Romania
Tel. .................................... +40 720 175 215
E-mail.......................... cristian.butoi@wartsila.com

RUSSIA
Wärtsilä Vostok LLC
Marine Business Office
St. Petersburg
Business centre Linkor 36 A
Petrogradskaya naberezhnaya,
St. Petersburg, Russia 197101
Tel. .................................... +7 812 448 3248
Fax .................................... +7 812 448 3241

Wartsilä Ship Design
St. Petersburg
Okeansky Prospekt, 17, office 1009/1,
Vladivostok Russia 690091
Tel. .................................... +7 4232 401600
Fax .................................... +7 4232 432004
Wärtsilä Marine Solutions Worldwide

Services Office Murmansk
Murmansk sea fishery harbour, ent. 8, Murmansk, Russia 183001
Tel./Fax: +7 (8152) 286-662

SENEGAL
Wärtsilä West Africa
Immeuble Le Thiariane 7th floor
Mermoz Place OMVS
PO Box 21861 Dakar - Senegal
Tel. +221 33 865 41 00
E-mail: west.africa@wartsila.com

SERBIA
Wärtsilä Ship Design Serbia d.o.o
Vrsacka 67, 21000 Novi Sad, Serbia
Tel. +381 21 500101

SINGAPORE
Wärtsilä Singapore Pte Ltd.
14 Benoi Crescent, 629977 Singapore, Singapore
Tel. +65 6265 9122
Fax +65 6264 0802
E-mail: Sgmarine@wartsila.com
Wärtsilä Ship Design Singapore Pte Ltd.
14 Benoi Crescent, 629977 Singapore, Singapore
Tel. +65 6562 1138
Fax +65 6562 1238
E-mail: shipdesign.singapore@wartsila.com

SOUTH AFRICA
Wärtsilä South Africa (Pty) Ltd.
Marine Business
20 Dorsetshire Street, Paarden Eiland, Cape Town, South Africa, 7405
P.O. Box 356, Paarden Eiland, Cape Town, South Africa, 7420
Tel. +27 21 511 1230
Fax +27 21 511 1412

SPAIN
Wärtsilä Ibérica S.A.
Marine Business Office Bermeo
Poligono Industrial Landabaso s/n, ES-48370 Bermeo, Spain
Tel. +34 946 170 100

Marine Business - Propulsion
Avda. Juan Carlos 1, No. 3, ES-39600 Maliaño, Spain
Tel. +34 946 170 100
E-mail: wartsilaiib@wartsila.com

Seals & Bearings
Pol. Industrial “As Gándaras” parcela 206, nave B-3, 36475 Porrino, Pontevedra
Tel. +34 986 344 048

Trident Las Palmas
C/ Nelson Mandela 11
35214, Teide, Las Palmas.
Office 24 hr: +34 828 905 839
Mobile 24h: +34 609 017 425
Email: info@trident-laspalmas.com

Burriel Navarro S.L.
Carrer dels Mecànics, 6
46120 Alboraia Valencia
Office 24 hr: +34 963 675 875
Fax: +34 963 675 158
Email: operations@burrielnavarro.es

SRI LANKA
Wärtsilä Lanka (Pvt) Ltd
77 Negombo Road, Wattala, Sri Lanka
Tel. +94 11 2980907
Fax: +94 11 4816422

SWEDEN
Wärtsilä Sweden AB
Services Office Gothenburg
Götaverksgatan 10, P.O. Box 8006,
402 77 Gothenburg, Sweden
Tel. +46 31 744 4600
Fax: +46 31 744 4670

Puregas Business AB
Torsåsgatan 3A, 392 39 Kalmar, Sweden
Tel. +46 480 77 00 00

SWITZERLAND
Wärtsilä Services Switzerland Ltd.
Zürcherstrasse 12, CH-8400 Winterthur
Tel. +41 52 262 49 00
Fax: +41 52 262 01 00
E-mail: mail-ch@wartsila.com
Wärtsilä Services Switzerland Ltd.
Land & Sea Academy (DTC)
Sulzer Allee 19, Building 650
CH-8404 Winterthur
Tel. +41 52 262 24 54

TAIWAN
Wärtsilä Taiwan Ltd.
Marine and Energy Business, Taipei Office
4F., No. 68, Sec. 2, Zhongshan N. Road,
Zhongshan District, Taipei City, Taiwan
Tel. +886 2 2522 2239
Fax: +886 2 2522 2550

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Wärtsilä Customer Support Centre

https://www.wartsila.com/services/support/
customer-support-centre-csc
E-mail..............................help@wartsila.com

CSC WEST
(Americas)
Telephone (24/7)
Argentina:............................+54 11 5984 40541
Brazil:.................................+55 21 3500 01942
Canada:...............................+1 (902) 700 8141
Chile:.................................+54 11 5984 40541
Colombia:..........................+57 1 508 85821
Dominican Rep.:..................+1 829 946 0499
Ecuador:.............................+593 2 393 15741
Mexico:...............................+52 555 350 90701
Panama:.............................+507 304 74901
Peru:.................................+51 1 700 79741
Puerto Rico:.........................+1 954 256 5236
USA:..................................+1 (954) 289 5892

In addition to English, support is available in the following languages during business hours
1) Spanish
2) Portuguese

CSC SOUTH
(Europe & Africa)
Telephone (24/7)
Cameroon:............................+237 213002750
France:...............................+33 413681134
Greece:...............................+30 2111 98 48 71
Italy:.................................+39 02 9475 47261
Kenya:...............................+254 20 760 2477
Nigeria:..............................+234 944580029
Senegal:.............................+221 338654103
Spain:.................................+34 944580019
South Africa:......................+27 213002750
Turkey:..............................+90 216 900 13732

In addition to English, support is available in the following languages during business hours
1) Italian
2) Turkish

CSC NORTH
(Europe)
Telephone (24/7)
Denmark:............................+45 32 729 203
Estonia:..............................+372 6 102 600
Finland:..............................+358 9 4245 4217
Germany:............................+49 40638 630 010
Hungary:.............................+36 18 088 156
Netherlands:.......................+31 10 742 0270
Norway:..............................+47 56 999 035
Poland:..............................+48 588 811 654
Russia:..............................+7 800 550 4832
Sweden:.............................+46 31 361 3467
UK:....................................+44 2036 999 935

CSC EAST
(Asia, Oceania, Middle East)
Telephone (24/7)
Australia:...........................+61 2 8319 6237
Bangladesh:.........................+880 177555 0695
China:...............................+86 21 8036 46691
India:................................+91 130 050 1002
Indonesia:...........................+62 21 3004 9731
Japan:.................................+81 3 4577 6377
Pakistan:.............................+92 3 158 1201
Philippines:.........................+63 132 000 63
Saudi Arabia:......................+971 1619 9152
Singapore:.........................+65 6813 3101
South Korea:.......................+82 2 519 944 1270
Sri Lanka:..........................+94 11 298 2658
Taiwan:..............................+886 32 2522 1060
United Arab Emirates:.........+971 1619 9110

1) Chinese language is also available Monday - Friday during office hours 8.30am - 5pm (Beijing time)
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