



WÄRTSILÄ

# WÄRTSILÄ SOLUTIONS FOR MARINE AND OIL & GAS MARKETS

ENGINES AND GENERATING SETS    HYBRID SOLUTIONS    BALLAST WATER MANAGEMENT  
WET & DRY WASTE    SHIP DESIGN    EXHAUST GAS CLEANING    LIFECYCLE SOLUTIONS    SIMULATION & TRAINING  
PARTS SOLUTIONS    FRESH WATER GENERATION    PROPULSORS    GEARS    VALVES    FLEET OPERATIONS SOLUTIONS  
ELECTRICAL & AUTOMATION    ENERGY EFFICIENCY MANAGEMENT    ENTERTAINMENT SYSTEMS    NAVIGATION & COMMUNICATIONS  
GAS SOLUTIONS    MAINTENANCE AND REPAIR SERVICES    SEALS, BEARINGS AND STERN TUBES    SHIP TRAFFIC CONTROL SOLUTIONS



ENERGY MANAGEMENT

ASSET MANAGEMENT

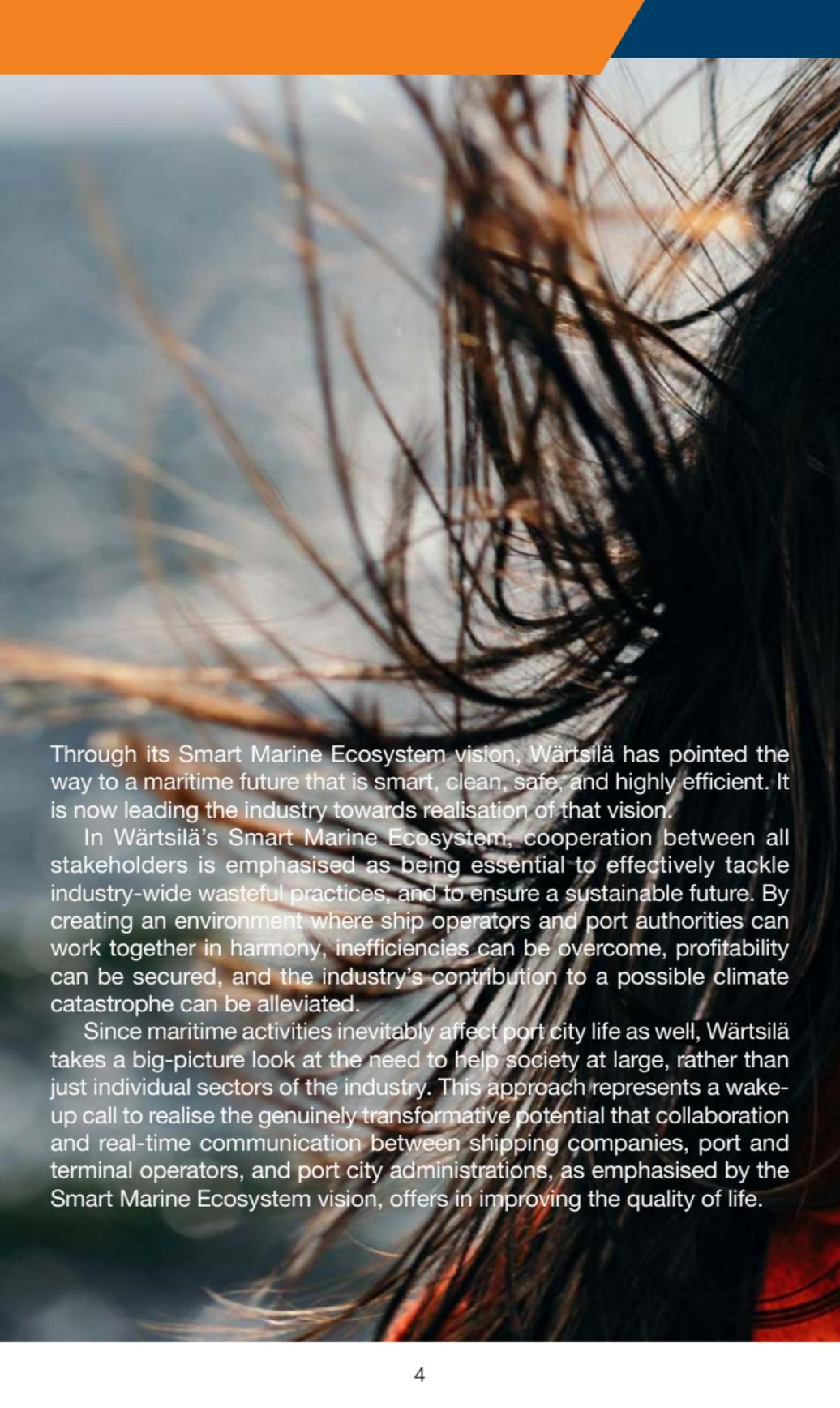
VOYAGE MANAGEMENT

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- **Marine Markets**
- **Oil & Gas Markets**



Through its Smart Marine Ecosystem vision, Wärtsilä has pointed the way to a maritime future that is smart, clean, safe, and highly efficient. It is now leading the industry towards realisation of that vision.

In Wärtsilä's Smart Marine Ecosystem, cooperation between all stakeholders is emphasised as being essential to effectively tackle industry-wide wasteful practices, and to ensure a sustainable future. By creating an environment where ship operators and port authorities can work together in harmony, inefficiencies can be overcome, profitability can be secured, and the industry's contribution to a possible climate catastrophe can be alleviated.

Since maritime activities inevitably affect port city life as well, Wärtsilä takes a big-picture look at the need to help society at large, rather than just individual sectors of the industry. This approach represents a wake-up call to realise the genuinely transformative potential that collaboration and real-time communication between shipping companies, port and terminal operators, and port city administrations, as emphasised by the Smart Marine Ecosystem vision, offers in improving the quality of life.



## Smart Marine solutions for a cleaner and more efficient future

Wärtsilä continues to apply its Smart Marine approach to all its activities and in its product development work, whereby a matrix of asset, energy, and voyage management solutions can optimise operations throughout the ship's lifecycle.

A prime example of this is Wärtsilä's Fleet Operations Solution (FOS). Designed to achieve the highest level of safety at sea, increase fleet efficiency, and simplify everyday tasks, both onboard and ashore, FOS unites all navigational processes and voyage data on a single platform, thereby allowing the crew and operations centre to work as one synchronized unit. FOS creates seamless operations in a way never before possible.

FOS is also central to Wärtsilä's efforts to enable Just-in-Time port arrivals. This will alleviate the wasteful burning of fuel and harmful exhaust emissions caused by ships waiting at anchor for berthing.

Wärtsilä Expert Insight is another innovative breakthrough aimed at greatly enhancing the safety, reliability and efficiency of installed equipment and systems. The solution leverages artificial intelligence and advanced



diagnostics to deliver real-time monitoring, enabling proactive customer support for dealing with anomalous situations.

The IntelliTug project collaboration between Wärtsilä and PSA Marine is bringing to life a smart harbour tug, which by autonomously performing a range of routine missions, can enhance the work of the tug master.

These initiatives are enhanced with the company's investments in research on alternative fuels for the future, including bio and synthetic fuels. The fuel flexibility of the combustion engine means that it will remain the heart of ship propulsion, since it allows the use of future renewable and gaseous fuels as they become market-ready and available. In fact, flexibility is a central theme throughout Wärtsilä's Smart Marine approach, which emphasises solutions that are retrofittable, compatible with competitor brands, and which can leverage data from 3rd party clouds.

Everything is aimed at making a valuable and significant contribution to lowering the environmental footprint imposed by shipping. Enabling sustainable societies with smart technology is central to Wärtsilä's commitment to its customers.

 **CLICK for more info**





## 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 orientation to installation engineering, 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.

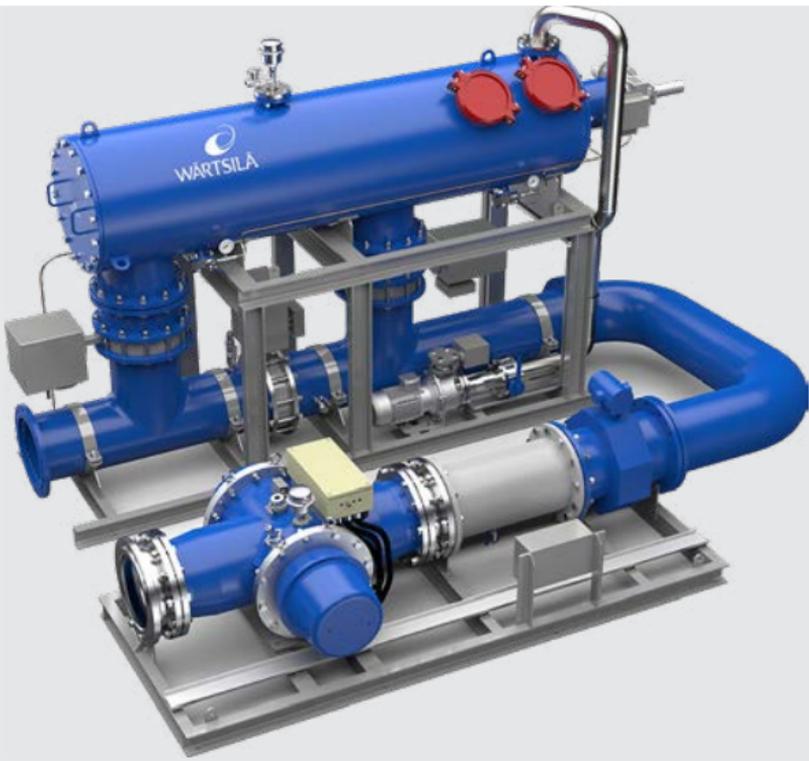
The system has a flexible design enabling it to be arranged to suit available onboard spaces. The system can be designed and supplied to treat ballast water covering the full range of ballast pump sizes. There are 5 distinct Wärtsilä Aquarius® UV BWMS system sizes available with capacities ranging from 125 m<sup>3</sup>/h to 1000 m<sup>3</sup>/h. Capacities above 1000 m<sup>3</sup>/h up to 6000 m<sup>3</sup>/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 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 Type Approval has been granted in accordance with the requirements of 33 CFR 151.2026 in all salinity ranges (fresh, brackish & sea water)

# Ballast Water Management



Wärtsilä Aquarius® UV system	Maximum capacity (m <sup>3</sup> /h)	Total installed power (kW)
AQ-125-UV	125	19
AQ-300-UV	300	48
AQ-500-UV	500	63
AQ-750-UV	750	93
AQ-1000-UV	1000	100

Pressure drop	
Normal operation	0.3 barg

## ■ Wärtsilä Aquarius® EC

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 6 distinct Wärtsilä Aquarius® EC BWMS standard modules available with capacities ranging from 55 m<sup>3</sup>/h to 4000 m<sup>3</sup>/h.

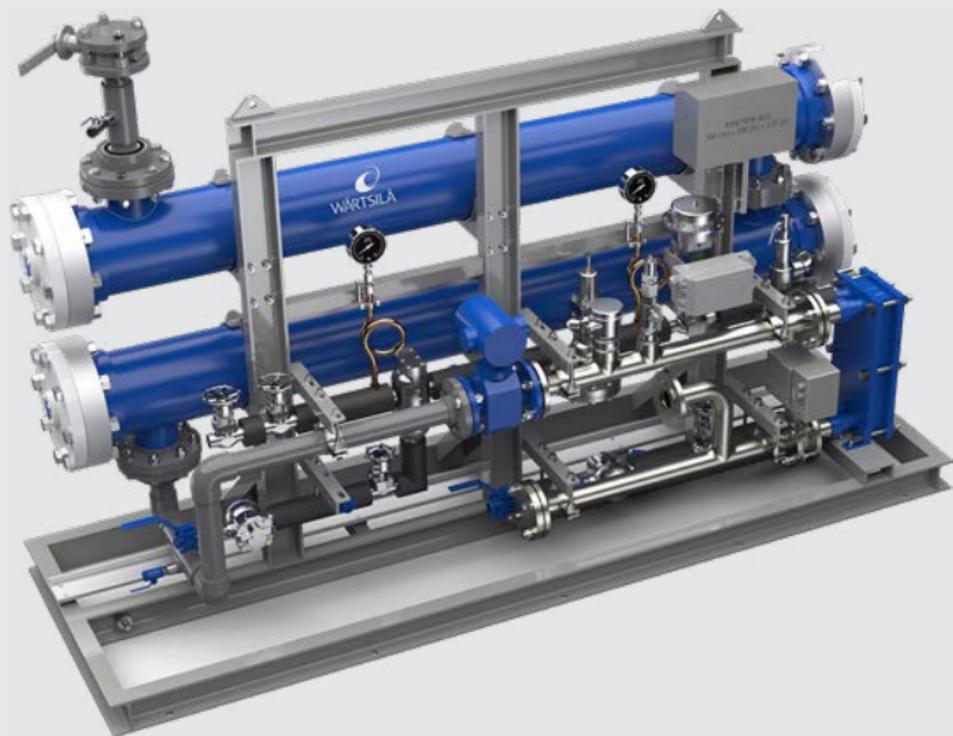
System capacities above 4000 m<sup>3</sup>/h are achieved by installing multiple systems in parallel.

For ease of installation the scope of supply is flexible from a kit of parts 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 Type Approval has been granted in accordance with the requirements of 33 CFR 151.2026.

# Ballast Water Management



Wärtsilä Aquarius® EC system	Maximum capacity (m <sup>3</sup> /h)	Total Power (kW) Installed / Nominal
AQ-550-EC	550	38 / 33
AQ-1200-EC	1200	75 / 65
AQ-1650-EC	1650	104 / 90
AQ-2500-EC	2500	161 / 140
AQ-3300-EC	3300	202 / 174
AQ-4000-EC	4000	245 / 211

Pressure drop	
Normal operation	0.3 barg

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).



## Control Systems

### ■ 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 positioning 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 auto-manoevres.

- 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



### 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.

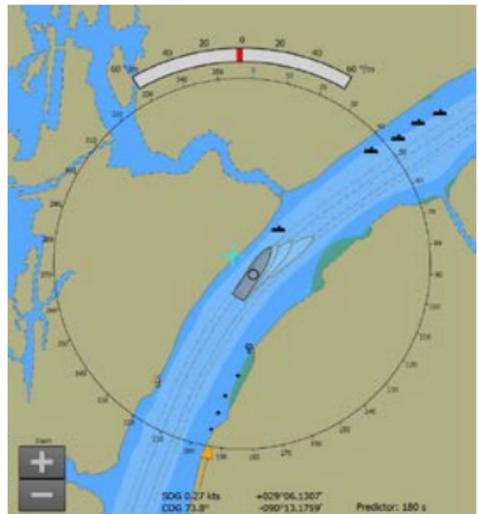


The Wärtsilä Smart Ship family of controls includes:

- 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.



## Electric Propulsion



### ■ 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.

## Electric Propulsion

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

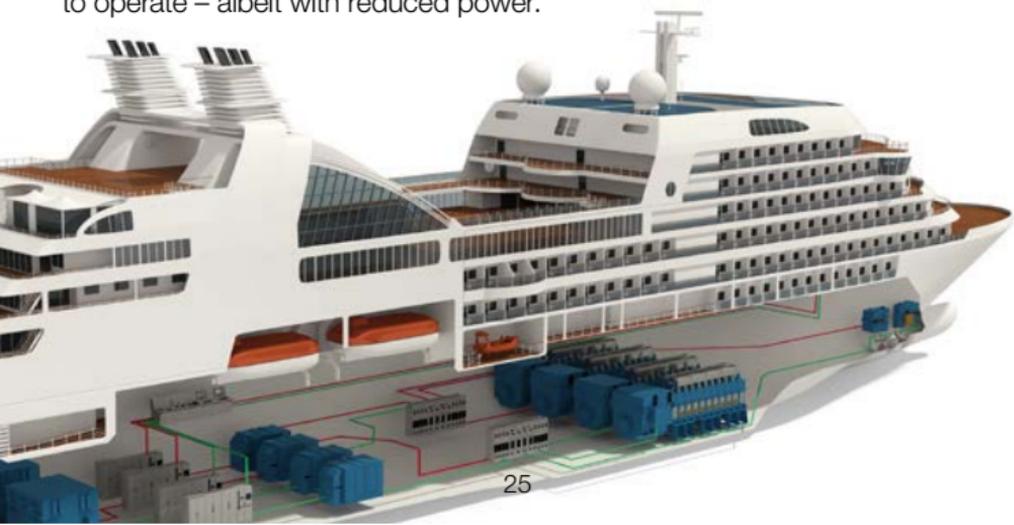
Frequency converters with line controlled inverters (LCI = synchroconverters) are designed with direct current (DC) intermediate circuits. They comprise thyristor rectifiers on the mains side and a thyristor inverter on the motor side. LCI converters are available for supplying synchronous motors in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



## Hybrid Solutions

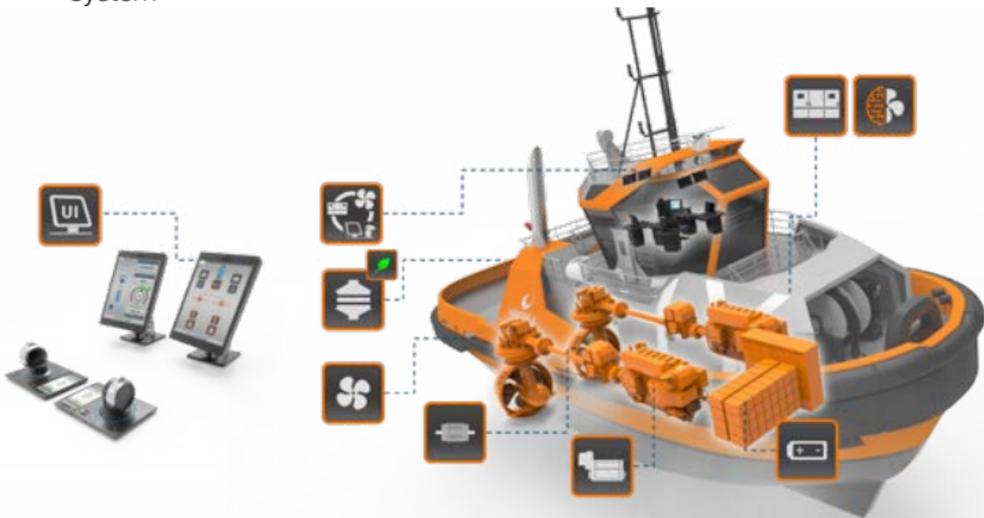
### ■ Wärtsilä HY

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



The 'Vilja', an escort tug operated by the Port of Luleå in Sweden, is the first vessel of its kind operating with the Wärtsilä HY hybrid power module. It is designed by Robert Allan Ltd. Copyright: Port of Luleå.

- **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.



## Hybrid Propulsion



### ■ 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, AVR's, 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

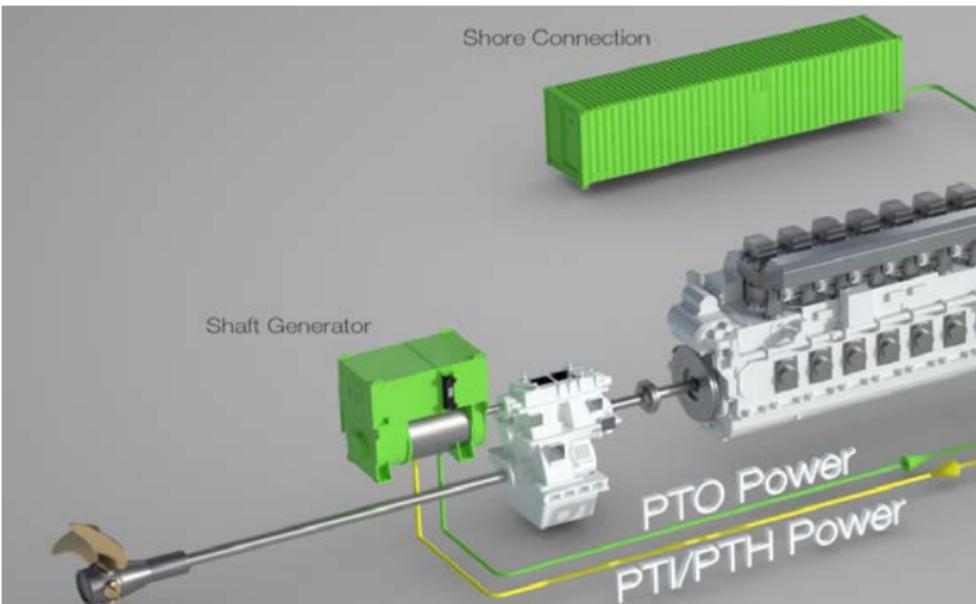
### ■ Shaft Generator Systems – PTO/PTI/PTH Applications

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



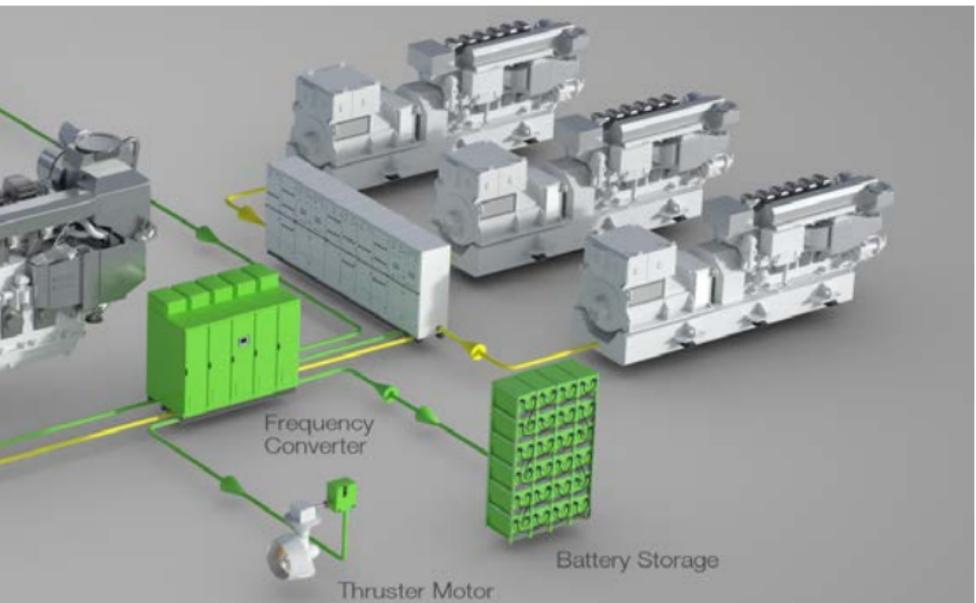
## Power Generation

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.



## Power Distribution



### ■ Power Distribution

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  $I^{CW}$  1sec: up to 120 kA

Protection grade: IP54, bottom open

- Ambient temperature: 45°C or 50°C acc. to Class Requirements
- Basic requirements: I<sup>EC</sup>, 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  $I^{CW}$  1sec: up to 100 kA

Protection grade: IP54, bottom open

- Ambient temperature: 45°C or 50°C acc. to class requirements
- Basic requirements: I<sup>EC</sup>, 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

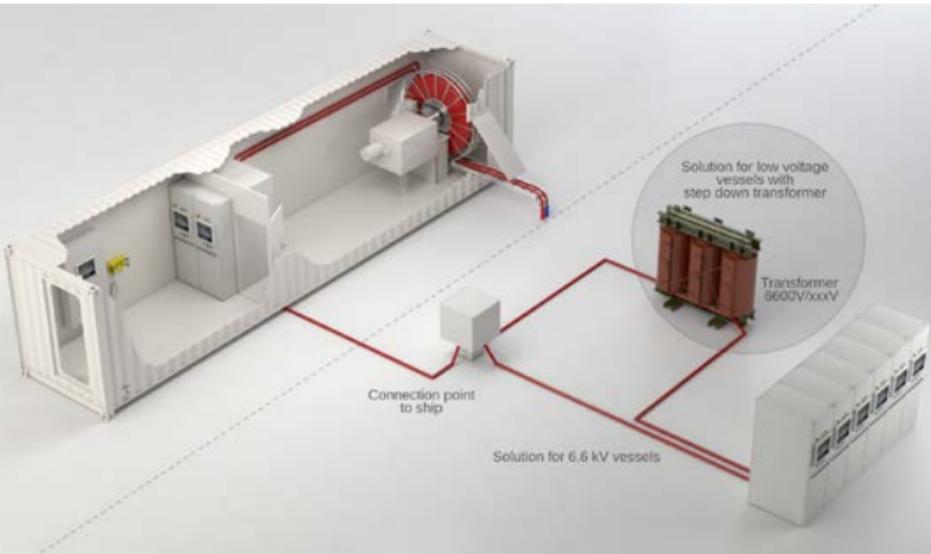
For protection and control of the power supply, Wärtsilä integrates its own developed protection system, the GPM 500.

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

## Power Distribution



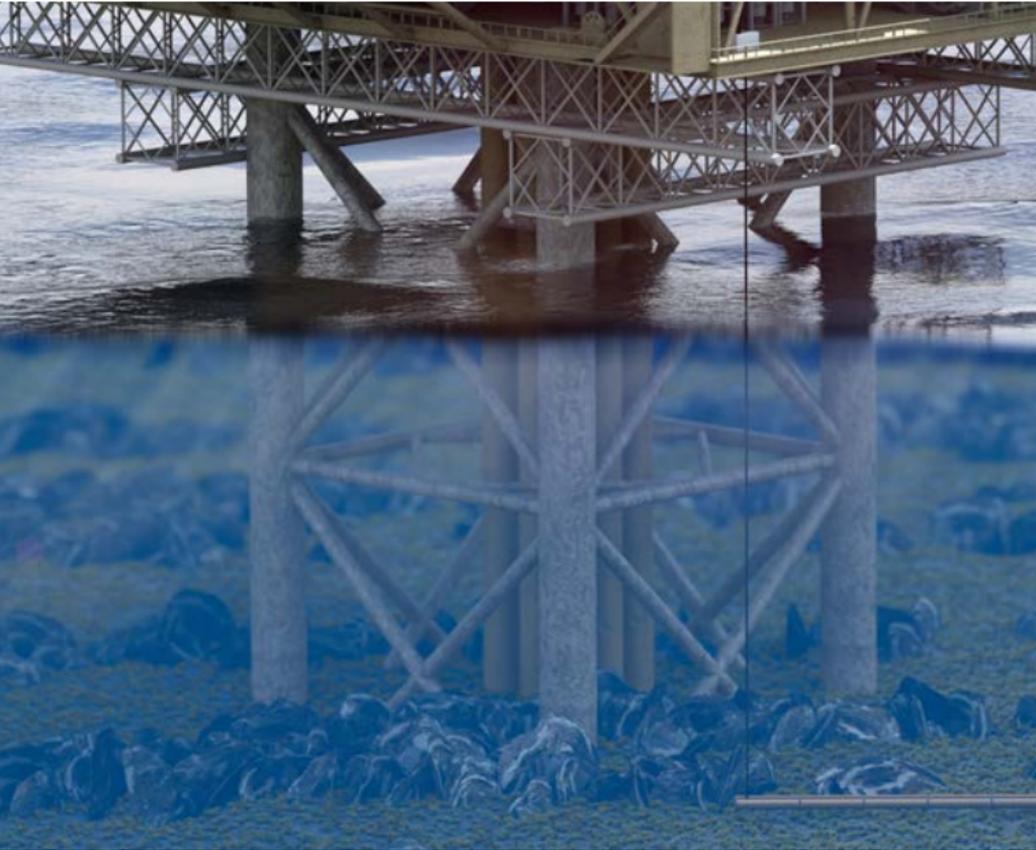
separately on-board the vessel, or containerised for siting at a specific on-board location. Upon request, we can develop tailor-made solutions for all vessel types. We offer the full range of turnkey integration options.

[CLICK for more info](#)

## 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.





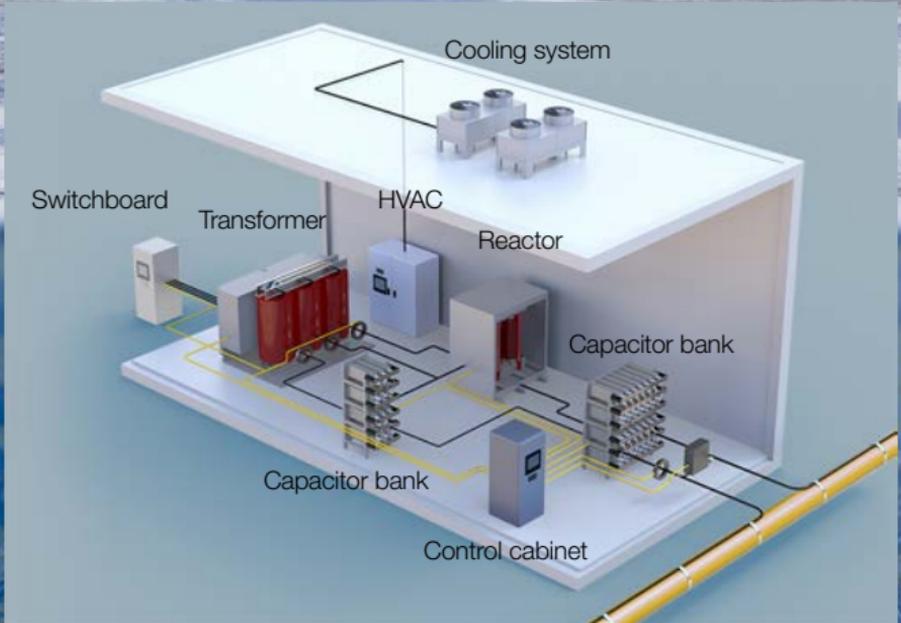
### ■ Wartsilä Direct Electric Heating

Wartsilä 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.

Wartsilä 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
- Topsides 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



Wärtsilä JOVYSTAR OCEAN (5–200 kVA)



Wärtsilä JOVYTEC PNT (1–3 kVA)

### ■ 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.

## 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 JOVYLOAD BRAKE



Wärtsilä JOVYLOAD CONPOWER

## 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%.



## Entertainment, Safety and Security

### ■ 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

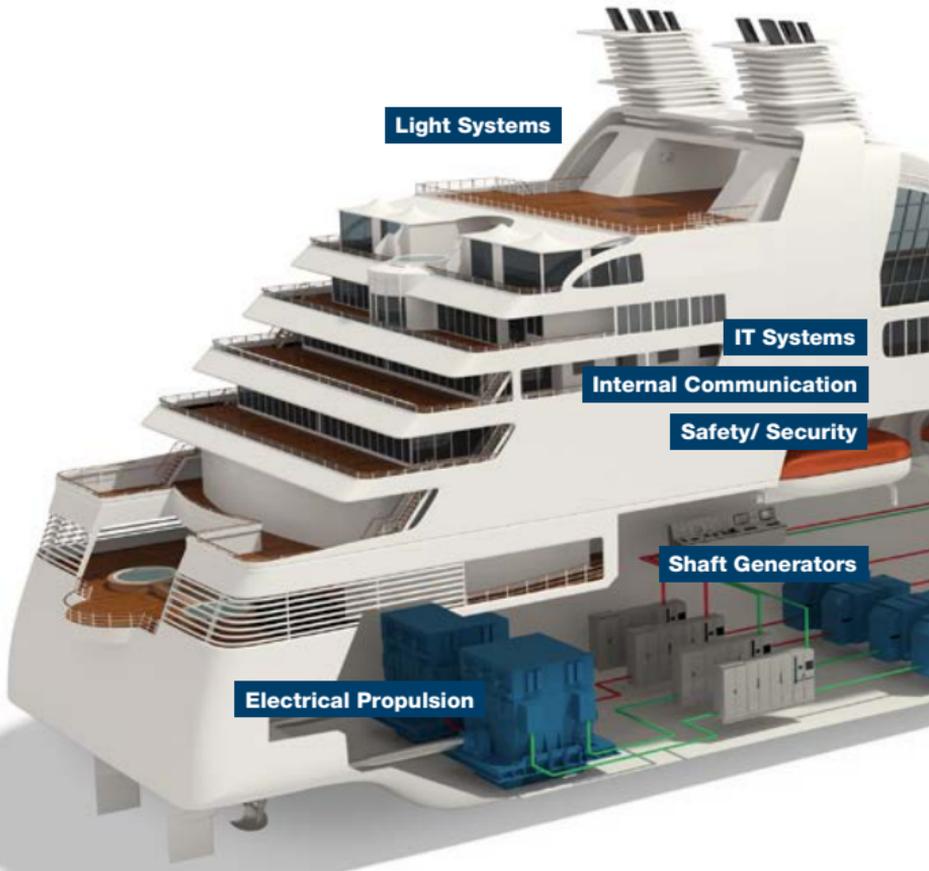


## Turnkey Solutions

### ■ Turnkey Solutions

Wärtsilä Turnkey Solutions is one of the leading system houses for the supply of complete electrical and electronic system packages on vessels. The Turnkey Solutions business unit offers system integration competencies and acts as single contractor for the shipyard, taking the full responsibility for the vessel's electrical system, from initial engineering up to installation and commissioning.

### Turnkey Solutions – System Integrated Approach



Systems/Basic Engineering

Detailed Engineering

Procurement

## Turnkey Solutions

### Benefits for the shipyard

#### Risk mitigation (delays/costs)

- One point of responsibility
- Reduced construction risk based on a reliable performance in the whole chain from design to delivery
- Reduced technical risk due to the employment of experts
- Early risk identification (incl. third parties)
- Reliable budget planning

#### Optimisation

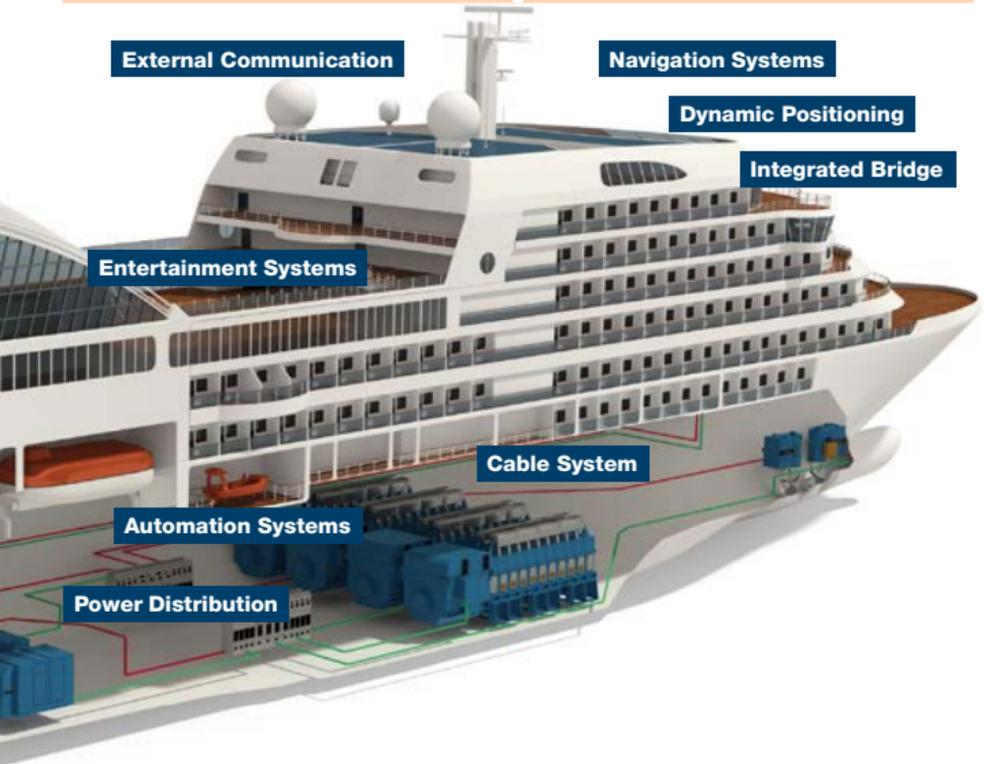
- Integrated approach: the System as a whole will be addressed by the respective skilled experts in order to achieve optimised cost benefit in the total system solution including third party equipment and not only in the individual systems
- Embedded engineer for bidding advantage

#### Capacities

- Due to unavailability or strategic interest not to fully utilize the electrical and procurement department of the shipyard

#### Financial strength /reliability

- Wärtsilä is a financially strong business partner, able to sustain financial pressures throughout the entire lifecycle of the project and stay at the side of the shipyard till the fulfilment of the project



Project Management

Project Execution

Commissioning/Warranty phase

## eniram

A WÄRTSILÄ COMPANY

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.

### Engine Model

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

### 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

### 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)



### Environmental Forecasts, Hindcasts and Eniram Databases

Incorporates detailed wind, wave, current, temperature and depth information to every decision

### Performance Monitoring

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

### Route Benchmarking

Analyzes the route performance

### Service Energy Model

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

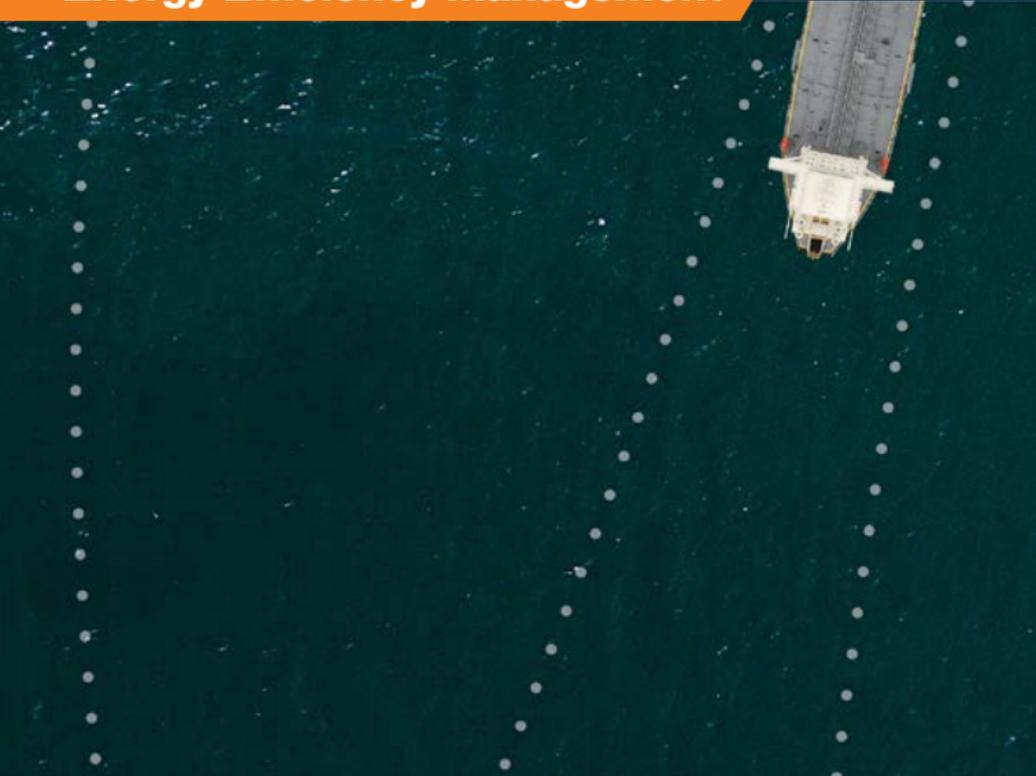
### Optimum Trim Model

Finding optimum trim dynamically in varying conditions

### Virtual STW Sensing

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





## **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.

## 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.



## 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.

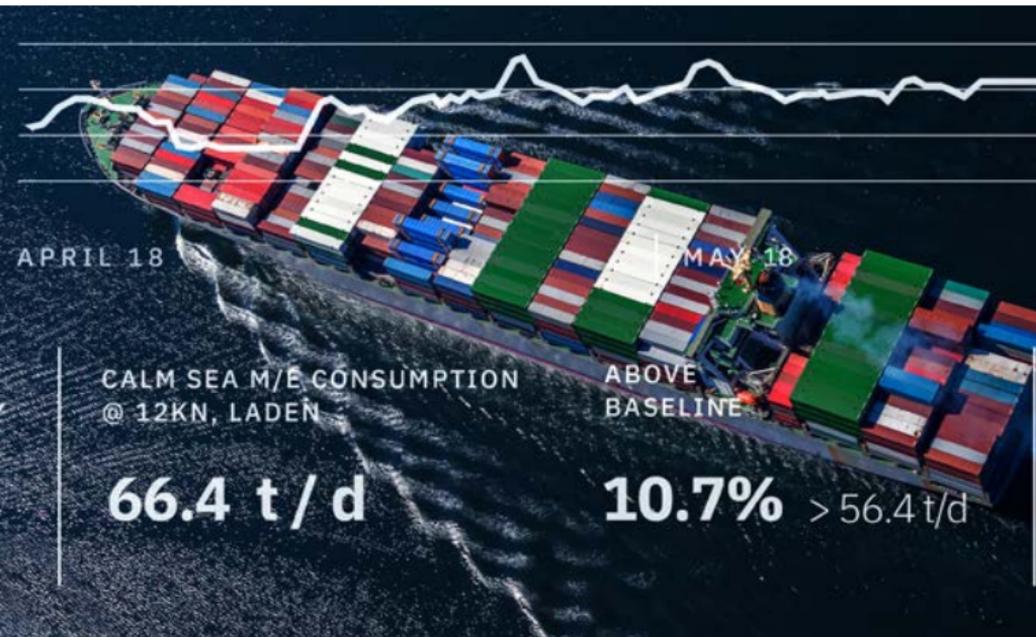


## Vessel efficiency – Optimising technical performance

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

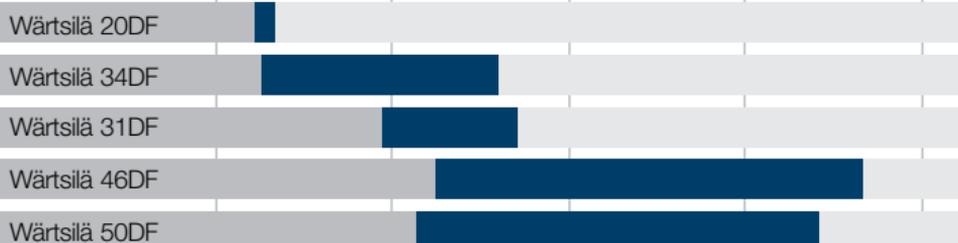
### Benefits:

- 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.

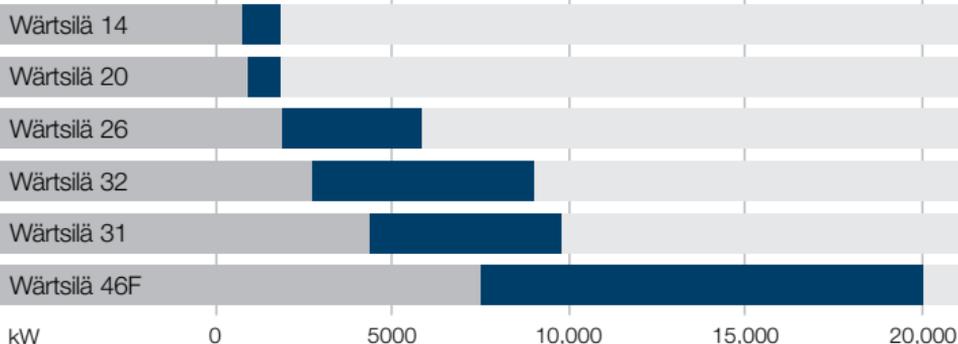


## Power range for Wärtsilä engines

### Wärtsilä dual-fuel engines



### Wärtsilä diesel engines



## 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.



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

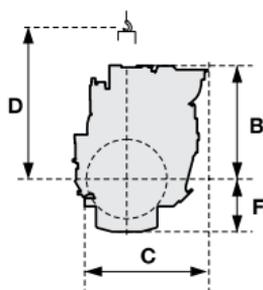
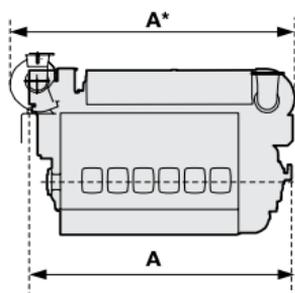
### Rated power

Engine type	kW
6L20DF	1 110
8L20DF	1 480
9L20DF	1 665

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

Engine type	A*	A	B	C	D	F	Weight
6L20DF	3 254	3 108	1 705	1 690	1 800	624	9.4
8L20DF	3 973	3 783	1 705	1 824	1 800	624	11.1
9L20DF	4 261	4 076	1 705	1 824	1 800	624	11.7

For definitions see page 65.



## Dual-fuel Engines

Wärtsilä 31DF		IMO Tier III
Cylinder bore	310 mm	Fuel specification: Fuel oil
Piston stroke	430 mm	700 cSt/50°C 7200 sR1/100°F
Cylinder output	550 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB
Speed	750 rpm	
Mean effective pressure	27.2bar	BSEC 7300 kJ/kWh at 85% load
Piston speed	10.75 m/s	

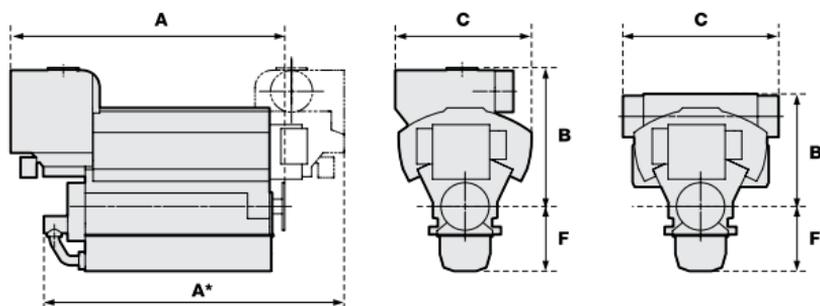
### Rated power

Engine type	kW
8V31DF	4 400
10V31DF	5 500
12V31DF	6 600
14V31DF	7 700
16V31DF	8 800

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

Engine type	A*	A	B	C	F	Weight
8V31DF	6 196	6 087	3 205	3 115	1 496	56.8
10V31DF	6 836	6 727	3 205	3 115	1 496	66.1
12V31DF	8 090	7 840	3 137	3 500	1 496	77.7
14V31DF	8 730	8 480	3 137	3 500	1 496	85.3
16V31DF	9 370	9 120	3 137	3 500	1 496	94.1

\* Turbocharger at flywheel end  
For definitions see page 65.



## Dual-fuel Engines

Wärtsilä 34DF		IMO Tier III, EPA T3	
Cylinder bore	340 mm	Fuel specification: Fuel oil	
Piston stroke	400 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	500 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	750 rpm		
Mean effective pressure	22.0 bar	BSEC 7530 kJ/kWh	
Piston speed	10.0 m/s	BSGC 7440 kJ/kWh	

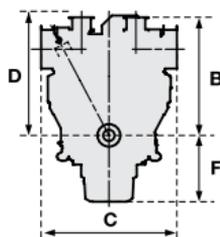
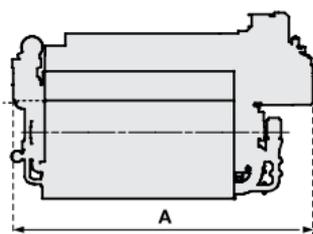
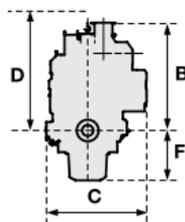
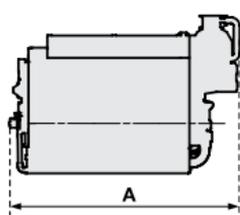
### Rated power

Engine type	kW
6L34DF	3 000
8L34DF	4 000
9L34DF	4 500
12V34DF	6 000
16V34DF	8 000

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

Engine type	A	B	C	D	F	Weight
6L34DF	5 335	2 550	2 380	2 345	1 155	35
8L34DF	6 315	2 550	2 295	2 345	1 155	44
9L34DF	6 869	2 550	2 610	2 345	1 155	49
12V34DF	6 865	2 435	2 900	2 120	1 210	61
16V34DF	7 905	2 570	3 325	2 120	1 210	77

For definitions see page 65.



## Dual-fuel Engines

Wärtsilä 46DF		IMO Tier III	
Cylinder bore	460 mm	Fuel specification: Fuel oil	
Piston stroke	580 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	1145 kW/cyl	ISO 8217, category ISO-F-DMX, DMA & DMB	
Speed	600 rpm		
Mean effective pressure	23.8 bar	BSEC 7460 kJ/kWh BSGC 7420 kJ/kWh	
Piston speed	11.6 m/s		

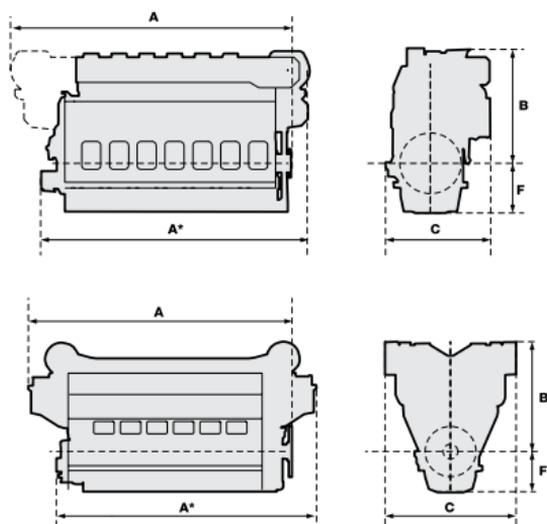
### Rated power

Engine type	kW
6L46DF	6 870
7L46DF	8 015
8L46DF	9 160
9L46DF	10 305
12V46DF	13 740
14V46DF	16 030
16V46DF	18 320

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

Engine type	A	A*	B	C	F	Weight
6L46DF	8 953	8 670	3 255	3 185	1 430	102
7L46DF	9 773	9 635	3 255	3 185	1 430	118
8L46DF	10 590	10 310	3 445	3 185	1 430	130
9L46DF	11 413	11 130	3 445	3 185	1 430	146
12V46DF	10 350	11 120	3 670	4 555	1 620	184
14V46DF	11 400	12 170	3 670	4 555	1 620	223
16V46DF	12 700	13 450	3 860	5 174	1 620	235

For definitions see page 65.



## Dual-fuel Engines

Wärtsilä 50DF		IMO Tier III	
Cylinder bore	500 mm	Fuel specification: Fuel oil	
Piston stroke	580 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	975 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	514 rpm		
Mean effective pressure	20.0 bar	BSEC 7480 kJ/kWh	
Piston speed	9.9 m/s	BSGC 7430 kJ/kWh	

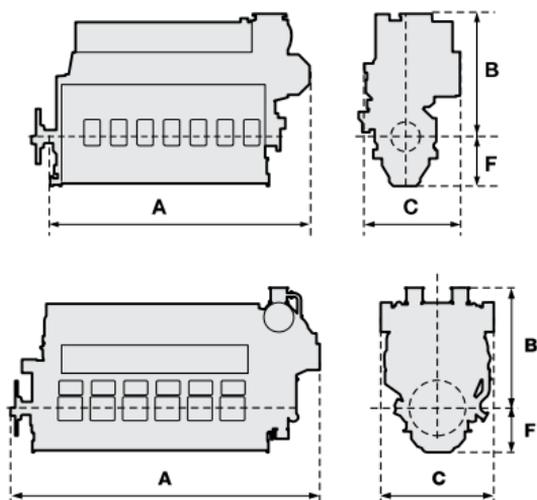
### Rated power

Engine type	kW
6L50DF	5 850
8L50DF	7 800
9L50DF	8 775
12V50DF	11 700
16V50DF	15 600

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

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

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 65.



## Diesel Engines

Wärtsilä 14		IMO Tier II or III
Cylinder bore	135 mm	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
Piston stroke	157 mm	
Speed	1600-1900 rpm	

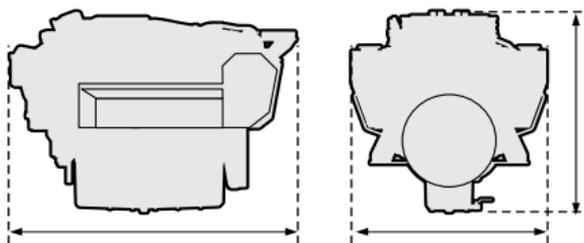
Rating	Maximum load	Overall load factor
A – Continuous Duty	Up to 100% of the time	80–100%
B – Heavy Duty	Up to 10 out of every 12 operating hours	40–80%
C – Medium Continuous Duty	Up to 6 out of every 12 operating hours	20–80%
D – Intermittent Duty	Up to 3 out of every 12 operating hours	< 50%

Wärtsilä 12V14 Rating	Nominal Power		Nominal Speed rpm
	kWm	bhp	
A	749	1 004	1 600
	810	1 086	1 800
B	790	1 059	1 600
	850	1 139	1 800
C	890	1 193	1 800
	920	1 233	1 900
D	970	1 300	1 800
	1 005	1 347	1 900

Wärtsilä 16V14 Rating	Nominal Power		Nominal Speed rpm
	kWm	bhp	
A	1 005	1 347	1 600
	1 080	1 448	1 800
B	1 055	1 414	1 600
	1 135	1 522	1 800
C	1 185	1 589	1 800
	1 225	1 642	1 900
D	1 295	1 736	1 800
	1 340	1 796	1 900

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

Engine type	Length	Width	Height	Weight
12V14	2 310	1 480	1 523	2.8
16V14	2 514	1 540	1 517	3.8



## Diesel Engines

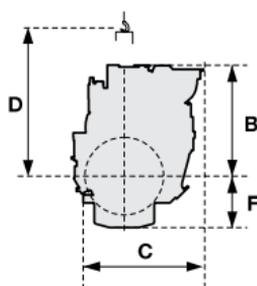
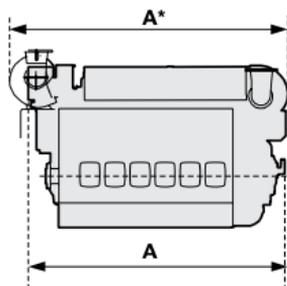
[CLICK for more info](#)

Wärtsilä 20		IMO Tier II or III
Cylinder bore	200 mm	Fuel specification: Fuel oil
Piston stroke	280 mm	700 cSt/50°C 7200 sR1/100°F
Cylinder output	200/220 kW/cyl	ISO 8217, category ISO-F-RMK 700
Speed	1000/1200 rpm	SFOC 189.9 g/kWh at ISO conditions
Mean effective pressure	27.3/25 bar	
Piston speed	9.3/11.2 m/s	

Rated power		
Engine type	kW/1000 rpm	kW/1200 rpm
4L20	800	–
6L20	1 200	1320
8L20	1 600	1760
9L20	1 800	1980

Dimensions (mm) and weights (tonnes)									
Engine type	A*	A	B*	B	C*	C	D	F	Weight
4L20	–	2 510	–	1 348	–	1 483	1 800	725	7.2
6L20	3 254	3 108	1 528	1 348	1 580	1 579	1 800	624	9.3
8L20	3 973	3 783	1 614	1 465	1 756	1 713	1 800	624	11.0
9L20	4 261	4 076	1 614	1 449	1 756	1 713	1 800	624	11.6

\* Turbocharger at flywheel end.  
For definitions see page 65.



## Diesel Engines

Wärtsilä 26		IMO Tier II or III
Cylinder bore	260 mm	Fuel specification: Fuel oil
Piston stroke	320 mm	700 cSt/50°C 7200 sR1/100°F
Cylinder output	340 kW/cyl	ISO 8217, category ISO-F-RMK 700
Speed	1000 rpm	SFOC 188.7 g/kWh at ISO conditions
Mean effective pressure	24 bar	
Piston speed	10.7 m/s	

### Rated power

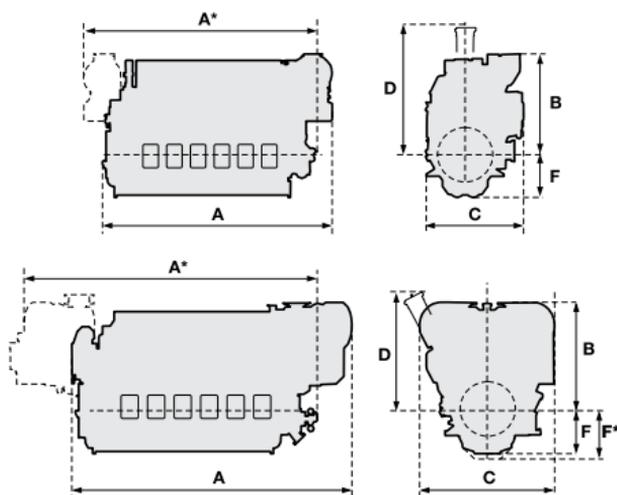
Engine type	kW
6L26	2 040
8L26	2 720
9L26	3 060
12V26	4 080
16V26	5 440

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

Engine type	A*	A	B*	B	C*	C	D	F dry sump	F wet sump	Weight dry sump	Weight wet sump
6L26	4 387	4 130	1 882	1 833	1 960	2 020	2 430	818	950	17.0	17.2
8L26	5 302	5 059	2 023	1 868	2 010	2 107	2 430	818	950	21.6	21.9
9L26	5 691	5 449	2 023	1 868	2 016	2 107	2 430	818	950	23.3	23.6
12V26	5 442	5 314	2 034	2 034	2 552	2 602	2 060	800	1 110	28.7	29.0
16V26	6 223	6 025	2 151	2 190	2 489	2 763	2 060	800	1 110	36.1	37.9

\* Turbocharger at flywheel end.

For definitions see page 65.



## Diesel Engines

Wärtsilä 31		IMO Tier II or III
Cylinder bore	310 mm	Fuel specification: Fuel oil
Piston stroke	430 mm	700 cSt/50°C 7200 sR1/100°F
Cylinder output	610 kW/cyl	ISO 8217, category ISO-F-RMK 700
Speed	750 rpm	SFOC 167.7 g/kWh at ISO conditions
Mean effective pressure	30.1bar	
Piston speed	10.75 m/s	

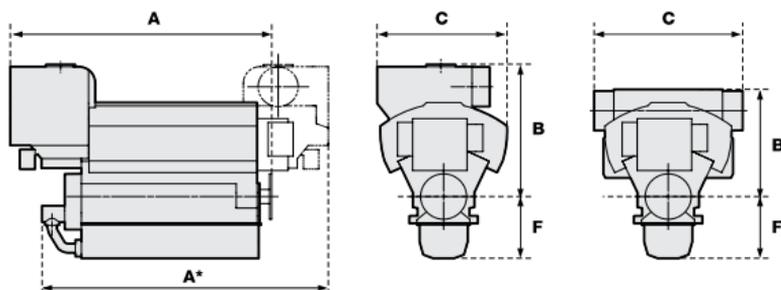
### Rated power

Engine type	kW
8V31	4 880
10V31	6 100
12V31	7 320
14V31	8 540
16V31	9 760

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

Engine type	A*	A	B	C	F	Weight
8V31	6 196	6 087	3 205	3 115	1 496	56.3
10V31	6 836	6 727	3 205	3 115	1 469	65.6
12V31	8 090	7 840	3 137	3 500	1 496	77.1
14V31	8 730	8 480	3 137	3 500	1 496	84.6
16V31	9 370	9 120	3 137	3 500	1 496	93.3

\* Turbocharger at flywheel end  
For definitions see page 65.



## Diesel Engines

Wärtsilä 32		IMO Tier II or III
Cylinder bore	320 mm	Fuel specification: Fuel oil
Piston stroke	400 mm	700 cSt/50°C      7200 sR1/100°F
Cylinder output	580 kW/cyl	ISO 8217, category ISO-F-RMK 700
Speed	750 rpm	SFOC 178.8 g/kWh at ISO conditions
Mean effective pressure	28.9 bar	
Piston speed	10.0 m/s	

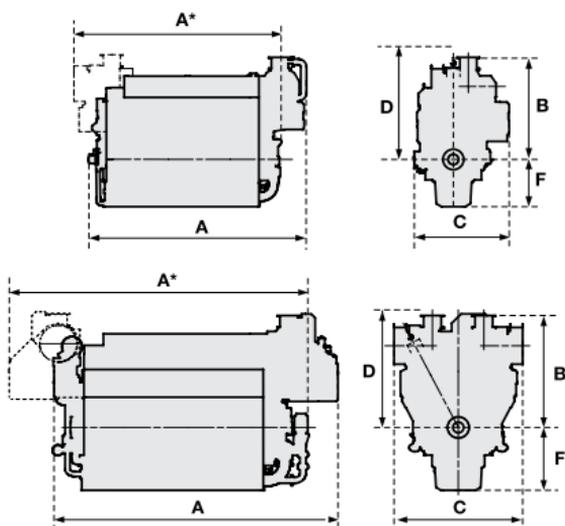
### Rated power

Engine type	kW
6L32	3 480
8L32	4 640
9L32	5 220
12V32	6 960
16V32	9 280

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

Engine type	A*	A	B*	B	C	D	F	Weight
6L32	5 570	5 130	2 432	2 295	2 380	2 345	1 155	35
8L32	6 400	6 379	2 457	2 375	2 610	2 345	1 155	44
9L32	6 885	6 869	2 455	2 375	2 610	2 345	1 155	49
12V32	7 098	6 865	2 516	2 430	2 900	2 120	1 210	57
16V32	8 041	7 905	2 516	2 595	3 325	2 120	1 210	71

\* Turbocharger at flywheel end.  
For definitions see page 65.



## Diesel Engines

Wärtsilä 46F		IMO Tier II or III
Cylinder bore	460 mm	Fuel specification: Fuel oil
Piston stroke	580 mm	700 cSt/50°C 7200 sR1/100°F
Cylinder output	1200 kW/cyl	ISO 8217, category ISO-F-RMK 700
Speed	600 rpm	SFOC 175 g/kWh at ISO conditions
Mean effective pressure	24.9 bar	Option: Lubricating oil module integrated on engine.
Piston speed	11.6 m/s	

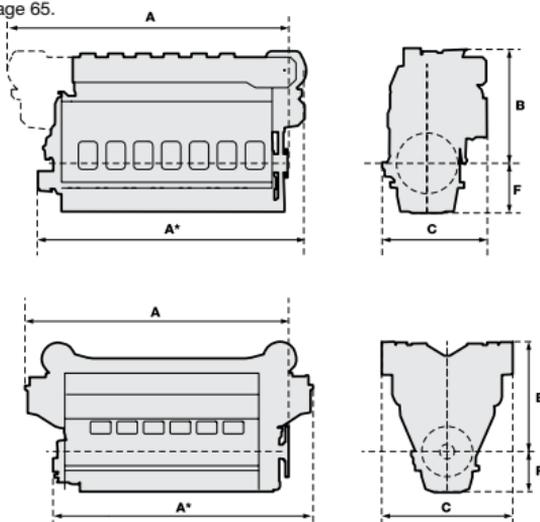
### Rated power

Engine type	kW
6L46F	7 200
7L46F	8 400
8L46F	9 600
9L46F	10 800
12V46F	14 400
14V46F	16 800
16V46F	19 200

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

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

\* Turbocharger at flywheel end.  
For definitions see page 65.



## 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/Nm<sup>3</sup>

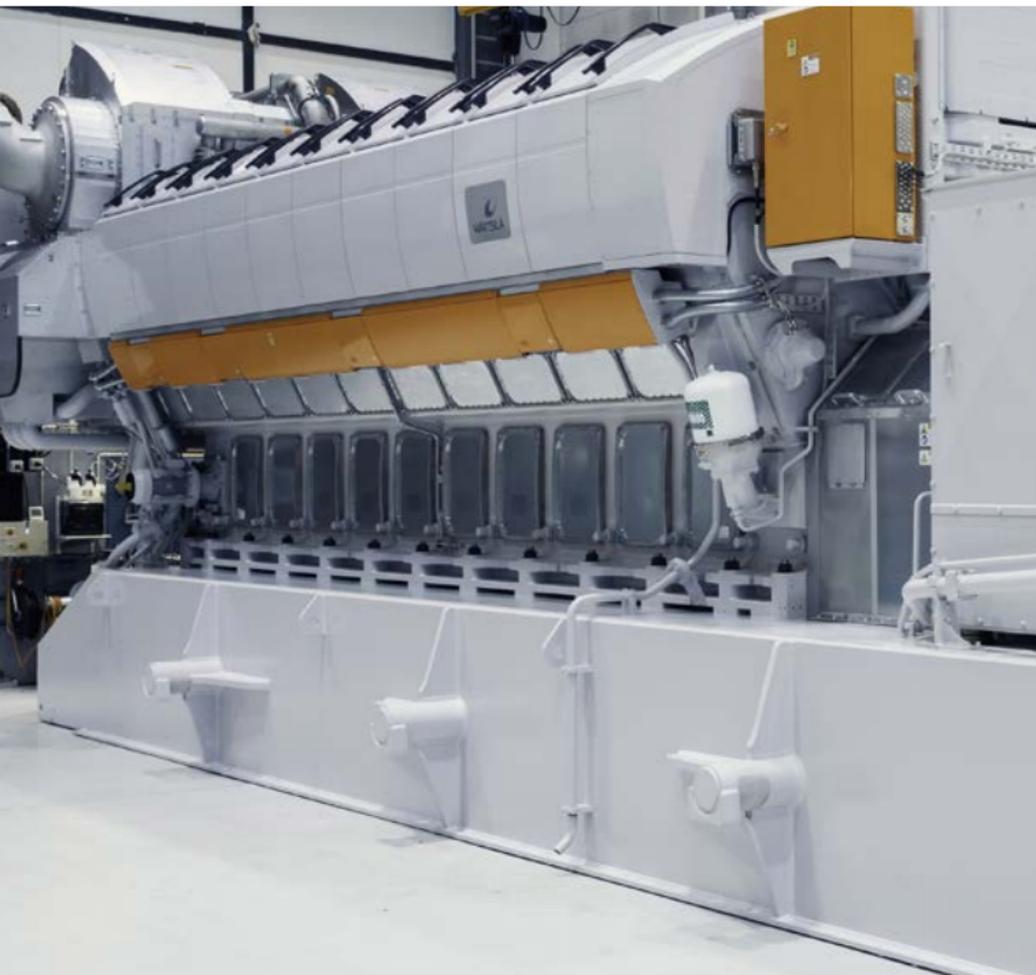
#### ISO standard reference conditions

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

## Generating Sets

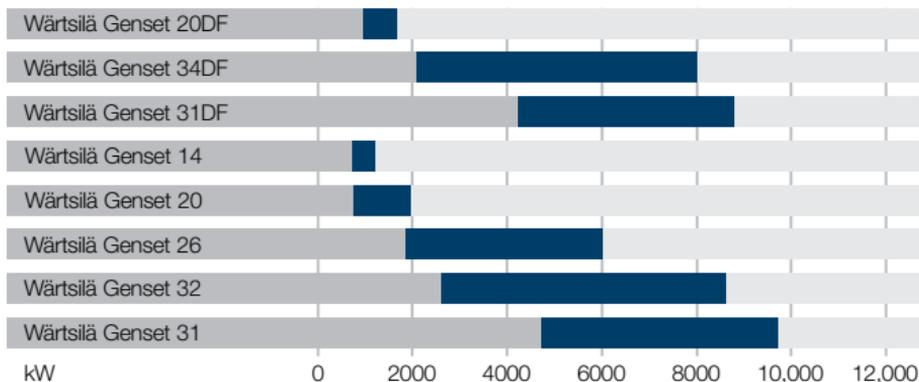
### Wärtsilä Gensets

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.



## Generating Sets

### Power Range for Wärtsilä Gensets



## Generating Sets

Wärtsilä Genset 31SG		IMO Tier III
Cylinder bore	310 mm	Fuel specification: Natural gas
Piston stroke	430 mm	
Cylinder output	530, 550 kW/cyl	Methane number > 70
Speed	720, 750 rpm	
Mean effective pressure	27.1, 27.2 bar	BSFC 7243 kJ/kWh
Piston speed	10.75 m/s	
Generator voltage	0.4-13.8 kV	
Generator efficiency	0.95-0.97	

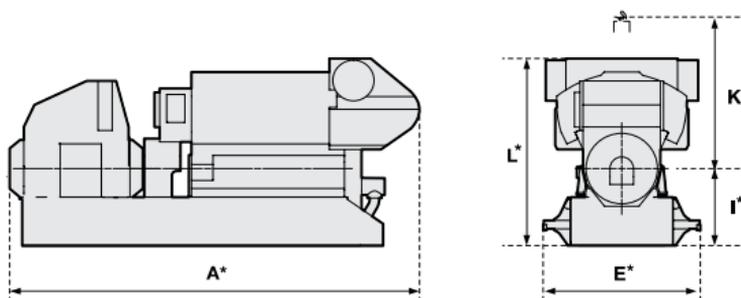
### Rated power

Engine type	60 Hz		50 Hz	
	530 kW/cyl, 720 rpm		550 kW/cyl, 750 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
8V31SG	4 240	4 070	4 400	4 225
10V31SG	5 300	5 090	5 500	5 280
12V31SG	6 360	6 100	6 600	6 335
14V31SG	7 420	7 120	7 700	7 390
16V31SG	8 480	8 140	8 800	8 450

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

Engine type	A*	E*	I*	K	L*	Weight*
8V31SG	9 100	3 600	1 750	2 400	5 000	94.3
10V31SG	9 900	3 600	1 750	2 400	5 000	107.2
12V31SG	11 300	3 600	1 800	2 400	4 950	122.3
14V31SG	11 900	3 600	1 900	2 400	5 050	138.4
16V31SG	12 540	3 600	1 900	2 400	5 050	150.4

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 20DF		IMO Tier III	
Cylinder bore	200 mm	Fuel specification: Fuel oil	
Piston stroke	280 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	160/185 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	1000/1200 rpm		
Mean effective pressure	22.0, 21.0 bar	BSEC 8390 kJ/kWh	
Piston speed	9.3, 11.2 m/s	BSGC 8220 kJ/kWh	
Generator voltage	0.4–13.8 kV		
Generator efficiency	0.95–0.96		

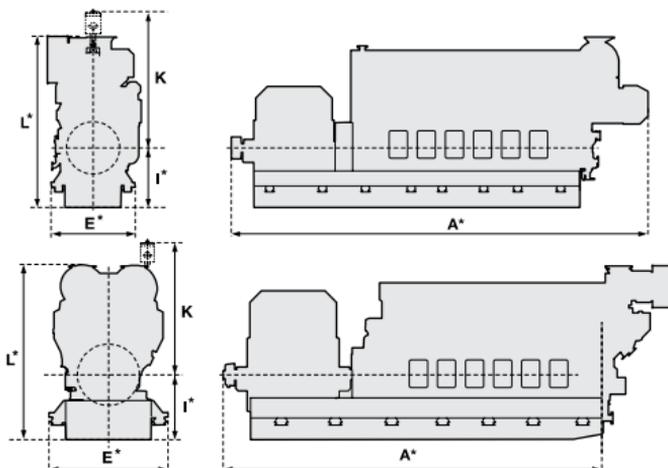
### Rated power

Engine type	60 Hz		50 Hz	
	185 kW/cyl, 1200 rpm		160 kW/cyl, 1000 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L20DF	1 110	1 065	960	920
8L20DF	1 480	1 420	1 280	1 230
9L20DF	1 665	1 600	1 440	1 380

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

Engine type	A*	E	I*	K	L*	Weight
6L20DF	5 325	2 070	895/975/1025	1 800	2 731	16.9
8L20DF	6 030	2 070	1025/1075	1 800	2 781	20.8
9L20DF	6 535	2 300	1075/1125	1 800	2 831	23.9

For definitions see page 77.



## Generating Sets

<b>Wärtsilä Genset 31DF</b>		IMO Tier III	
Cylinder bore	310 mm	Fuel specification: Fuel oil	
Piston stroke	430 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	530, 550 kW/cyl	ISO 8217, category ISO-F-RMK 700	
Speed	720, 750 rpm		
Mean effective pressure	27.1, 27.2 bar	BSEC 7300 kJ/kWh	
Piston speed	10.3, 10.75 m/s		
Generator voltage	0.4-13.8 kV		
Generator efficiency	0.95-0.97		

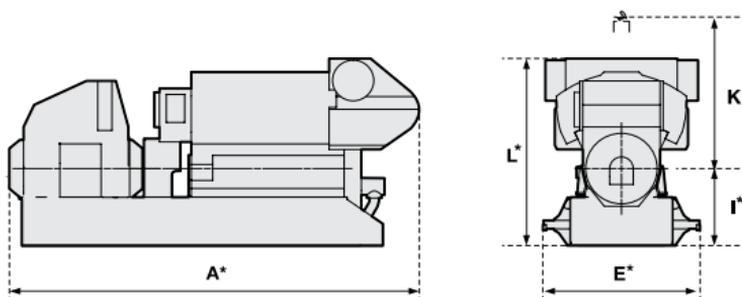
### Rated power

Engine type	60 Hz		50 Hz	
	530 kW/cyl, 720 rpm		550 kW/cyl, 750 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
8V31DF	4 240	4 070	4 400	4 225
10V31DF	5 300	5 090	5 500	5 280
12V31DF	6 360	6 100	6 600	6 335
14V31DF	7 420	7 120	7 700	7 390
16V31DF	8 480	8 140	8 800	8 450

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

Engine type	A*	E*	I*	K	L*	Weight*
8V31DF	9 100	3 600	1 750	2 400	5 000	94.3
10V31DF	9 900	3 600	1 750	2 400	5 000	107.2
12V31DF	11 300	3 600	1 800	2 400	4 950	122.3
14V31DF	11 900	3 600	1 900	2 400	5 050	138.4
16V31DF	12 540	3 600	1 900	2 400	5 050	150.4

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 34DF		IMO Tier III, EPA T3	
Cylinder bore	340 mm	Fuel specification: Fuel oil	
Piston stroke	400 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	480, 500 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	720, 750 rpm		
Mean effective pressure	22.0 bar	BSEC 7590 kJ/kWh	
Piston speed	9.6, 10.0 m/s	BSGC 7490 kJ/kWh	
Generator voltage	0.4–13.8 kV		
Generator efficiency	0.95–0.97		

### Rated power

Engine type	60 Hz		50 Hz	
	480 kW/cyl, 720 rpm		500 kW/cyl, 750 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L34DF	2 880	2 770	3 000	2 890
8L34DF	3 840	3 690	4 000	3 840
9L34DF	4 320	4 150	4 500	4 320
12V34DF	5 760	5 530	6 000	5 770
16V34DF	7 680	7 370	8 000	7 680

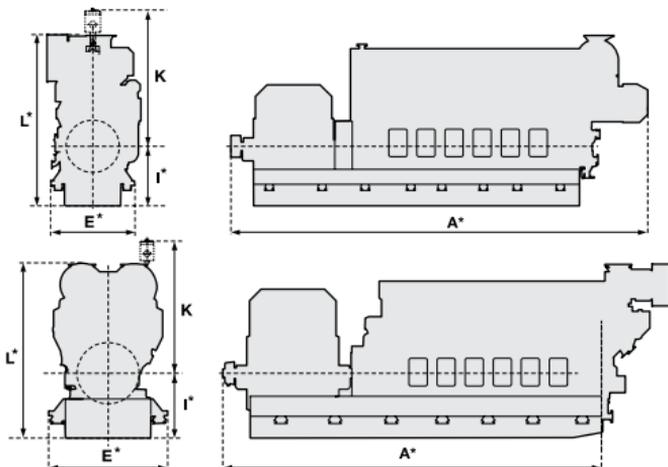
### Dimensions (mm) and weights (tonnes)

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

\* Dependent on generator type.

Generator output based on a generator efficiency of 96%.

For definitions see page 77.



## Generating Sets

Wärtsilä Genset 14		IMO Tier II or III
Cylinder bore	135 mm	Fuel specification: Light fuel oil, maximum sulphur content 0.5%
Piston stroke	157 mm	
Speed	1500, 1800 rpm	ISO 8217, category ISO-F-DMX, DMA, DMZ
Generator voltage	0.4 - 0.69 kV	SFOC 205,0 g/kWh at ISO condition
Generator efficiency	0.95 - 0.96	

### Rated power 60Hz

Engine type	Engine kW	Gen. kW	Engine kW	Gen. kW	Engine kW	Gen. kW
12V14	710	675	790	750	910	865
16V14	945	900	1 055	1 000	1 215	1 155

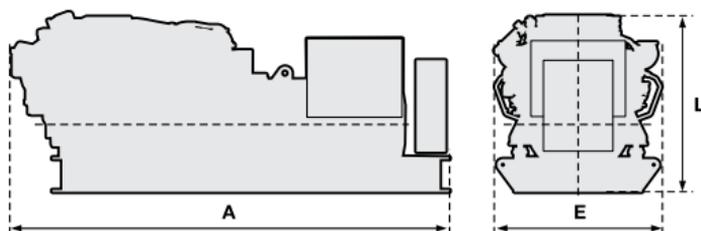
### Rated power 50Hz

Engine type	Engine kW	Gen. kW	Engine kW	Gen. kW
12V14	710	675	790	750
16V14	945	900	1 055	1 000

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

Engine type	A*	E*	L*	Weight*
12V14	3 800	1 480	1 600	5.5
16V14	4 600	1 540	1 600	7.5

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 20		IMO Tier II or III	
Cylinder bore	200 mm	Generator voltage	0.4–13.8 kV
Piston stroke	280 mm	Generator efficiency	0.95–0.96
Cylinder output	185, 200, 220 kW/cyl	Fuel specification: Fuel oil	
Speed	900, 1000, 1200 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	28.0, 27.3, 25.0 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	8.4, 9.3, 11.2 m/s	SFOC 189.9 g/kWh at ISO conditions	

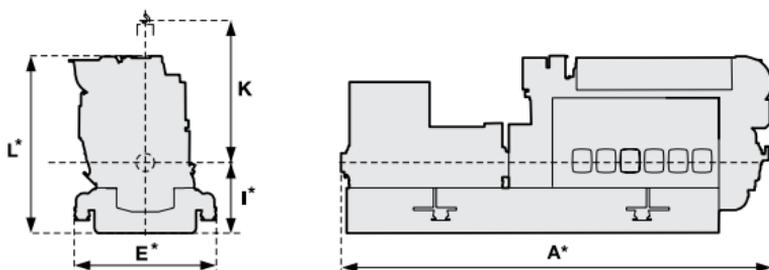
### Rated power

Engine type	60 Hz				50 Hz	
	185 kW/cyl, 900 rpm		220 kW/cyl, 1200 rpm		200 kW/cyl, 1000 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW	Engine kW	Gen. kW
4L20	740	700	–	–	800	760
6L20	1 110	1 055	1 320	1 255	1 200	1 140
8L20	1 480	1 405	1 760	1 670	1 600	1 520
9L20	1 665	1 580	1 980	1 880	1 800	1 710

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

Engine type	A*	E*	I*	K	L*	Weight*
4L20	5 113	1 860	895	1 800	2 275	15.9
6L20	5 783	1 860	895	1 800	2 275	18.7
8L20	6 508	2 010	1 225	1 800	2 462	22.8
9L20	6 784	2 010	1 225	1 800	2 457	23.3

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 26		IMO Tier II or III	
Cylinder bore	260 mm	Generator voltage	0.4–13.8 kV
Piston stroke	320 mm	Generator efficiency	0.95–0.96
Cylinder output	325, 340 kW/cyl	Fuel specification: Fuel oil	
Speed	900, 1000 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	25.5, 24 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	9.6, 10.7 m/s	SFOC 185.8 g/kWh at ISO conditions	

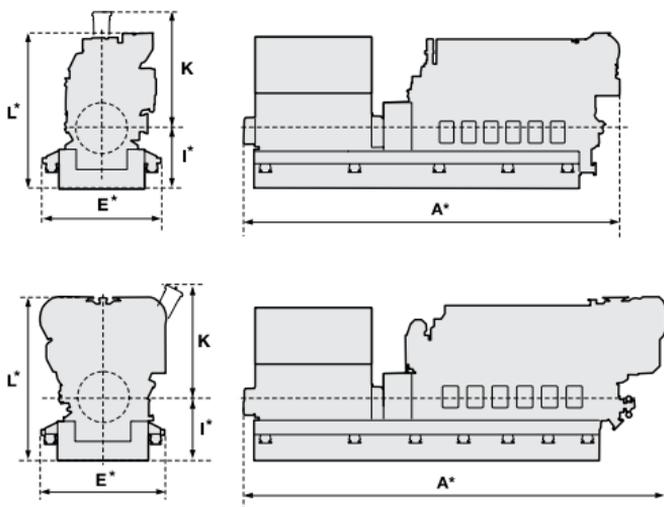
### Rated power

Engine type	60 Hz		50 Hz	
	325 kW/cyl, 900 rpm		340 kW/cyl, 1000 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L26	1 950	1 870	2 040	1 960
8L26	2 600	2 495	2 720	2 610
9L26	2 925	2 810	3 060	2 940
12V26	3 900	3 745	4 080	3 915
16V26	5 200	4 990	5 440	5 220

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

Engine type	A*	E*	I*	K	L*	Weight*
6L26	7 500	2 300	1 200	2 430	3 033	35
8L26	8 000	2 300	1 200	2 430	3 068	45
9L26	8 500	2 300	1 300	2 430	3 168	50
12V26	8 400	2 700	1 560	2 765	3 686	60
16V26	9 700	2 700	1 560	2 765	3 716	70

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 31		IMO Tier II or III	
Cylinder bore	310 mm	Generator voltage	0.4–13.8 kV
Piston stroke	430 mm	Generator efficiency	0.95–0.97
Cylinder output	590, 610 kW/cyl	Fuel specification: Fuel oil	
Speed	720, 750 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	30.3, 30.1 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	10.3, 10.75 m/s	SFOC 167.7 g/kWh at ISO conditions	

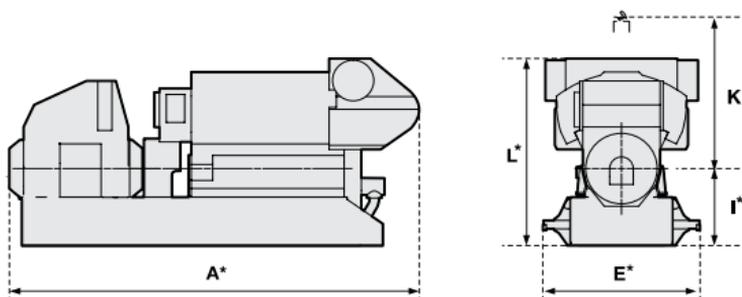
### Rated power

Engine type	60 Hz		50 Hz	
	590 kW/cyl, 720 rpm		610 kW/cyl, 750 rpm	
	Engine kW	Gen. kW	Engine kW	Gen. kW
8V31	4 720	4 530	4 880	4 685
10V31	5 900	5 665	6 100	5 855
12V31	7 080	6 800	7 320	7 030
14V31	8 260	7 930	8 540	8 200
16V31	9 440	9 060	9 760	9 370

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

Engine type	A*	E*	I*	K	L*	Weight*
8V31	9 100	3 600	1 750	2 400	5 000	94.3
10V31	9 900	3 600	1 750	2 400	5 000	107.2
12V31	11 300	3 600	1 800	2 400	4 950	122.3
14V31	11 900	3 600	1 900	2 400	5 050	138.4
16V31	12 540	3 600	1 900	2 400	5 050	150.4

\* Dependent on generator type and size.  
For definitions see page 77.



## Generating Sets

Wärtsilä Genset 32		IMO Tier II or III	
Cylinder bore	320 mm	Generator voltage	0.4–13.8 kV
Piston stroke	400 mm	Generator efficiency	0.95–0.97
Cylinder output	560, 580 kW/cyl	Fuel specification: Fuel oil	
Speed	720, 750 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	28.9 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	9.6, 10.0 m/s	SFOC 178.8 g/kWh at ISO conditions	

### Rated power

Engine type	60 Hz/720 rpm		50 Hz/750 rpm	
	560 kW/cyl		580 kW/cyl	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L32	3 360	3 230	3 480	3 340
7L32	3 920	3 770	4 060	3 900
8L32	4 480	4 300	4 640	4 450
9L32	5 040	4 840	5 220	5 010
12V32	6 720	6 450	6 960	6 680
16V32	8 960	8 600	9 280	8 910

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

Engine type	A*	E*	I*	K	L*	Weight*
6L32	8 345	2 490	1 450	2 345	3 745	57
7L32	9 391	2 690	1 630	2 345	3 960	69
8L32	10 410	2 690	1 630	2 345	4 010	76
9L32	10 505	2 890	1 630	2 345	4 010	86
12V32	10 700	3 060	1 700	2 120	4 130	100
16V32	11 465	3 360	1 850	2 120	4 445	127

\* 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 77.

## Generating Sets

### Definitions and 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/Nm<sup>3</sup>

#### 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.



Fuel booster unit.

## Auxiliary Systems



Preheating unit



Oil mist separator module.



Fuel oil transfer pump module with heater.

## SO<sub>x</sub> Abatement



### ■ 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-SO<sub>x</sub> with up to four venturi, the I-SO<sub>x</sub> with its reduced footprint and installation ease, and lastly the Q-SO<sub>x</sub> boasting a hefty power range.

Each scrubber design has 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 can also be delivered with the option of hybrid ready.

## SO<sub>x</sub> Abatement



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, the EU and the US Coast Guard (USCG). 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.

## SO<sub>x</sub> Abatement

### ■ Wärtsilä Open Loop Scrubber System

The Wärtsilä open loop system is designed to remove SO<sub>x</sub> from exhaust gas through the utilisation 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 SO<sub>x</sub> in the exhaust to mix with the seawater, thus forming sulphuric acid and sulphates. 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 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

The Wärtsilä closed loop system is designed to remove SO<sub>x</sub> from exhaust gas through the utilisation of seawater and an added alkali.

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 SO<sub>x</sub> 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 effluent 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 excellent efficiency, allowing safe and compliant operation in both low alkaline waters as well as in the open ocean.

# Exhaust Gas Cleaning

SO<sub>x</sub> Abatement



## NO<sub>x</sub> Abatement



### ■ Wärtsilä NO<sub>x</sub> 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<sub>x</sub> 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<sub>x</sub> Reducer (NOR) is an emission after-treatment system based on the Selective Catalytic Reduction (SCR) technology for Nitrogen Oxide (NO<sub>x</sub>) 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

# Exhaust Gas Cleaning

## NO<sub>x</sub> Abatement



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 NO<sub>x</sub> 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.



Wärtsilä Fleet Operations Solution saves costs and increases safety by automatically optimising route, providing the fullest and latest voyage data, while keeping the onboard and onshore parties informed and notified.

3 main areas you get covered with Wärtsilä Fleet Operations Solution's benefits:

## **Safety**

- supports you in creating a route that is 100 % safe, on account of the most up-to-date charts and publications;
- brings better transparency of connected vessels, onboard voyage planning, tracking and situational awareness ensure safety of a voyage.

## **Efficiency**

- save up to 20 % in fuel costs;
- plan routes in 30 minutes instead of hours;
- use real-time AI-based decision support on the bridge and via mobile devices.

## **Compliance**

- it reduces ecological impact by having access to analytics for fuel economy and efficient assets use;
- It automatically generates reports to avoid human administration errors, saves crew's time and demonstrates easier compliance with IMO, EU-MRV and other regulations.

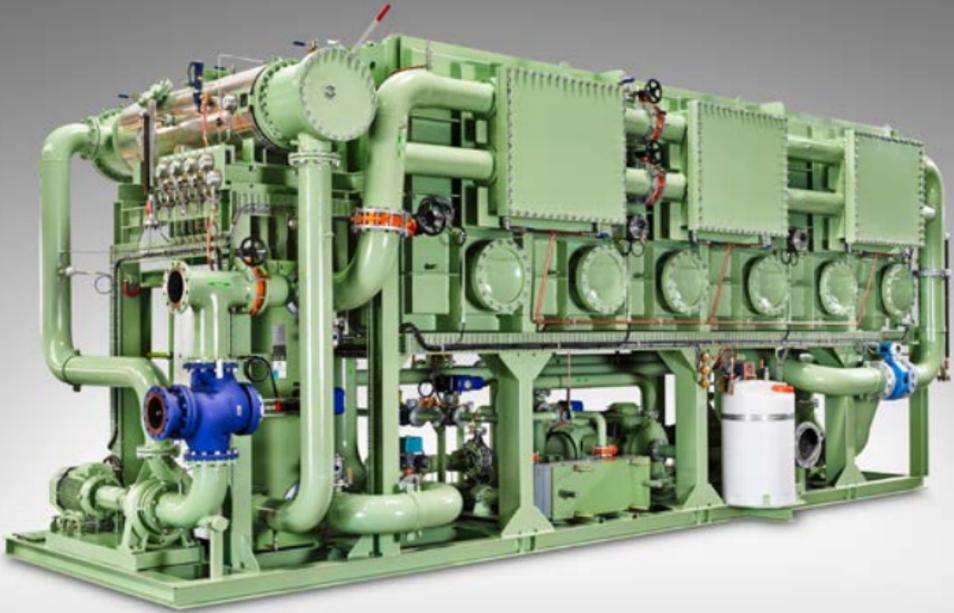


Wärtsilä Fleet Operations Solution supports creating a compelling business by removing the need for investment in hardware, allowing experimentation with digital solutions at minimal risk. The solution leverages existing hardware that acts as a central data aggregator and hub thereby removing the need for large upfront investment. From there, a modular service model allows the rolling out of digital solutions as different use cases are identified.

600 vessels of the entire Anglo-Eastern fleet roll out Wärtsilä Fleet Operations Solution: *“We are keen to use the advantages of new digital means to maximise the efficiency of our voyages and the performance of our fleet. Realizing the opportunities of Wärtsilä Fleet Operations Solution, we look forward to contribute to the further development of the solution as an early adopter,”* comments Capt. Pradeep Chawla Anglo-Eastern Global QHSE Director.

J. Lauritzen AVS trials: *“...It saves 15k USD on just one Atlantic voyage by just one vessel: we simply compare what Navi-Planner (part of Fleet Operations Solution by Wärtsilä) tells us to do with the recommendations coming from weather routing provider. Navi-Planner Weather Optimization [AIR] saves around 22 tons of fuel”.*

## Fresh Water Generation



### ■ ■ 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  $\leq 4$  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



## Fresh Water Generation

### ■ Reverse Osmosis

Reverse Osmosis (RO) is a water purification technology that uses a semi-permeable membrane to remove salts and ions from seawater to provide fresh water. Customers are now able to source both RO and Evaporator systems from the same supplier, while the two technologies can be combined into a Wärtsilä developed Smart Fresh Water Generation System to secure a cost-effective and fully automatic solution.

The Wärtsilä RO systems deliver between 10 and 1500 tons per day of fresh water. It features a modular and flexible design, and is customised to meet the operational and space requirements of the vessel. The system is applicable to virtually all vessel types.



### Characteristics:

- Capacity 40–1500 t/d
- Single and two pass design
- Steady production of fresh water at a wide sea water temperature range between 0–32°C
- Full-automatic or semi-automatic operation
- Standard automation: Siemens S7-1500
- Easy connection to the Ship Automation and Control System
- UV sterilizers after prefiltration to extend membrane life

### Advantages:

- Low energy consumption
- Easy operation and maintenance
- Flexible design according to the requirements and space
- Different materials can be selected for components and piping
- Modular design for retrofit projects and limited space
- Suppliers of critical components can be selected (membranes, high pressure pumps, energy recovering devices, automation)

## Fresh Water Generation

- All proven suppliers from Western Europe and US
- Support at design and installation stages
- Less chemical consumption

### ■ The Wärtsilä HiTE

The Wärtsilä HiTE is a multi-stage evaporator specifically designed for small to medium capacities of 30 to 150 tons per day. Previously, significant design compromises were needed in order to handle such capacities. The HiTE is designed to function in a wide range of operational areas, i.e. shallow waters with poor seawater quality, where alternative technologies, like the reverse osmosis or plate technology reach their limits. Thanks to the multi stage design the HiTE has a specific heat consumption as low as 185–240 kWh/t which represents a saving of 75% compared to single stage evaporators.

#### Characteristics

- Capacity 30–150 t/d
- Steady production of fresh water at a wide temperature range between 0–32°C
- Flexible in using heat sources with either steam, engine jacket water or a combination of these two
- Full-automatic or semi-automatic operation
- Multi-stage design

#### Advantages

- Lowest energy consumption in its range due to the multi-stage design
- Designed to make maintenance easy for longer operation
- Unique process optimizing efficiency and dependability
- Part-load capability
- High quality distillate  $\leq 5$  ppm



## Fuel Gas Supply Systems

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 LNGPac™

Wärtsilä LNGPac™ is a complete fuel gas handling system for LNG-fuelled ships consisting 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, including WinGD and other engines' makers.

#### **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



## Fuel Gas Supply Systems

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.

### 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.

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 fuel pump. With single-shell tanks the LNG pump is assembled with either a deep-well or a submerged 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.

## Fuel Gas Supply Systems

### Maintenance oriented design

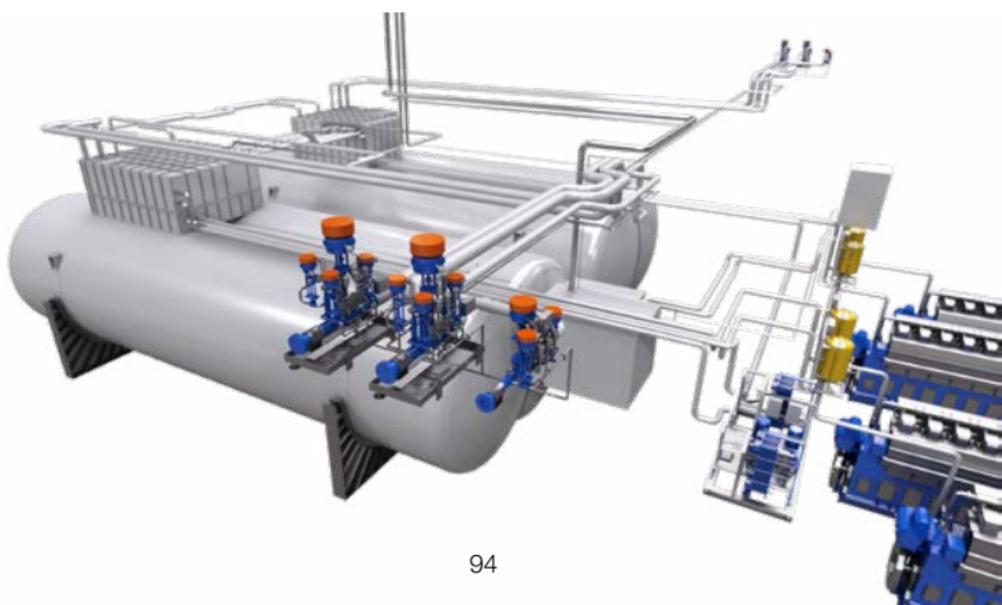
LNGPac™ design focuses on enabling safe service and maintenance of all core equipment related to the operational functionality of LNG bunkering and gas consumption without any need for emptying the tank.

IMO C-type LNG-tank	Double-wall tank	Single-wall tank	
LNG Volume	25 – 500 cbm	300 – 5000 cbm	500 – 5000 cbm
Dmax ( $2 < L/D < 7$ )	6.5 m	10 m	10m
Design pressure	4 – 9 barg	4 – 7 barg	4 – 7 barg
Insulation	Vacuum	PUR	PUR
Tank type	Single-lobe	Single-/Bi-lobe	Multi-lobe
Positioning	Horizontal or Vertical, Top- or Below-deck		
Secondary barrier		Not required	
Bunkering capacity (DN 50-200)		40 – 1000 cbm/h	

### 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.



## Inert Gas Systems

### ■ 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 off shore 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<sub>x</sub> and NO<sub>x</sub> 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 designed based on compact modules, offering important savings in space and installation cost for newbuild and retrofit vessels.



## Inert Gas Systems

When discharging crude oil or less refined petroleum products, our Multi-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 ship's 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 cleaning and cleaning: venturi scrubbing, wet filter and spray section
- Concentric arrangement independent of ship's pitching and rolling
- Internally coated with GRE and venturi tube in corrosion and heat resistant steel



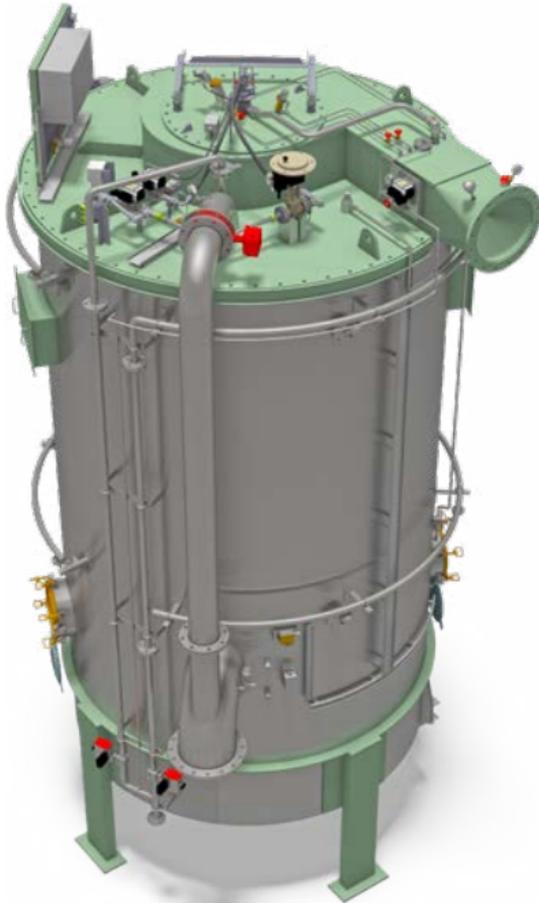
## Inert Gas Systems

### ■ 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.



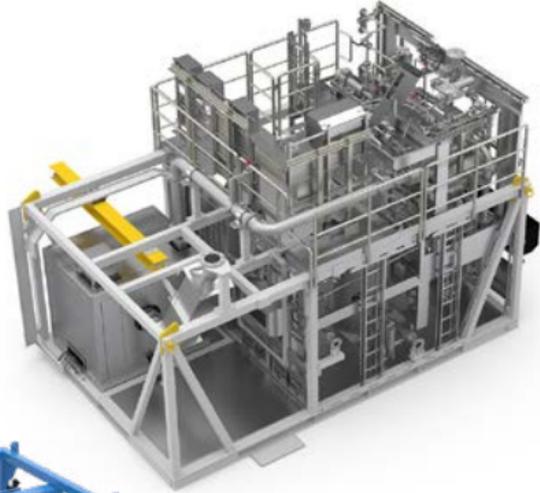
## Inert Gas Systems

### ■ 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.



Offshore Inert Gas Package skid solution for FPSO

## Cargo Handling Systems

### ■ 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<sup>3</sup>.



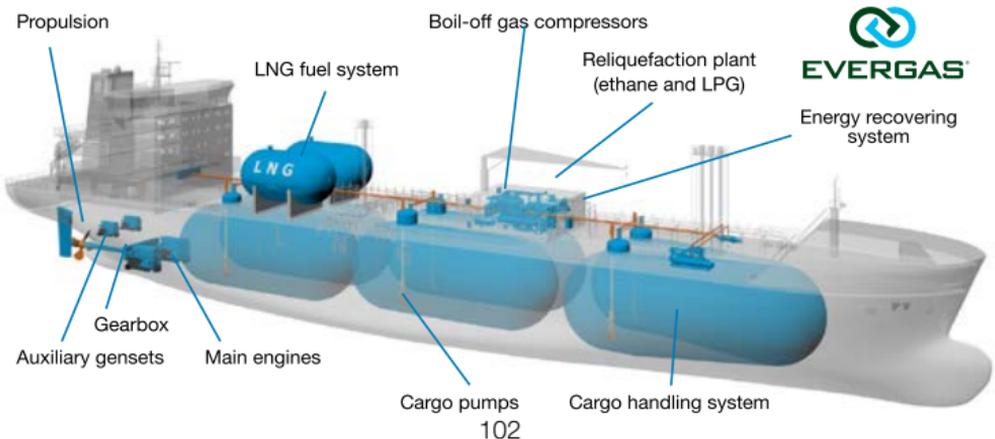


### ■ Wärtsilä Cargo Handling System for Ethylene/Multi Gas Carriers

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.



## Cargo Handling Systems

### ■ Wärtsilä Cargo Handling System for Semi-refrigerated Gas Carriers

The semi-refrigerated segment covers the range from 4000 m<sup>3</sup> to 30,000 m<sup>3</sup>. 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<sup>3</sup> to 13,000 m<sup>3</sup>. 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.

## 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 168-173.

## VOC 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.



## Regasification

### ■ Wärtsilä LNG Regasification

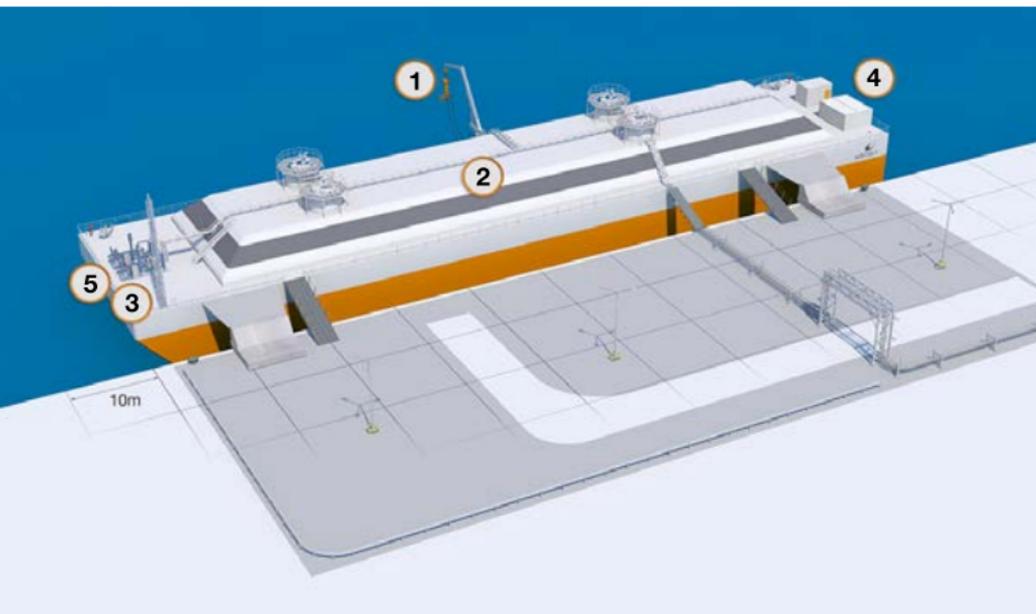
Our portfolio of LNG regasification technologies represents an industry benchmark in terms of energy efficiency, robustness, and operational flexibility.

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 sea water 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.



## Regasification



FSRB with a 15,000 m<sup>3</sup> LNG storage

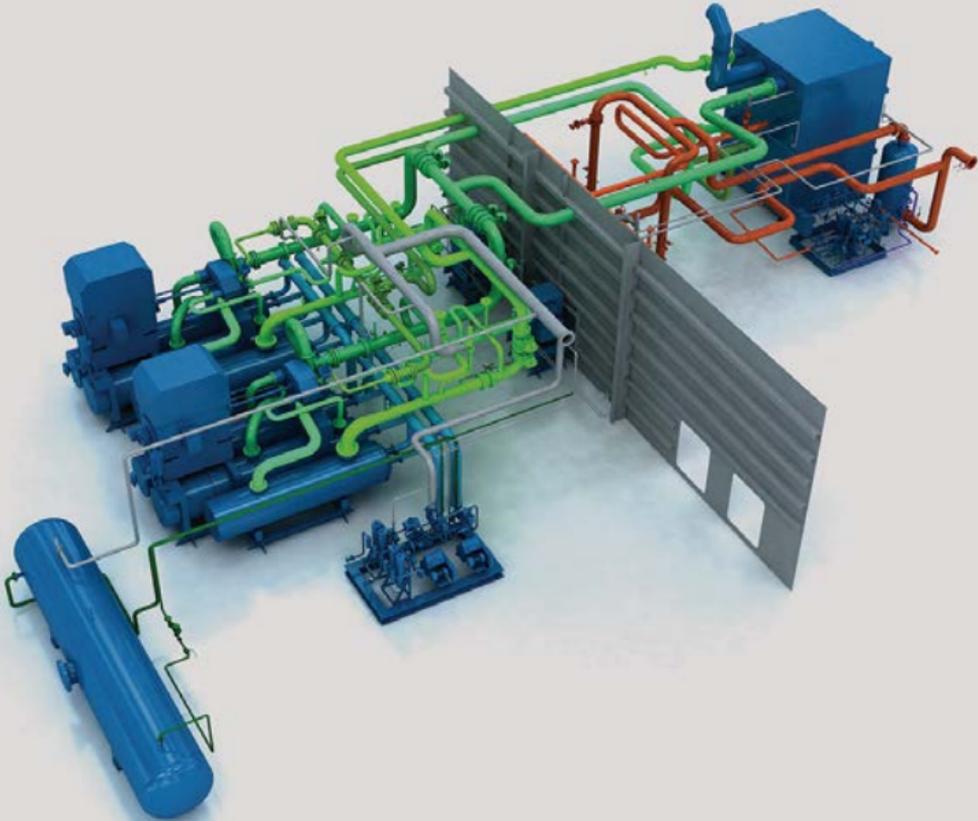
### ■ Floating Storage and Regasification Barges (FSRBs)

The smallest FSRUs today are around 120,000 m<sup>3</sup>. 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 m<sup>3</sup>) 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.

## Liquefaction and BOG Reliquefaction



### ■ 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.

## Liquefaction and BOG Reliquefaction

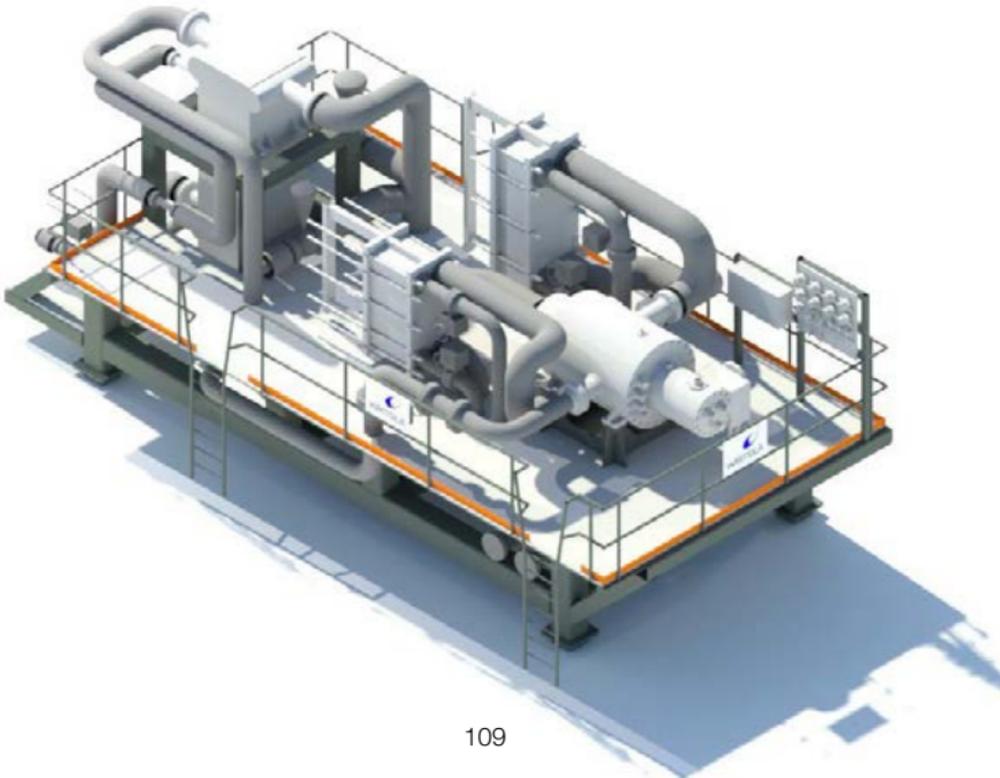
### ■ Compact Reliq

Wärtsilä has been a pioneer in BOG reliquefaction and the Compact Reliq is a continuation of our strong development activities in this field. As the global market for LNG applications expands, greater flexibility in meeting these growing needs is required.

As with previously delivered Wärtsilä reliquefaction systems, the Compact Reliq is based on well-proven Brayton technology. This allows a portion of the BOG to be utilised as fuel for the vessel, while the excess can be liquefied and sold with the LNG cargo.

The system is designed to reliquefy boil-off gas (BOG) or vapor return onboard gas carriers and LNG bunker vessels, and for keeping the cargo cool so as to extend its holding time without the use of refrigerants. Its compact design enables it to be installed on existing vessels without extensive modification work.

The system is prepared in line with Wärtsilä's Smart Marine approach to take advantage of the latest digital technologies to optimise efficiency. It is ready instrumented for remote monitoring and online operational support, and requires minimal maintenance between 5-year interval docking. The Compact Reliq is compatible with Wärtsilä's Operational Performance Improvement and Monitoring (OPERIM) protocol, and can be fully integrated with the ship's Planned Maintenance System (PMS).



## Liquefaction and BOG Reliquefaction

### ■ 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.



The Kollsnes II plant located near Bergen, Norway features a complete LNG plant including a total gas cleaning system.

## Biogas 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 CO<sub>2</sub> 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 in to the gas grid, compressed to produce bioCNG or liquefied for bioLNG. It's also possible to capture the CO<sub>2</sub> from the plant and use this for commercial purposes.

## Biogas Solutions

### ■ Biogas Liquefaction

#### MIXED REFRIGERANT (MR) PROCESS – THE PERFECT SOLUTION FOR BIOGAS LIQUEFACTION

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 m<sup>2</sup>
- 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.



The biogas liquefaction plant was delivered to the municipality of Oslo. For this plant, Wärtsilä also delivered a molecular-sieve absorption system for CO<sub>2</sub> cleaning stage.

## Tank Control Systems

### ■ Wartsilä Tank Control Systems for Whessoe Products

If your product is LNG, LPG or ammonia, Wartsilä 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

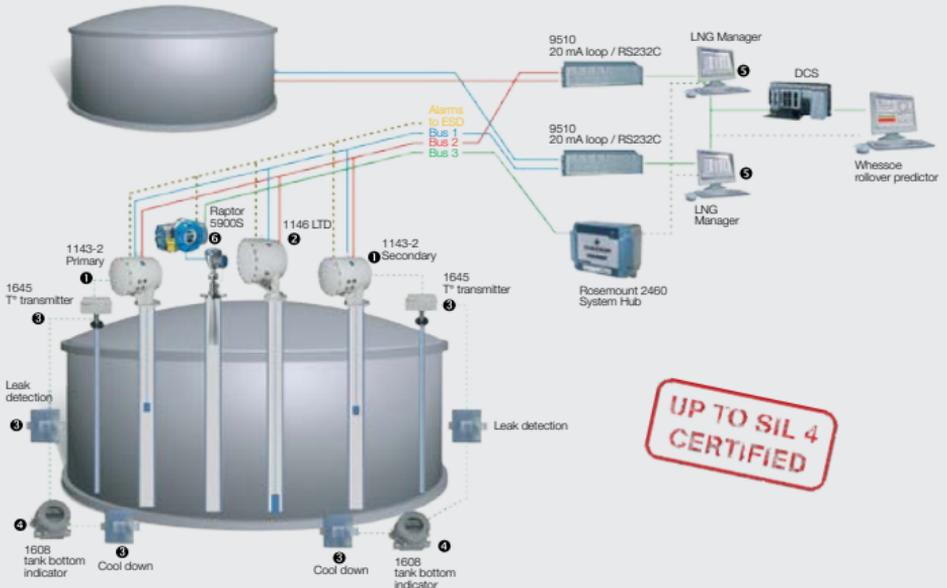
- World leaders in LNG marine gauging, more than 320 vessels supplied worldwide
- FLIV isolation valves.

### Product and chemical carriers

- LPG level gauging
- Alarm systems
- Supervisory control and data acquisition system.



## Tank Control Systems



## ■ 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.

## Tank Control Systems



### ■ 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.

## 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 Wärtsilä 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.

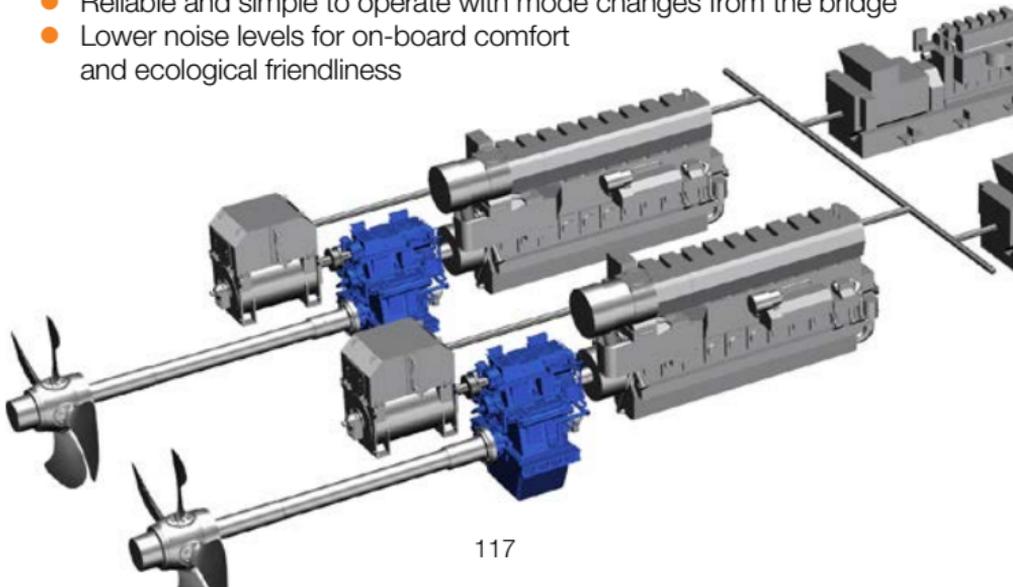
The key feature of the 2-speed gearbox is the possibility to reduce the propeller speed while the speed of the vessel remains constant in operating conditions where vessel speed is below maximum. This results in fuel savings of up to 15% when compared to a single speed mechanical propulsion system. At the same time, nitrogen oxide (NO<sub>x</sub>) and sulphur oxide (SO<sub>x</sub>) 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

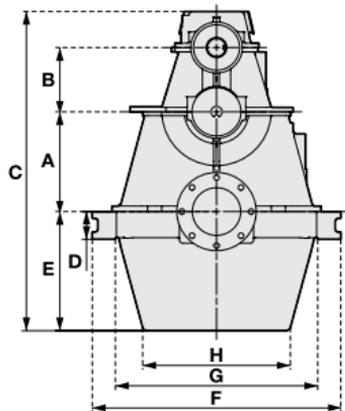
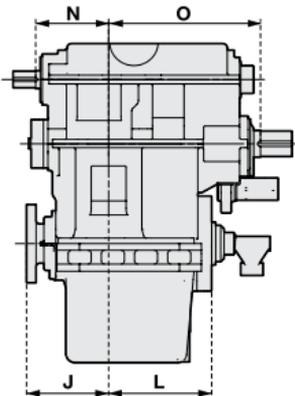


## Single Input Gears

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

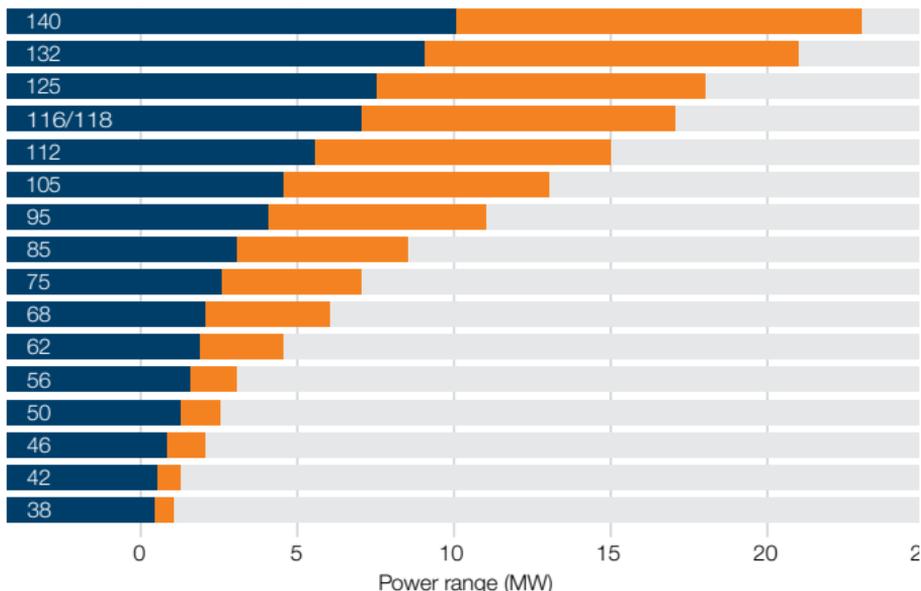
Gear type/size	A	B Std-Max	C	D	E	F	G	H	J	L	N	O SCV/SV	Weight tonnes*
SCV38	380	290	1305	115	465	1000	750	530	340	538	230	650	2.1
SCV42	420	320	1435	125	510	1500	830	585	530	558	255	715	2.7
SCV46	460	350	1570	140	560	1580	910	640	570	595	280	785	3.4
SCV50	500	380	1724	150	590	1340	1024	720	470	592	420	1035	4.2
SCV56	560	410	1848	160	645	1500	1110	800	530	650	450	1100	6.0
SCV62	620	440-470	2210	180	740	1580	1240	880	570	662	350	1150	7.0
SCV68	680	460-510	2370	200	800	1720	1360	960	625	720	370	1250	8.0
SCV75	750	480-530	2460	220	880	1850	1480	1040	660	800	450	1300/1095	10.0
SCV85	850	510-560	2720	250	1000	2100	1680	1178	730	915	550	1470/1220	13.0
SCV95	950	580-630	3025	280	1145	2350	1880	1327	800	1025	450	1640/1350	19.5
SCV105	1050	600	3328	250	1125	2628	2192	1668	1410	624	618	970	24.0
SV112	1120	600	3550	260	1198	2804	2272	1772	1500	660	615	800	24.0
SCV112	1120	700	3650	260	1198	2804	2272	1772	1500	660	595	1800	29.0
SV118	1180	600	3610	300	1190	2824	2268	1758	1520	716	615	827	30.0
SCV118	1180	700	3710	300	1190	2824	2268	1758	1520	716	595	1800	32.0
SV125	1250	600	3805	300	1325	1954	2396	1888	1600	808	615	860	31.0
SCV125	1250	700	3905	300	1325	1954	2396	1888	1600	808	595	1950	36.5
SV132	1320	600	3940	300	1390	3084	2516	2018	1630	850	615	875	34.0
SCV132	1320	700	4040	300	1390	3084	2516	2018	1630	850	610	2020	39.0
SV140	1400	600	4250	350	1500	3250	2600	2150	1700	900	720	920	40.0
SCV140	1400	700	4350	350	1500	3250	2600	2150	1700	900	680	2200	44.0

\* Not binding



## Single Input Gears

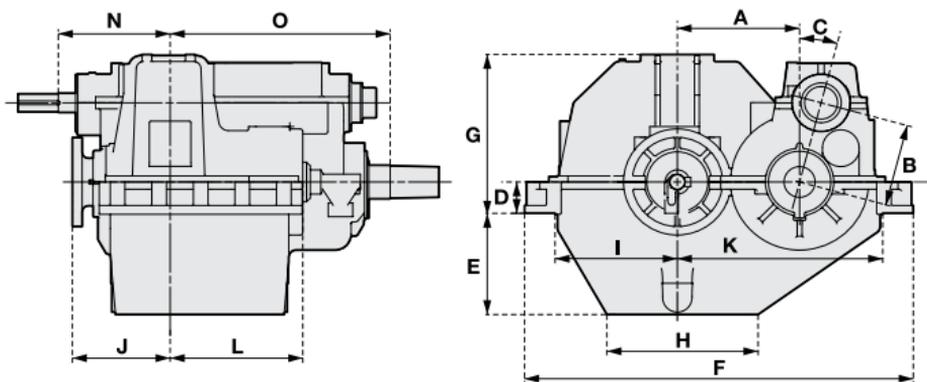
### Single input gears, power range



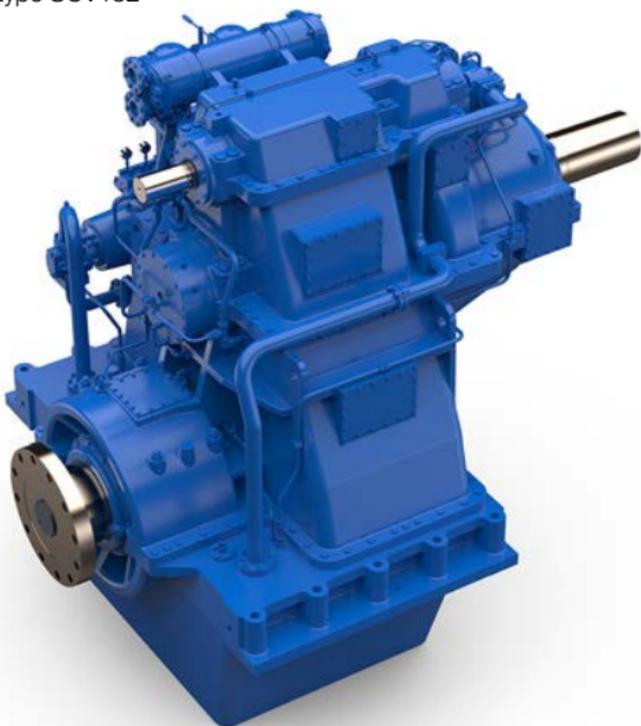
### Single input gears, horizontal offset, dimensions (mm)

Gear type/size	A	B	C	D	E	F	G	H	I	J	K	L	N	O SCH/SH	Weight tonnes*
SCH68	680	510	0	100	700	2000	840	650	515	570	1095	730	500	1245	8.0
SCH75	750	530	15	280	885	2230	1220	865	735	660	1115	800	515	1670	11.5
SCH85	850	580	15	320	1000	2495	1440	970	830	730	1245	915	550	1800	15.0
SCH95	950	580	15	450	750	2710	1520	2250	830	1215	1420	540	700	1640	20.0
SCH105	1050	630	20	500	771	2995	1658	2195	910	1405	1545	560	750	1700/1510	30.0
SCH116	1160	670	20	550	850	3300	2240	2500	1015	1435	1715	725	830	1100/1800	40.0

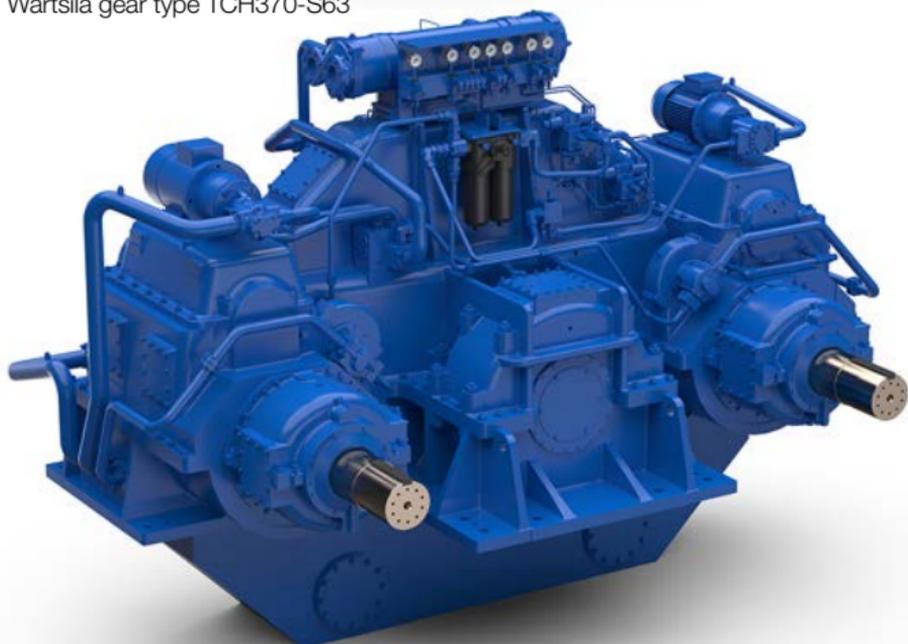
\* Not binding



Wärtsilä gear type SCV132



Wärtsilä gear type TCH370-S63



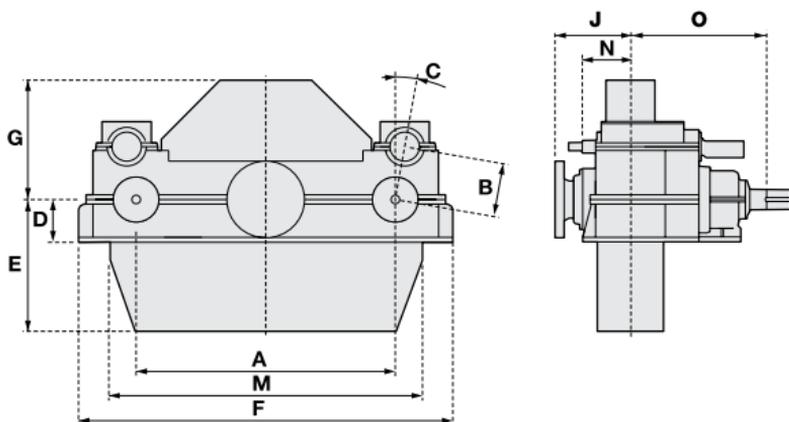
## Double Input Gears

### Double input gears, dimensions (mm)

Gear type/size	A	B	C	D	E	F	G	J	M	N	O	Weight tonnes*
TCH190	1900	460	10	320	980	2750	890	555	2300	360	995	15.0
TCH240	2400	490	20	450	1315	3580	1455	730	3135	570	1220	20.0
TCH250	2500	530	12.5	450	1400	3700	1150	800	3230	570	1290	28.0
TCH270	2700	580	10	500	1330	3900	1690	880	3410	600	1560	28.0
TCH350	3500	580	10	700	1855	5370	1630	1270	4380	790	2140	50.0
TCH370	3700	630	10	700	1855	5565	1645	1270	4580	880	2140	60.0
TCH380	3800	630	0	700	1700	5600	2000	1270	4700	900	220	55.0

\* Not binding

TCH type



### Double input gears vs Wärtsilä engines

Gear type	Engine offset (mm)	Engine type
TCH190	1900	W20
TCH240	2400	Electric motors
TCH250	2500	W26 (L-version)
TCH270	2700	W32 (L-version) and W34DF (L-version)
TCH350	3500	W12V32, W6L46F, W6L50DF
TCH370	3700	W16V32, W18V32, W8L46F, W9L46F, W8L50DF, W9L50DF, W12V34DF, W16V34DF, W46DF (L-version)
TCH380	3800	W8V31, W10V31

## 2-speed Gears

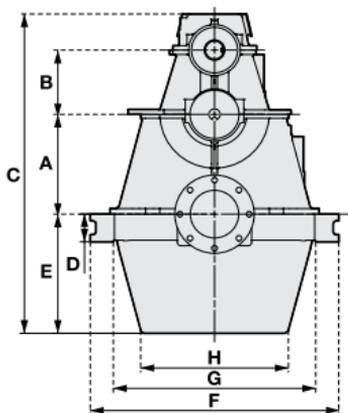
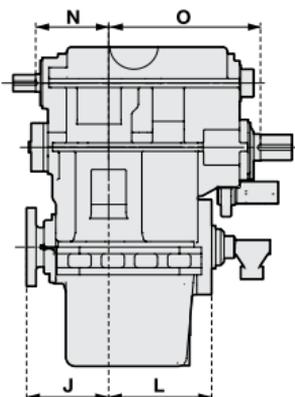
### 2-speed gears, vertical offset, dimensions (mm)

Gear type/ size	A	B	C	D	E	F	G	H	J	L	N	O	Weight tonnes
SCV80/2-P54	800	540	2680	220	880	1960	1580	1150	660	800	580	1325	14.0
SCV90/2-P58	900	580	2760	250	1075	2210	1800	1300	730	915	650	1350	17.0
SCV100/2-P68	1000	680	3350	260	1100	2500	2000	1470	800	1036	915	1800	24.0
SCV112/2-P68	1120	680	3500	260	1200	2805	2320	1772	1500	665	900	1800	32.0
SCV118/2-P68	1180	700	3700	300	1200	2800	2320	1750	1520	715	1050	1800	35.0

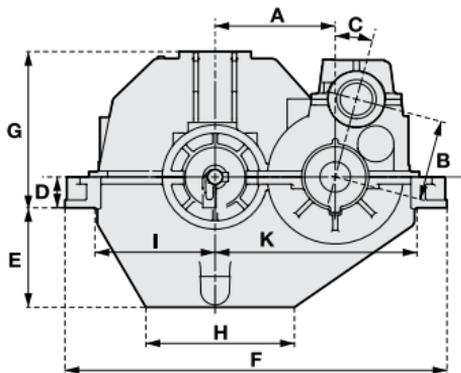
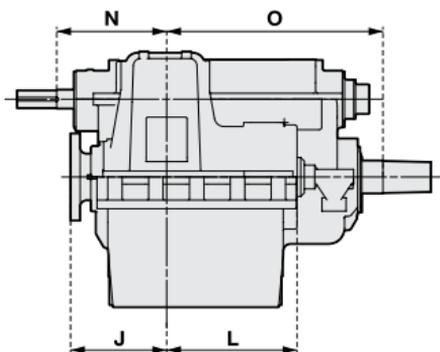
### 2-speed gears, horizontal offset, dimensions (mm)

Gear type/ size	A	B	C	D	E	F	G	H	J	L	N	O	Weight tonnes
SCH80/2-P54	800	540	15	220	700	2450	1050	950	660	800	580	1325	15.0
SCH90/2-P58	900	580	15	260	820	3000	1160	1130	730	985	650	1350	18.0
SCH100/2-P68	1000	680	15	260	840	3180	1870	1240	800	1036	915	1800	25.0
SCH112/2-P70	1120	680	15	260	950	3200	1950	1400	665	1500	1735	965	30.0
SCH118/2-P70	1180	700	15	300	1000	3500	1650	2000	1520	715	1050	1800	37.0

#### Vertical offset

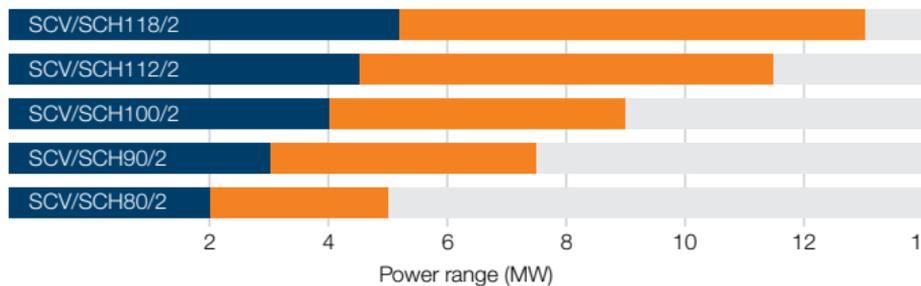


#### Horizontal offset



## 2-speed Gears

### 2-speed gears, power range



Wärtsilä gear type SCV90/2-PDC58



## WCP Propeller Systems

### ■ **Wärtsilä Controllable Pitch Propeller Systems**

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

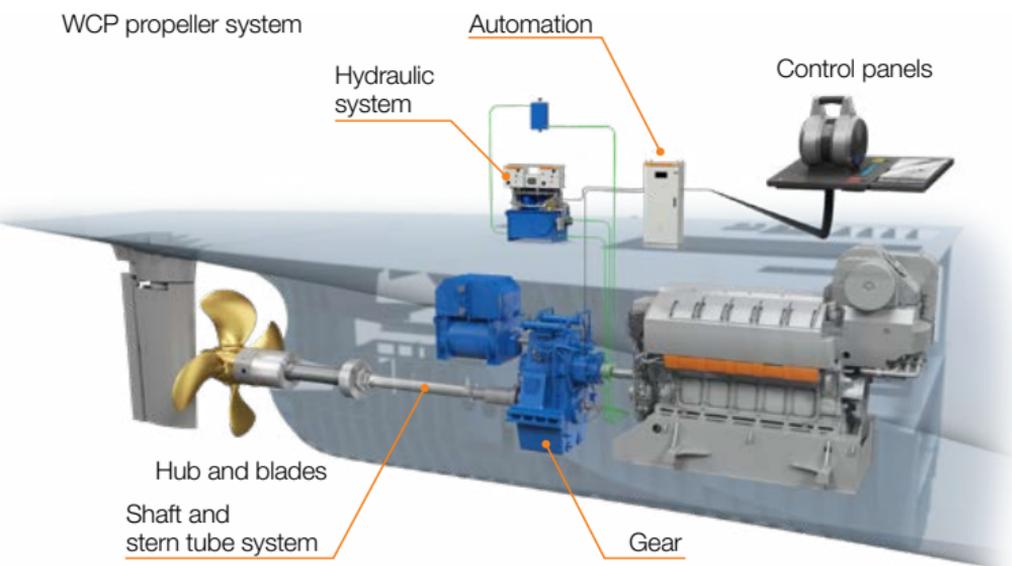
Power range starting from 500 kW, no upper limit

- 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

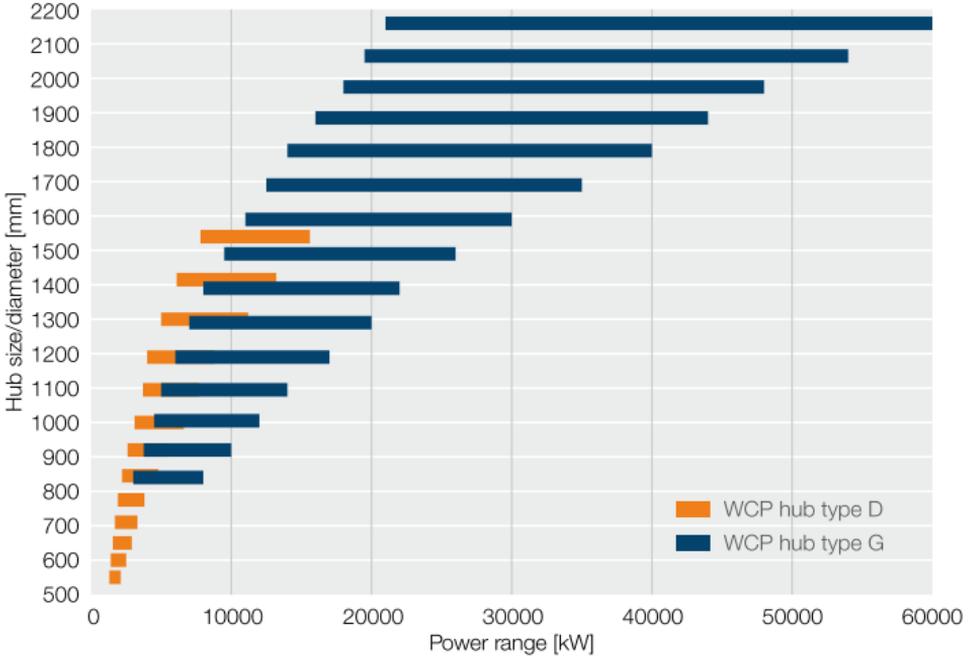
- US EPA Vessel General Permit 2013 compliance
- Zero pollution sterntube
- Under water replacement of propeller blades
- Trailing propellers or full blade feathering
- Navy/research/fishing requirements for low noise signature
- EnergoPac rudder or EnergoProFin hub cap for increased efficiency
- Continuous oil monitoring for increased reliability
- Wärtsilä High Performance (HP) Nozzle
- Shaft withdrawal interval reduction
- Cruise control and fuel savings with EcoControl functionality.

WCP propeller system



## WCP Propeller Systems

**Power range for Wärtsilä standard 4 bladed bronze hubs, without ice class notation**



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.

WCP hub type D



WCP hub type G



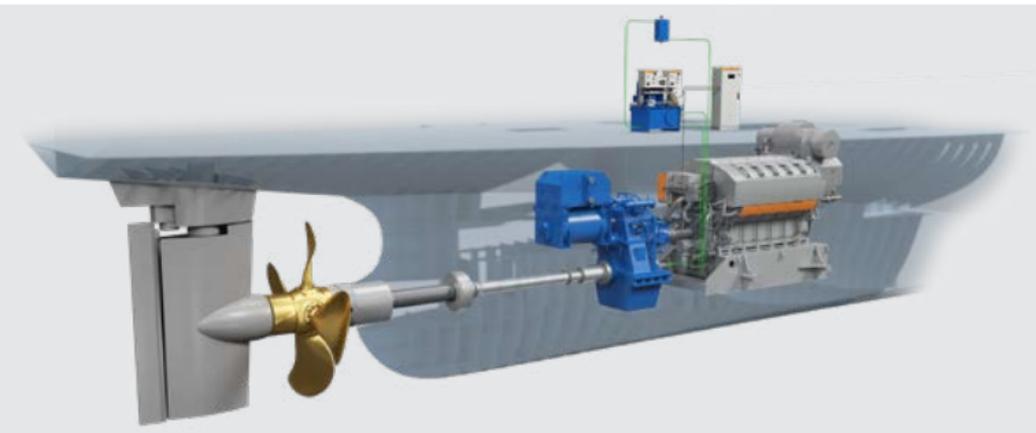
## WCP Propeller Systems

### ■ 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.

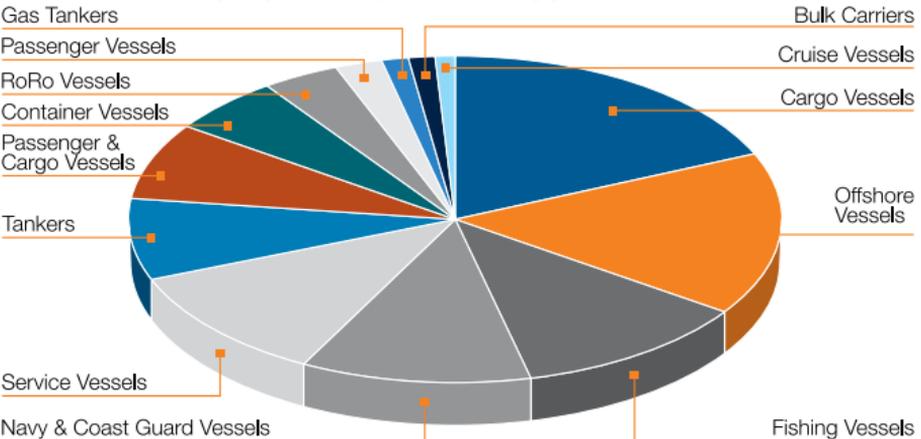
The benefits of integrated packages comprising a WCP system include:

- 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



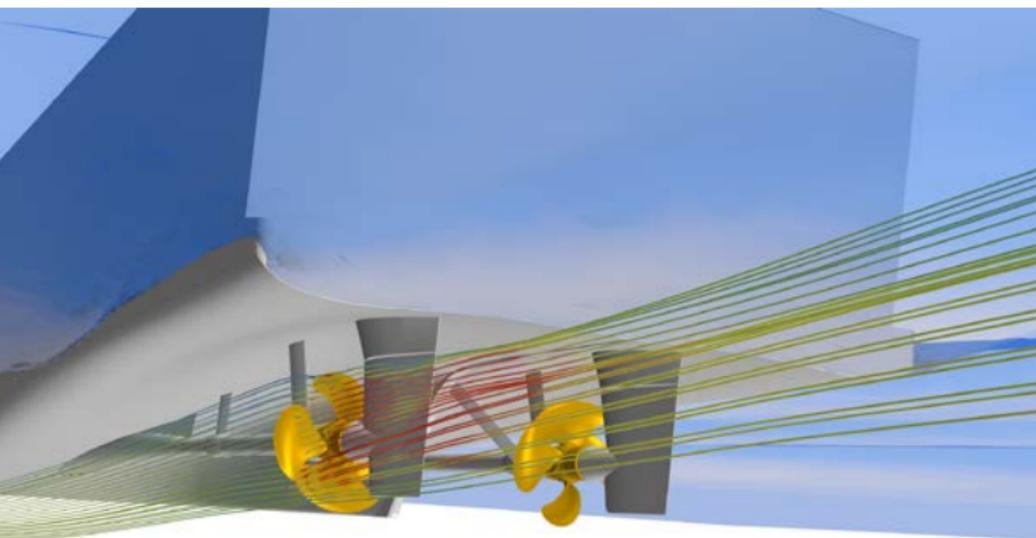
## WCP Propeller Systems

### ■ 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 95 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.



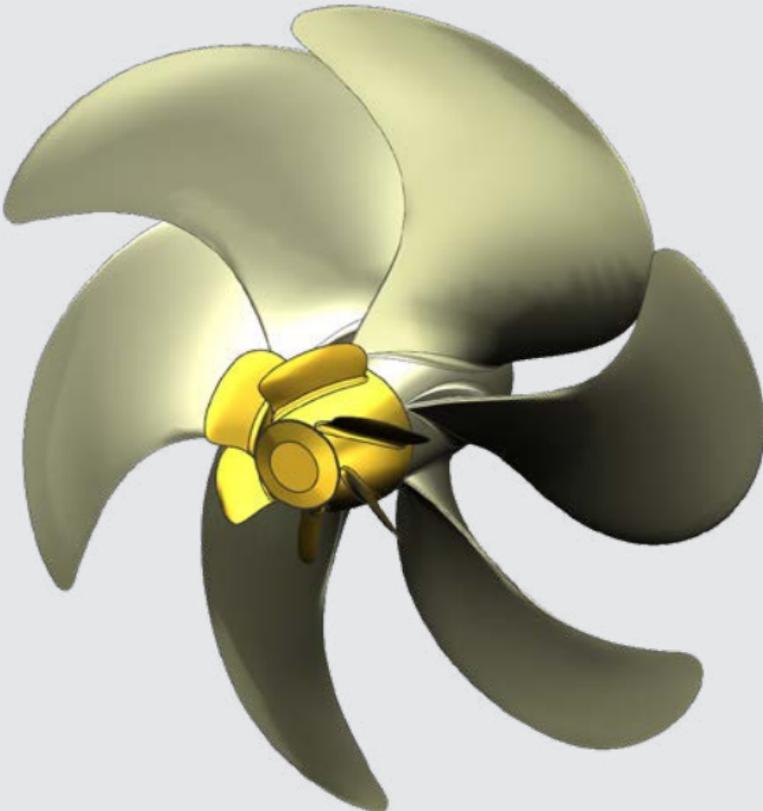
## Fixed Pitch Propellers

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.



## Fixed Pitch Propellers

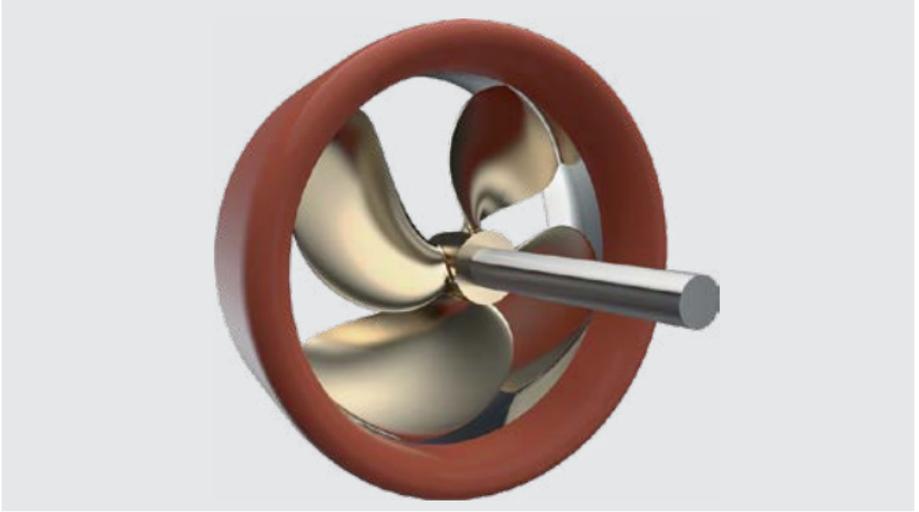


### ■ Coastal and Inland Waterway Propellers

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.

## Nozzles and Rudders



### ■ Wärtsilä High Performance Nozzle

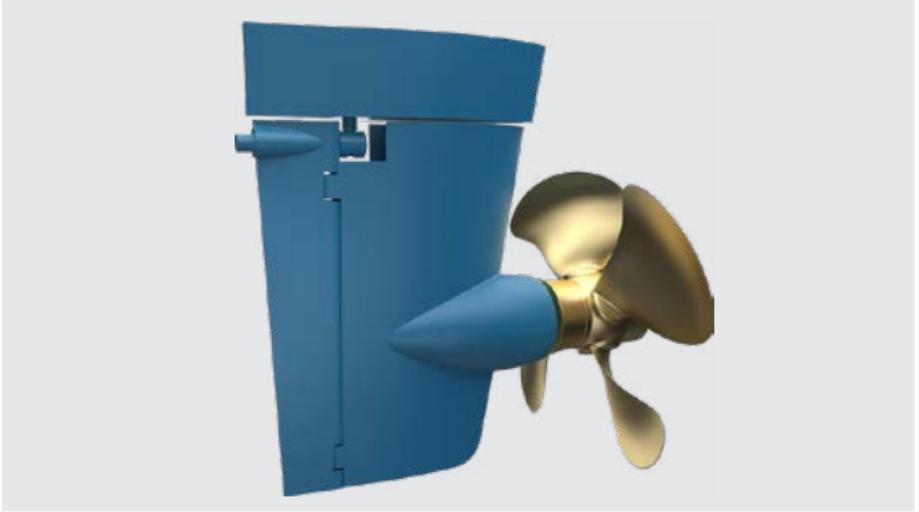
Fitting a nozzle increases the thrust at relatively low ship speeds. This allows for significant savings to be achieved in terms of fuel consumption, depending on the number of revolutions and the capacity of the engine. The improved Wärtsilä High Performance nozzle, the type HP nozzle, when combined 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.

## Nozzles and Rudders



### **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.

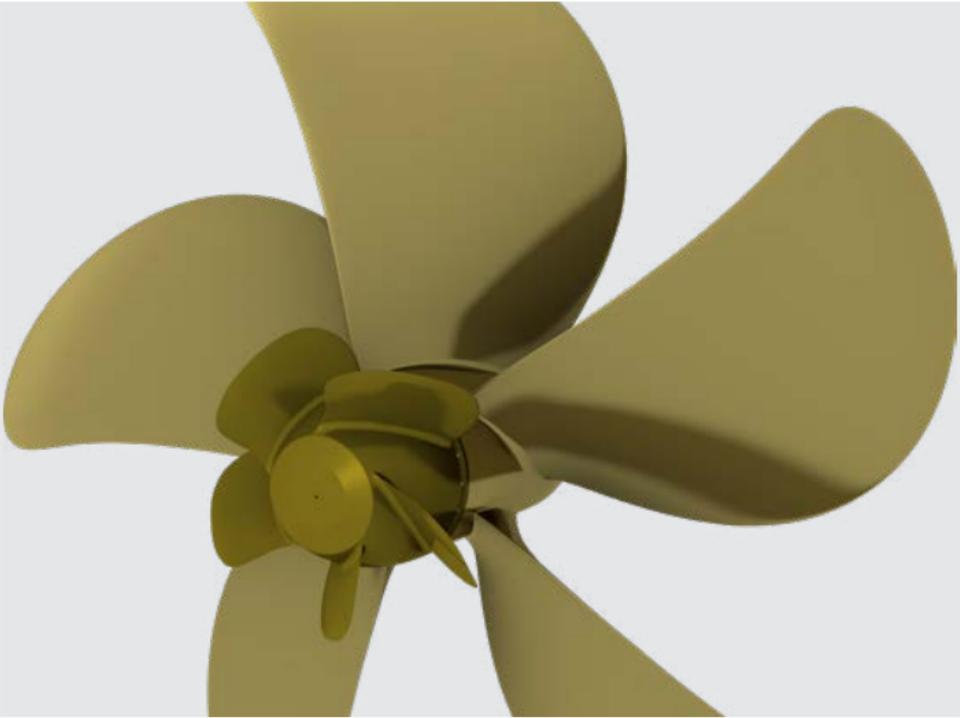
### **Typical applications**

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.

## Energy Saving Devices



### ■ EnergoProFin

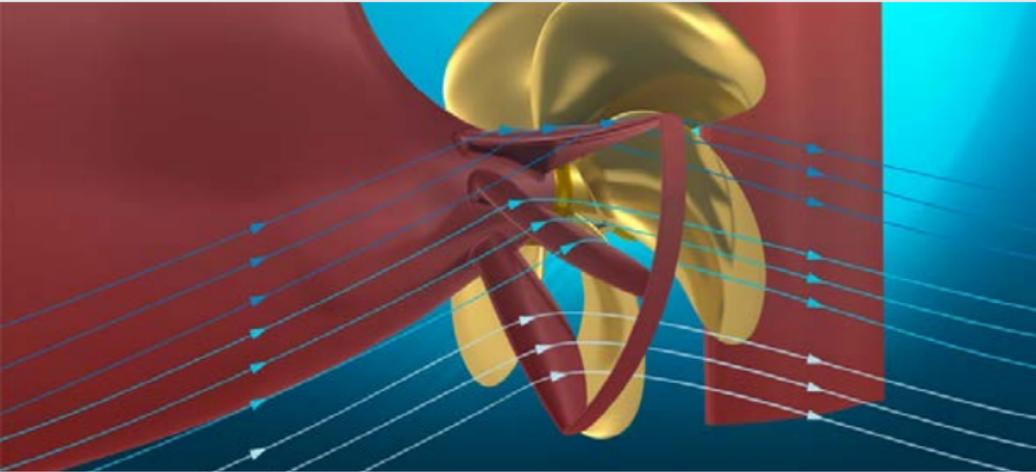
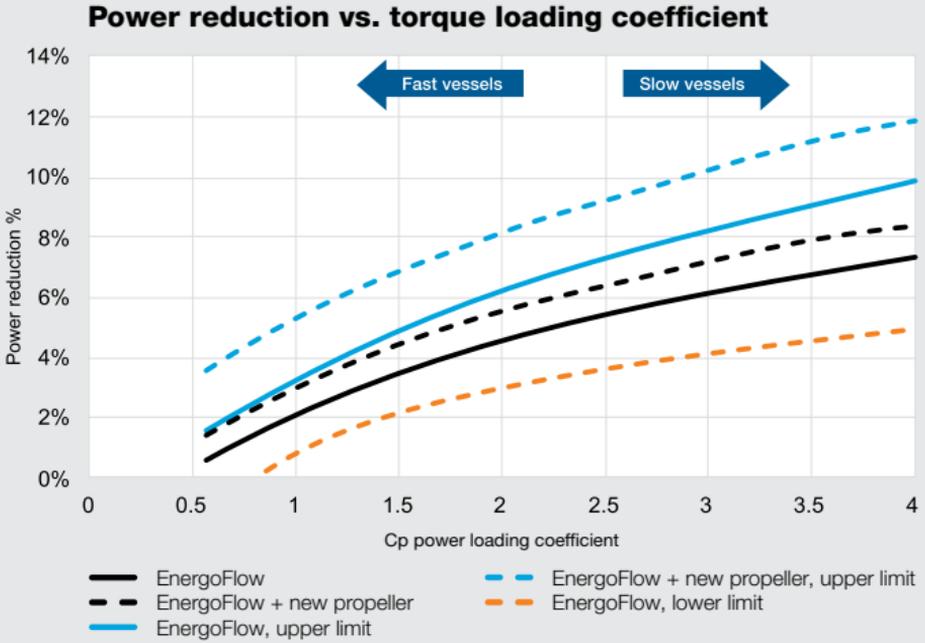
The Wärtsilä EnergoProFin is an energy saving propeller cap with fins that rotate together with the propeller. It improves propulsive efficiency by weakening the hub vortex, and by recovering kinetic energy from the rotating flow aft of the propeller blades. This solution provides average fuel savings 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,

## Energy Saving Devices



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.

## Steerable Thrusters

### ■ ■ **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.

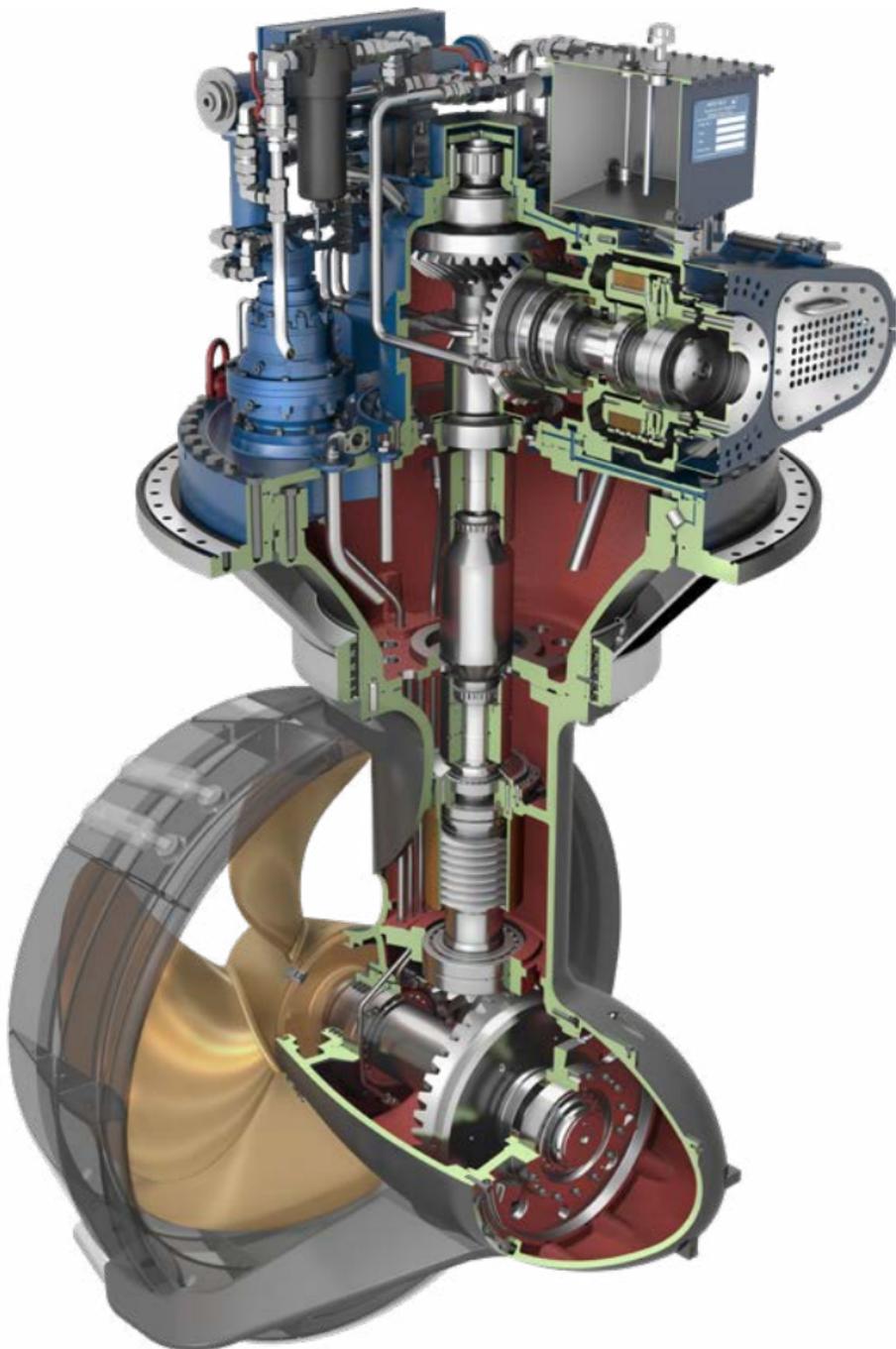
#### **Wärtsilä Underwater Mountable Thrusters**

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

### Wärtsilä Steerable Thrusters

Thruster type	Engine power <sup>(2)</sup> (kW)	Input speed (rpm)	Propeller diameter (mm)	Bollard pull <sup>(1)</sup> (tonnes)	
WST-11	900	750	1600	30	
	1050		1800	36	
WST-14	1150		1800	39	
	1275		1900	43	
	1400		2000	47	
WST-16	1400		900	2000	47
	1600		1000	2200	55
	1700		1200	2200	57
WST-18	1800		1600	2400	63
	1800		1800	2400	69
WST-21	2050		1000	2400	73
	2100			2600	80
WST-24	2400	2600		84	
	2400	2800		94	
WST-28	2800	750		2800	97
	2800	1000		3000	107
WST-32	3200	1200		3000	111
	3200			3200	

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

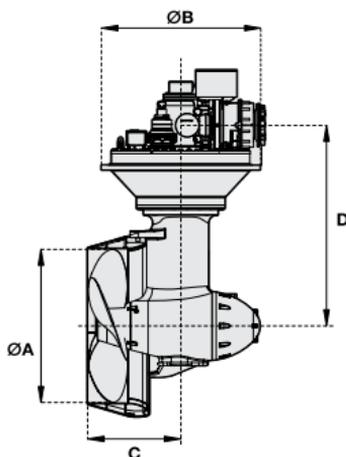
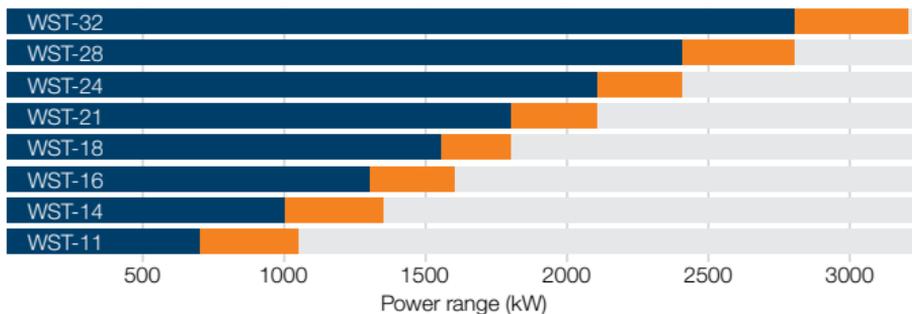
- Superior hydrodynamic performance for high bollard pull or maximum propulsion efficiency.
- Compatible with high speed engines (up to 1800 rpm).
- Compact dimensions with a high level of integration.
- Reliable propeller shaft and steering seals with monitoring.
- Robust design for reliable operations.
- 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.

## Steerable Thrusters

### Wärtsilä Steerable Thrusters range



### Wärtsilä Steerable Thrusters dimensions (mm)

Thruster Type	Dimensions					Weight <sup>1</sup> [kg]
	A [mm]	Weld-in	Bolt-in	PAL options		
		ØB [mm] (well diameter [mm])		D [mm]		
WST-11	1600	1942	1948	2400	2700	10000/11800
	1800	(2000)	(2000)			
WST-14	1800	1942	1948	2500	2800	10900/12860
	1900					
	2000					
WST-16	2000	2342	2326	2800	3150	17050/20400
	2200	(2400)	(2400)			
WST-18	2200	2342	2326	2900	3250	18600/21950
	2400	(2400)	(2400)			
WST-21	2400	2542	2512	3200	3500	24800/27500
	2600	(2600)	(2600)			
WST-24	2600	2692	2660	3500	3800	28500/31500
	2800	(2750)	(2750)			
WST-28	2800	2862	2825	3900	4200	32800/36100
	3000	(2920)	(2920)			
WST-32	3000	3042	3000	4000	4500	37000/41000
	3200	(3100)	(3100)			

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

Type	Power (max.) [kW]	Input speed [rpm]	Propeller type	Propeller diameter (A) [mm]	Depth (B) [mm]	Width (C) [mm]	Retraction (F) [mm]	Layout	Height without E-motor (H1) [mm]	Overall height <sup>1</sup> (H2) [mm]	Weight <sup>2</sup> [kg]
LMT CS/FS175MNR	1000	1200	FP or CP	1700	2836	2900	2220	L-drive	6120	7700	20000
LMT CS/FS200MNR	1200	1200	FP or CP	1900	2865	3020	2400	L-drive	7490	8600	27750
LMT CS/FS225MNR	1600	1200	FP or CP	2100	3435	3590	2655	L-drive	7280	8950	31200
								Z-drive	–	7330	35000
LMT CS/FS250MNR	2000	900	FP or CP	2400	3710	3666	3000	L-drive	8100	10500	34750
								Z-drive	–	8115	39950
WST-24R	2400	900	FP	2600 / 2800	4090	4410	3580	L-drive	9750	11690	48500
		1200						Z-drive	–	9700	50500
LMT FS2510MNR	3500	720	FP	3000 / 3200	4900	4500	4105	L-drive	11300	14460	105000
		900						Z-drive	–	11570	110000
LMT FS3500MNR	4500	720	FP	3400 / 3600	5845	4770	4720	L-drive	14560	16750	132000
								Z-drive	–	14230	132000
WST-65RU	6500	600	FP	4200	5550	5980	7200	L-drive	16850	20100	212500

#### 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.

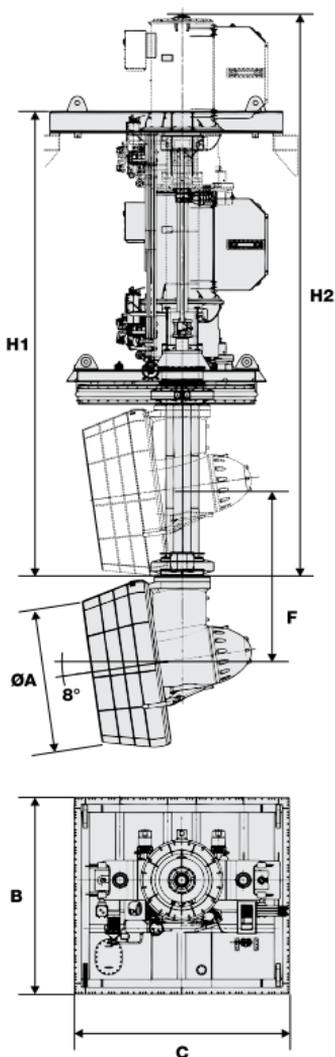
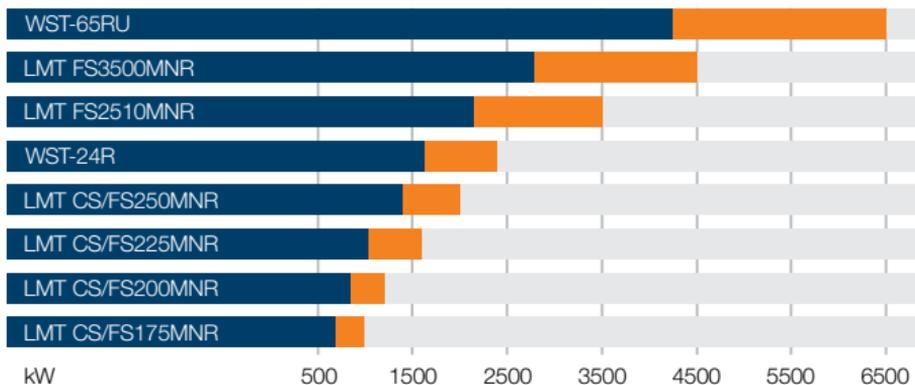
Dimensions and weights can vary depending on propeller type, propeller size and project specific customizations.

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



## 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° tilted propeller shaft or 3° 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				
Thruster type	Power <sup>(1)</sup> (kW)	Input speed (rpm)	Propeller diameter (mm)	Tilt
LMT FS1510NU	2435	720	2600	3° <sup>(2)</sup>
LMT FS2510NU	3500	539	3200	3° <sup>(2)</sup>
WST-45U	4000	720	3600	8°
	4500	600		
WST-55U	4500	720	3900	8°
	5500	600		
WST-65U	5500	720	4200	8°
	6500	600		

1) The power level is for dynamic positioning (DP) operation

2) Tilted nozzle

Dimensions (mm)										Weights (kg)		
Thruster type	A	B	C	D	E	F	G	H <sup>(1)</sup>	R	Outboard part <sup>(2)</sup>		Recept- acle <sup>(3)</sup>
										dry	in water	
LMT FS1510NU	2600	1936	1045	1642	1900	900	1188	1000	1350	19000	16920	2170
LMT FS2510NU	3000	2123	1266	1911	2220	900	1347	1000	1550	30000	26410	3055
		3200	2194	1266	1911	2220	900	1347	1000	1550	31800	27780
Thruster type	A	B	C	M	L	H				Outboard part <sup>(2)</sup>		Well <sup>(4)</sup>
										dry	in water	
WST-45U	3600	3300	2518	2324	2570	1242				51000	34500	9500
WST-55U	3900	3625	2648	2516	2763	1390				63500	41800	11900
WST-65U	4200	3820	3006	2719	3025	1390				77500	49500	13200

All weights and dimensions for 3° tilted nozzle (1510 through 2510 type) or 8° tilted propeller shaft (WST-45/55/65U type)

1) Options: 1200, 1600, 2000, 2400; project specific lengths on request

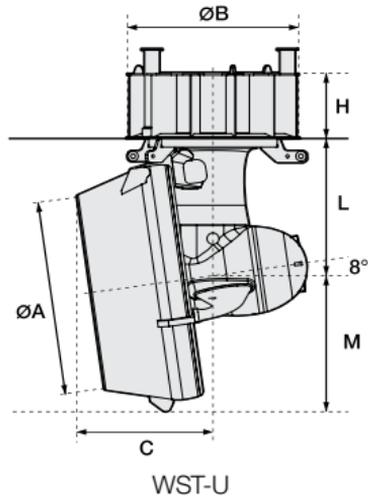
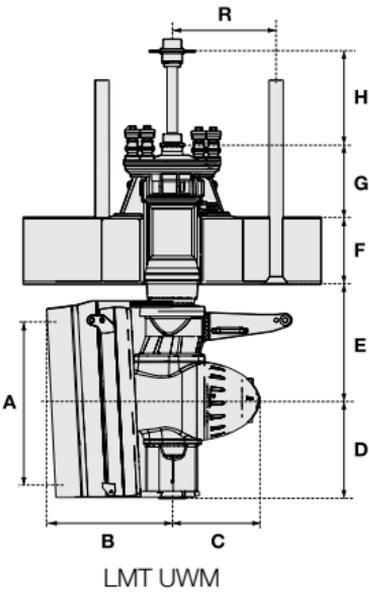
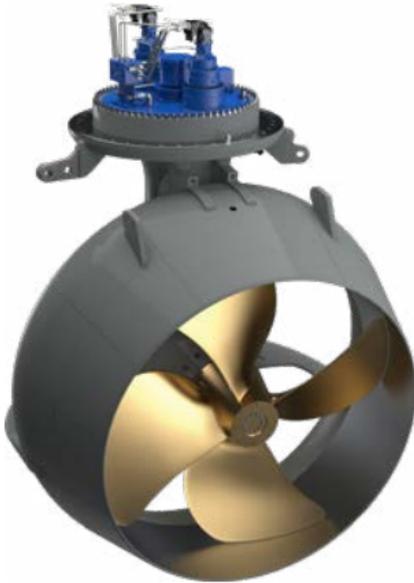
2) Indicative weight, with oil

3) Including pipe covers and valve

4) Including top cover, bottom cover, pipe covers, valves and position sensor

## Underwater Mountable Thrusters

### Wärtsilä Underwater Mountable Thrusters range



## 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

Thruster type	Maximum power <sup>1</sup>		Propeller diameter (D) (mm)	Length (L) (mm)	Weight <sup>2</sup>
	Manoeuvring AUX (kW)	Dynamic positioning (kW)			
CT/FT 125 H	614	603	1250	1550	3071
CT/FT 150 H	880	789	1500	1800	4544
WTT-11	1100	1000	1750	1970	6355
WTT-14	1450	1300	2000	2195	8707
WTT-16	1650	1475	2200	2115	10910
WTT-18	1850	1825	2200	2275	11986
WTT-21	2100	1825	2400	2275	12781
WTT-24	2400	2150	2600	2390	15063
WTT-28	2800	2400	2800	2970	21632
WTT-32	3300	2800	3000	3285	26338
WTT-36	3600	3200	3200	3350	31157
WTT-40	4000	3600	3400	3520	35834
WTT-45	4800	4050	3600	3660	40818
WTT-55 <sup>3</sup>	5500	5000	4000	4300	63677

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

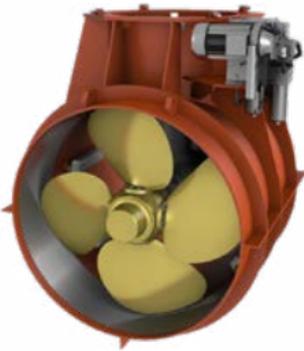
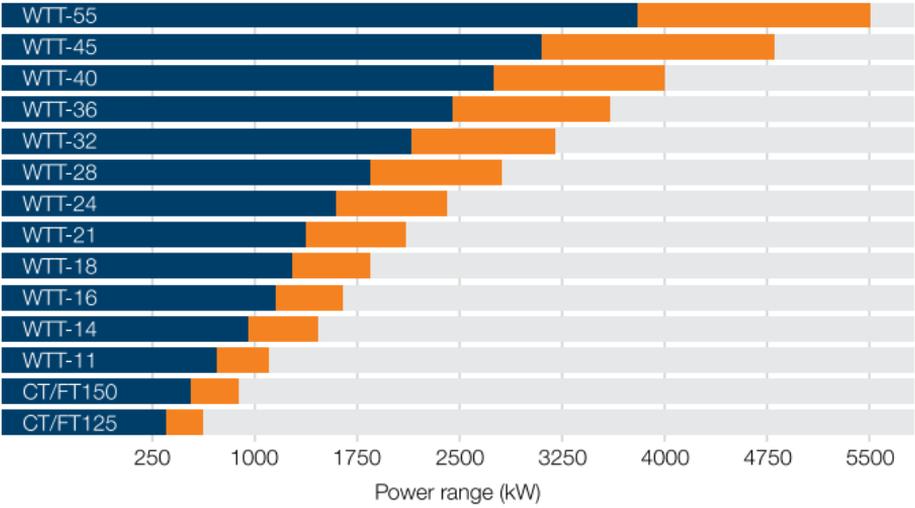
<sup>2</sup> Version with CP propeller including a standard tunnel with E-motor support, excluding E-motor.

<sup>3</sup> Available on request.

Values in italics are preliminary

## Transverse Thrusters

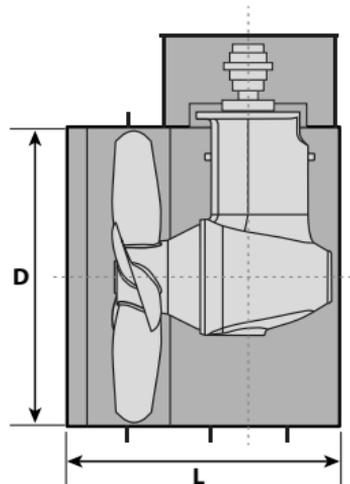
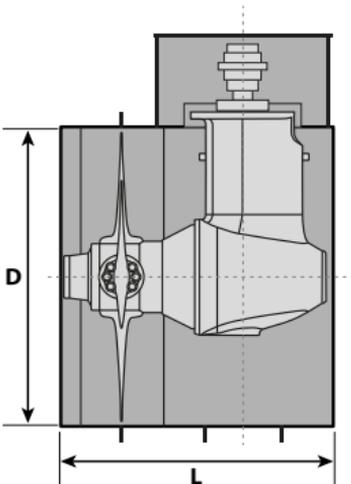
### Wärtsilä Transverse Thrusters range



WTT-11 CP



WTT-11 FP



## Waterjets



### ■ **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.

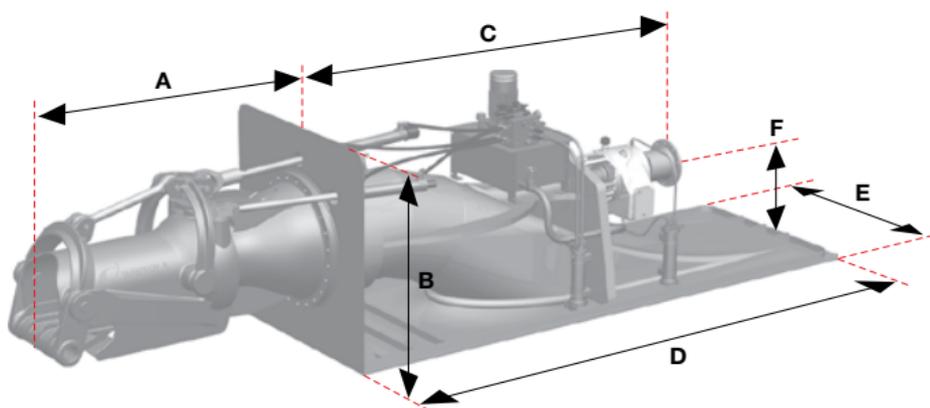
### **Key benefits**

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.

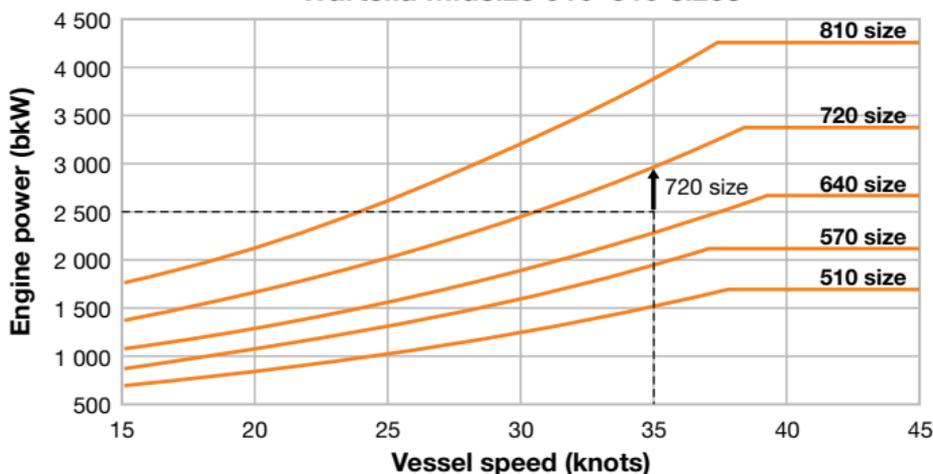
## Waterjets

Weight & dimensions table

Size	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	Weight steering (kg)	Weight booster (kg)	Entrained water (l)
510	1 540	1 065	2 350	2 975	1 100	510	1 400	1 050	450
570	1 730	1 190	2 520	3 325	1 200	570	1 750	1 300	600
640	1 930	1 335	2 720	3 735	1 400	640	2 400	1 800	850
720	2 170	1 500	3 000	4 200	1 400	720	2 850	2 250	1 250
810	2 440	1 690	3 220	4 725	1 400	810	3 600	3 000	1 750



Wärtsilä Midsize 510–810 sizes



## Waterjets

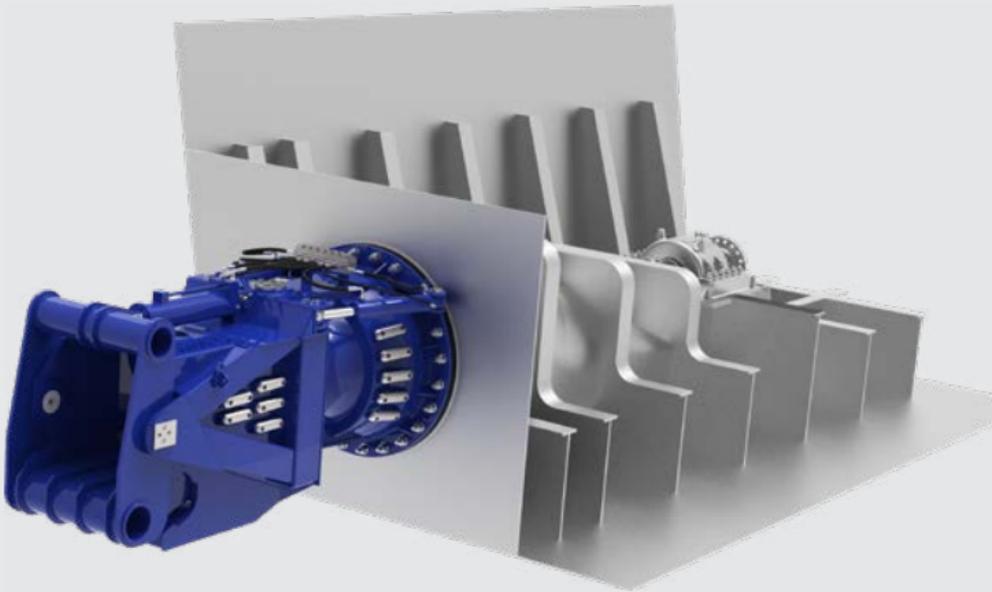
### ■ Wärtsilä Modular Waterjets

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

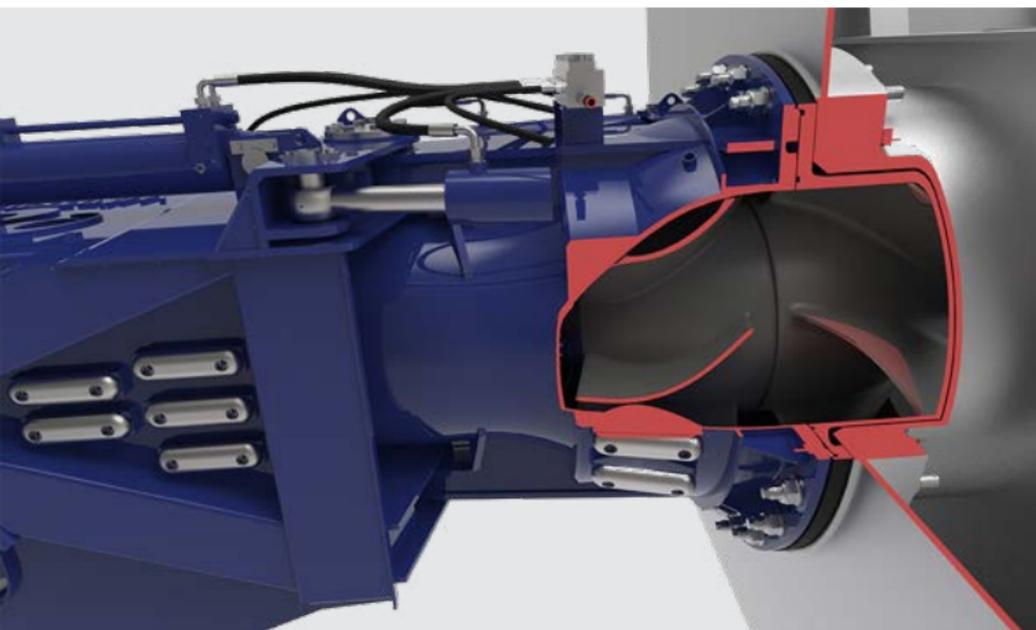
Wärtsilä axial waterjets are single stage, compact, high performance systems that combine mixed flow properties with an axial construction.



## Waterjets

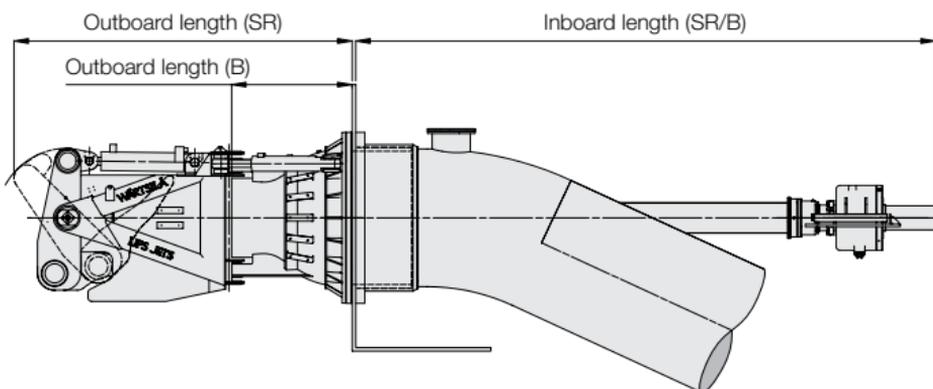
This results in much less space being needed on the vessel's transom, and greatly increased waterjet cavitation margins for optimum vessel operational flexibility. For naval architects, the axial jet technology creates the possibility to apply a larger power density onto narrower hulls in order to achieve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

## Waterjets



Express 4 – A high-speed RoPax ferry with a compact axial flow jet solution

## Waterjets

Weight and dimension table

Size	Outboard length SR (mm)	Outboard length B (mm)	Inboard length (mm)	Transom Flange (mm)	Mass Steerable (kg)	Mass Booster (kg)
510	1 500	610	2 290	655	750	525
570	1 650	650	2 600	730	1 050	700
640	1 860	730	2 870	820	1 450	1 100
720	2 040	780	3 210	920	2 000	1 400
810	2 320	900	3 550	1 035	2 800	1 900
910	2 560	960	4 020	1 165	4 000	2 500
1 000	2 800	1 050	4 360	1 280	5 000	3 400
1 100	3 040	1 120	4 740	1 405	6 700	4 300
1 200	3 310	1 220	5 260	1 535	8 600	5 750
1 300	3 580	1 320	5 640	1 665	11 000	7 000
1 400	3 870	1 440	6 020	1 790	12 500	8 100
1 500	4 110	1 510	6 520	1 920	15 300	10 200
1 620	4 470	1 640	6 970	2 075	18 900	12 600
1 720	4 770	1 780	7 410	2 200	23 200	15 100
1 880	5 190	1 920	8 030	2 405	29 200	19 100
2 020	5 580	2 050	8 550	2 585	34 300	23 500
2 180	6 020	2 210	9 160	2 790	42 500	28 100
2 350	6 450	2 380	9 800	3 005	52 500	34 400



Photo courtesy of Molinslinjen

## 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.

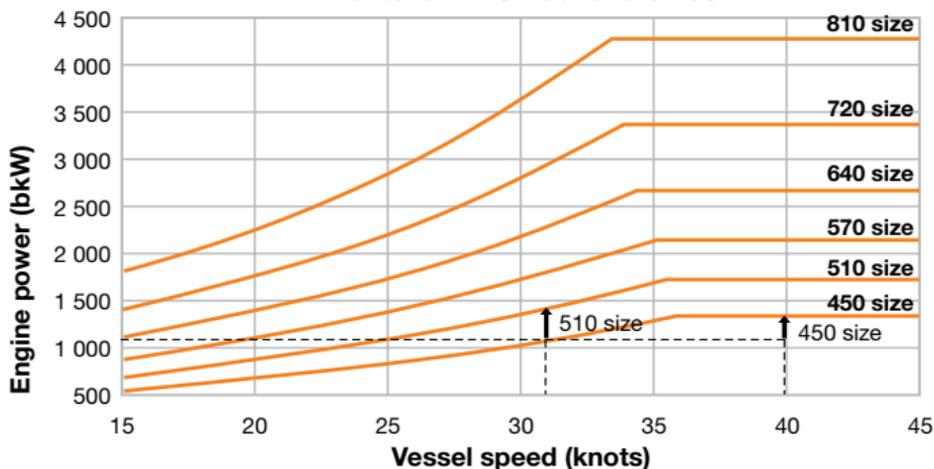
To ensure an optimised propulsion system for your vessel, we recommend that you contact Wärtsilä during the early stages of the design work. Please contact us for an optimised jet selection based on specific vessel design parameters, the operational profile, or for details of waterjets above 50 knots 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.

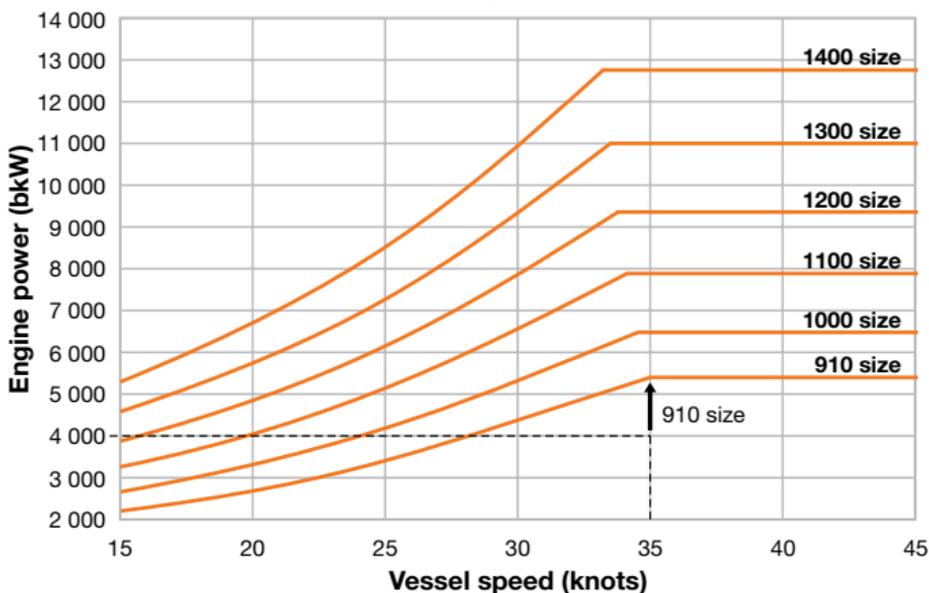
- **High speed vessels;** waterjets have better propulsion efficiency at ship speeds over 25–30 knots.
- **Shallow draft vessels;** the integrated steering function provides benefits for rescue vessels, inshore passenger ferries, landing crafts & special work boats.
- **High power density;** the pressure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

Wärtsilä WXJ 450–810 sizes

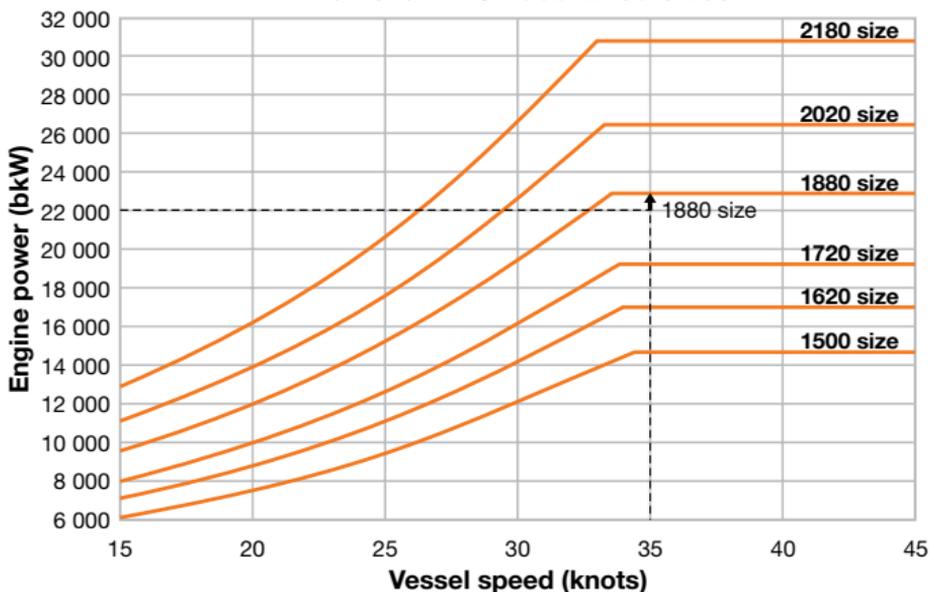


## Waterjets

### Wärtsilä WXJ 910–1400 sizes



### Wärtsilä WXJ 1500–2180 sizes





### ■ 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.

## Control Systems



**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

### 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 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 reliable products, which makes us the chosen valve supply partner all of the blue chip clients from the listed industry sectors.

### ■ ■ The World's Preferred Valve Solutions Partner

Wärtsilä Shipham Valves manufactures non-ferrous, high alloy valve solutions for the handling of 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" (and above) in nonferrous and high alloy materials.

### **Speciality materials – ‘our standard’**

Nickel Aluminium Bronze, Bronze,  
Duplex / Super Duplex Stainless Steel,  
Hastelloy®, Titanium, Monel®, Zirconium,  
Inconel® & Glass Reinforced Epoxy (GRE).

### **■ ■ Bespoke Valve Solutions for Offshore, Marine & Industrial Applications**

The range of products previously supplied by John Mills will continue to be available from within the enhanced Shipham design profiles.

Soft and hard replacement parts special face to face and other historical bespoke John Mills offerings will continue to be accommodated. This streamlining of the two offerings will enable us to continue to provide you with a competitive, available product range that will satisfy both your maintenance, repair and replacement needs as well as fulfilling those for new build schemes.

### **■ ■ Pipeline Ball & Gate Valves**

The Robert Cort range of Ball and Pipeline Gate Valves are no longer in manufacture and available as complete units. These ranges of valves are now obsolete, but we are committed to supporting your installed population through the provision and supply of replacement parts. In addition, through an agreement reached with Score Group we will now supplement this provision with in-situation, monitoring, inspection, maintenance and overhaul services. Both Wartsila and Score make a combined commitment to the lifetime cycle upkeep of the Robert Cort products installed in your facilities.



## 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

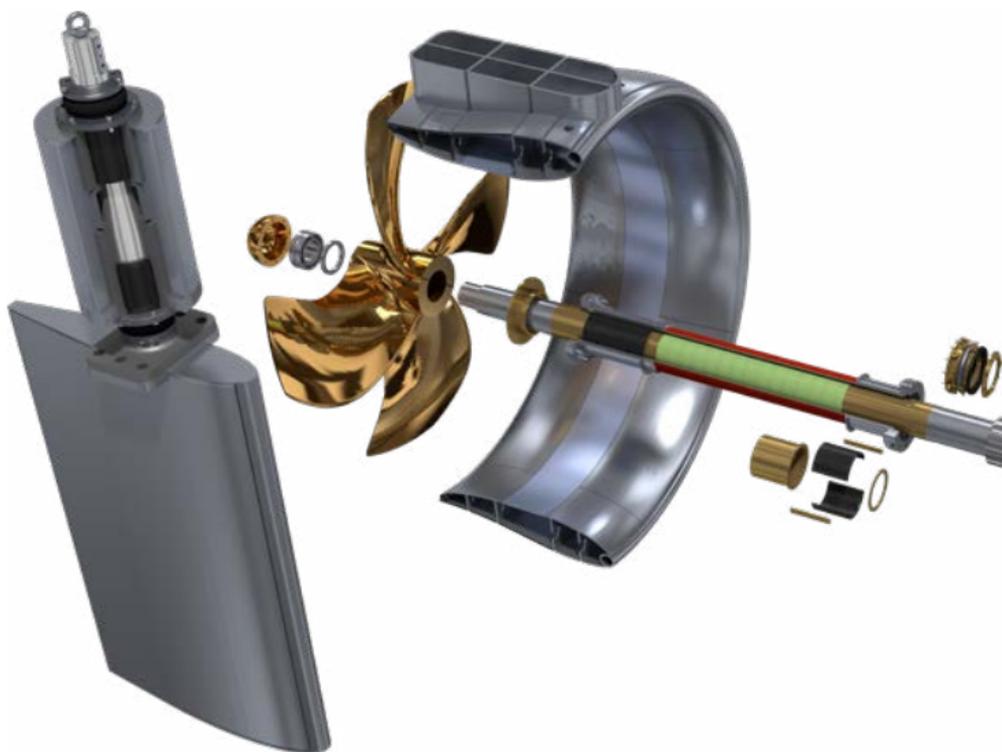
Access to our global service network together with our diverse product range reassures customers that their vessel is being looked after and reaching its full potential.

### 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

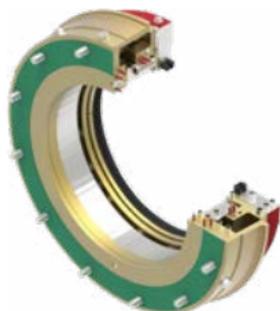
A hard-wearing environmentally compliant lip seal designed to eliminate oil leakage, the Wärtsilä Airguard delivers on reliability and compliance with current anti-pollution regulations.



Wärtsilä Airguard

#### Wärtsilä Sternguard OLS

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



Wärtsilä Sternguard OLS

#### Wärtsilä Sternguard IWSS

Running on Environmentally Acceptable Lubricants (EALs) and designed to operate in abrasive waters, the Wärtsilä Sternguard IWSS is an environmentally compliant adaptable outboard face sealing solution for vessels.

#### Wärtsilä Sternguard EJ

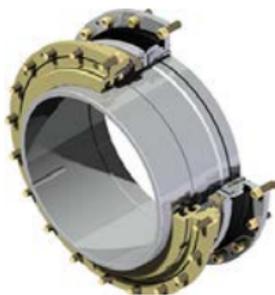
Technologically-advanced and built to endure tough conditions, the Wärtsilä Sternguard EJ face seal provides a dependable inboard sealing solution for small to medium sized vessels ranging from trawlers to tugs and offshore supply vessels.

#### 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.



## Seals



Wärtsilä Oceanguard

### 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

### 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 M

### 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 hard-wearing 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 M4**

### **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 Enviroguard PSE**

### **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 PSE**

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 Jetguard PSE**

### **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.



**Wärtsilä Floodguard**

## Bearings, couplings and stern tubes

### Bearings

#### Wärtsilä Sternsafe

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.

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

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 Linesafe

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.



Wärtsilä Sternsafe



Wärtsilä Envirosafe



Wärtsilä Linesafe



Wärtsilä thrust bearing

## Bearings, couplings and stern tubes

### **Wärtsilä Steersafe E bearing**

Adept at withstanding intense pressure, Wärtsilä Steersafe E can be used on rudders and stabilisers submersed 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.

### **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.



**Wärtsilä stern tubes**

## Shaft line 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.



**Wärtsilä Water Quality System**





### **Wärtsilä Shaft Line Repair Services**

Wärtsilä Shaft Line Repair Services brings together project managers, alignment and measurement specialists and field service experts from across the company for repair work on vessel shaft lines either damaged by a major shipping incident or presenting with symptoms of wear and tear.

#### **Project Management**

As primary point of contact, the Wärtsilä Shaft Line Repair Services project manager coordinates with the customer, collaborates with other teams and suppliers, and handles the ordering process to ensure marine incidents are dealt with as efficiently as possible.

#### **Alignment and Measurement**

With our patented gyro laser technology and skills in detecting vertical and horizontal misalignment, and analysing data, we can restore a vessel's shaft line to its correct position in a matter of hours. As well as carrying out static alignment checks, we can install the Wärtsilä Portable Condition Based Monitoring system (PCBM) – a portable root cause analysis tool designed to measure vibration, temperature and torque on the move.

#### **Field Service**

From lip-type seal bonding to face-type seal upgrades and CPP blade seal overhauls, we are skilled in performing onboard and underwater maintenance jobs, wherever and whenever required.



## 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 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.



**Offshore Vessels**



**Merchant Vessels**



**Fishing Vessels**



AHTS



Gas carriers



Pelagic Vessels



Specialised Offshore  
Vessels



Container feeders



Stern Trawlers



PSV



Tankers



Fish farm  
Service Vessel



**Ferries**



**Tugs**



**Special Vessels**



Shuttle Ferries



LNG Tugs



Offshore Wind



HY Tugs



Desalination Barge



## **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

Wärtsilä Ship Traffic Control provides tools for a coordinated, global approach to maritime traffic control, monitoring and decision support. It enables port-to-coast-to-country-to-country monitoring, control and support that is shared by relevant stakeholders, according to their needs and access level.

With the utilisation of automated self-learning decision support technologies, Wärtsilä Ship Traffic Control Solutions make it possible to operate a ship traffic control model similar to that available to the aviation industry. Ship movements can be advised and controlled by a country, even beyond territorial waters.

A new generation of Ship Traffic Control and Management Solutions is required to extend the safety and efficiency of navigation far beyond the limits of traditional coastal systems.



# Ship Traffic Control Solutions

Wärtsilä Ship Traffic Control Solutions embrace:

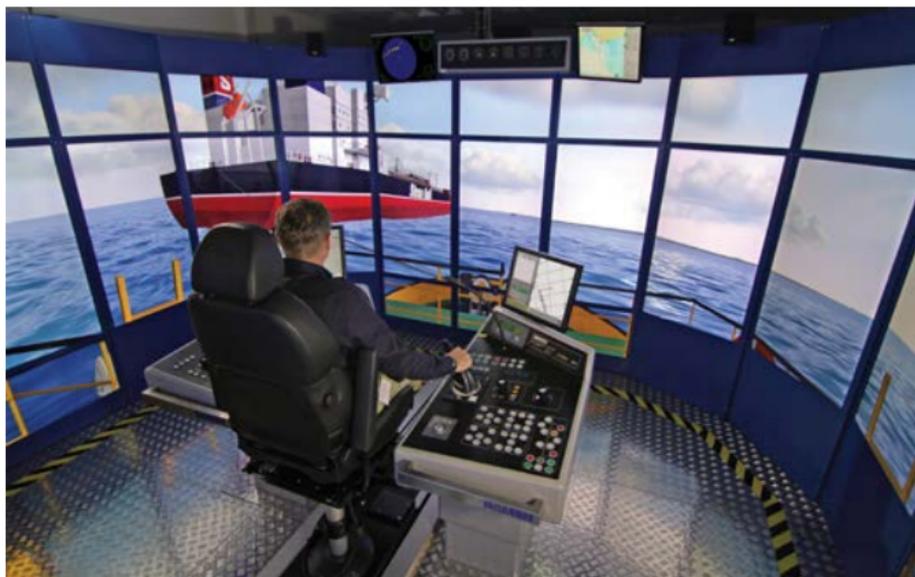
- Full range of products for different types of coastal projects
- Full compliance with international standards and requirements
- Wide range of configurations from port VTS to regional and national systems
- Advanced set of features providing vessel safety and efficiency, security, support of law enforcement operations, and protection of the environment
- Support for extensive range of sensors from different manufacturers
- Possibility to customise the software according to customer requirements for bespoke projects
- Creation of the common operational picture using sensor data and distribution of information amongst stakeholders.



# Simulation and Training

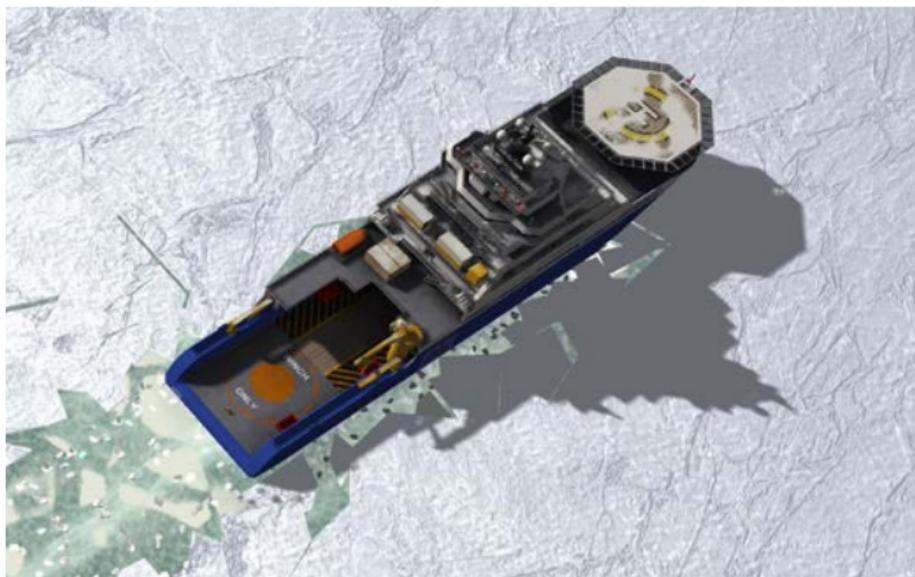
Wärtsilä Simulation and Training solutions connect maritime stakeholders by providing integrated solutions and high-quality content that bridges the gap between STCW and required level of competency.

Wärtsilä Simulation and Training business line steps up to the challenges of providing training in a digital world characterised by increased emphasis on learning methods that accommodate flexibility and collaboration. Wärtsilä Simulation and Training business line solutions are built from the ground up to train and prepare seafarers of the future. They offer micro-



# Simulation and Training

learning, enabling education anytime from 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. Furthermore, new content distribution technologies allow these solutions to reach seafarers on every platform, with options for virtual, augmented and mixed reality.



# Simulation and Training

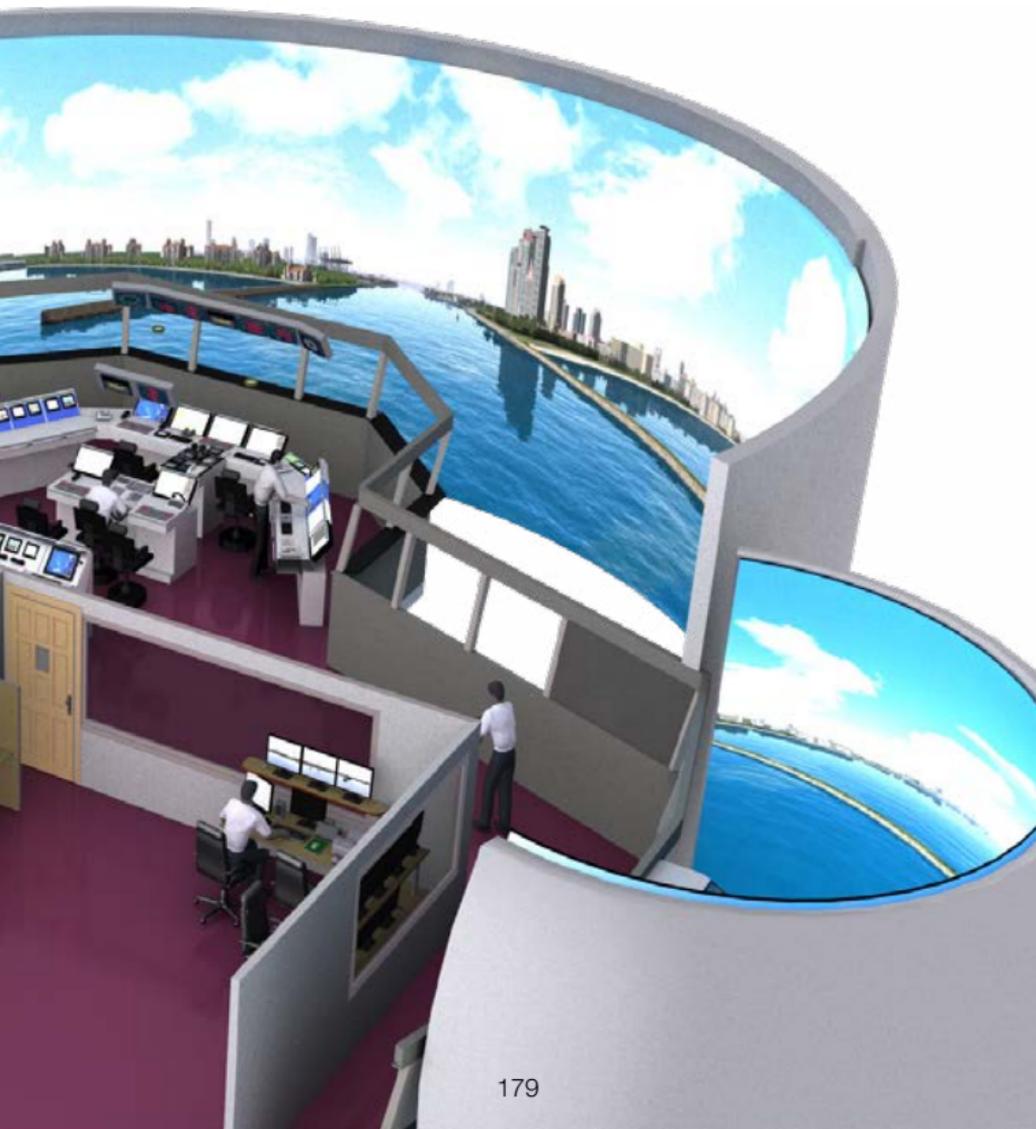
Wärtsilä Simulation technologies cover practically every aspect of modern ship operations and enable various levels of training – from familiarization, standard operation and watch-keeping, to advanced operations, troubleshooting and vessel resource management.

- Navigation and Bridge Simulators:
  - Wärtsilä ECDIS Simulator
  - Wärtsilä Fishing Simulator
  - Wärtsilä GMDSS Simulator
  - Wärtsilä Ice Navigation Simulator
  - Wärtsilä Naval applications
  - Wärtsilä Offshore and DP Simulator
  - Wärtsilä Oil Spill Response Simulator
- Wärtsilä NTPRO 5000 simulator R&D Applications
- Wärtsilä Search and Rescue Operations Simulator
- Wärtsilä Small Craft Simulator
- Wärtsilä Tug, Mooring and Inland Operations



# Simulation and Training

- Wärtsilä Survival craft simulator
- Wärtsilä VTS Simulation and Training Solutions
- Technological Simulators:
  - Wärtsilä ERS 5000 Engine Room Simulator
  - Wärtsilä High Voltage Training Breaker
- Wärtsilä Liquid Cargo Handling Simulator (LCHS 5000 TechSim)
- Wärtsilä LNG Bunkering and Fuel Gas Supply System Simulator
- Simulator Development Tools:
  - Wärtsilä Model Wizard
  - Wärtsilä Virtual shipyard



## Waste Water Processing

### ■ ■ Wärtsilä Sewage Treatment Plants

The Wärtsilä 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.



STC-13 sewage treatment plant

STC-02 sewage treatment plant



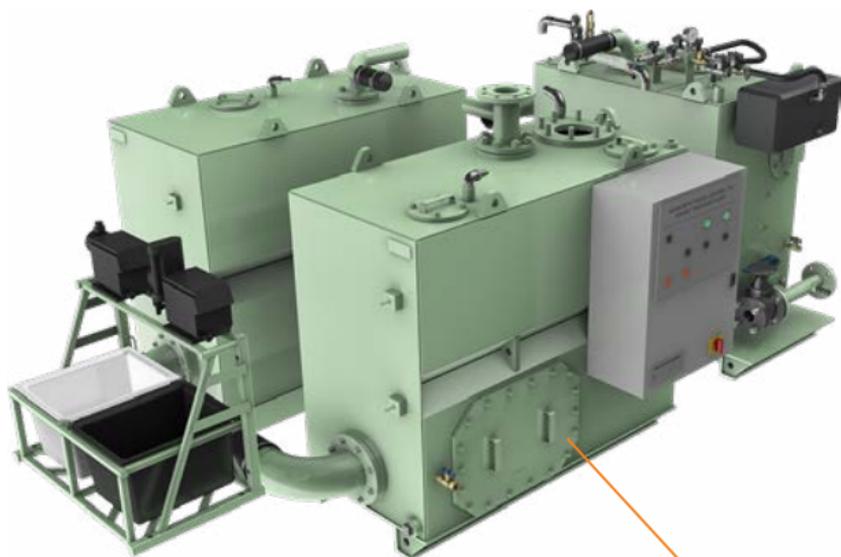
## Waste Water Processing

### ■ ■ 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.

Model No.	Width (mm)	Length (mm)
RTC20-14	655	1220
RTC40-14	730	1670
RTC60-14	830	1770
RTC80-14	880	1870



RTC-20 sewage treatment plant

## Waste Water Processing

### ■ ■ Wärtsilä Membrane BioReactor (MBR) Systems

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.

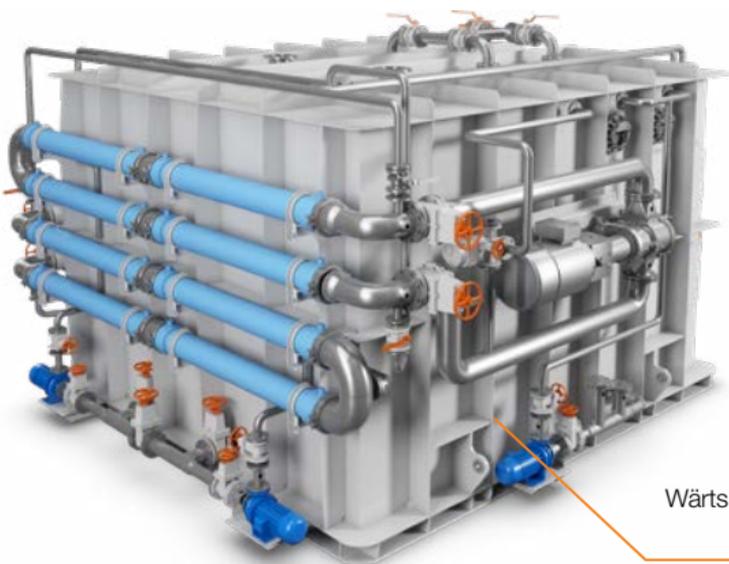
The process produces the highest quality discharge without requiring any addition or generation of chemicals that are hazardous to the environment or ship operation.

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.

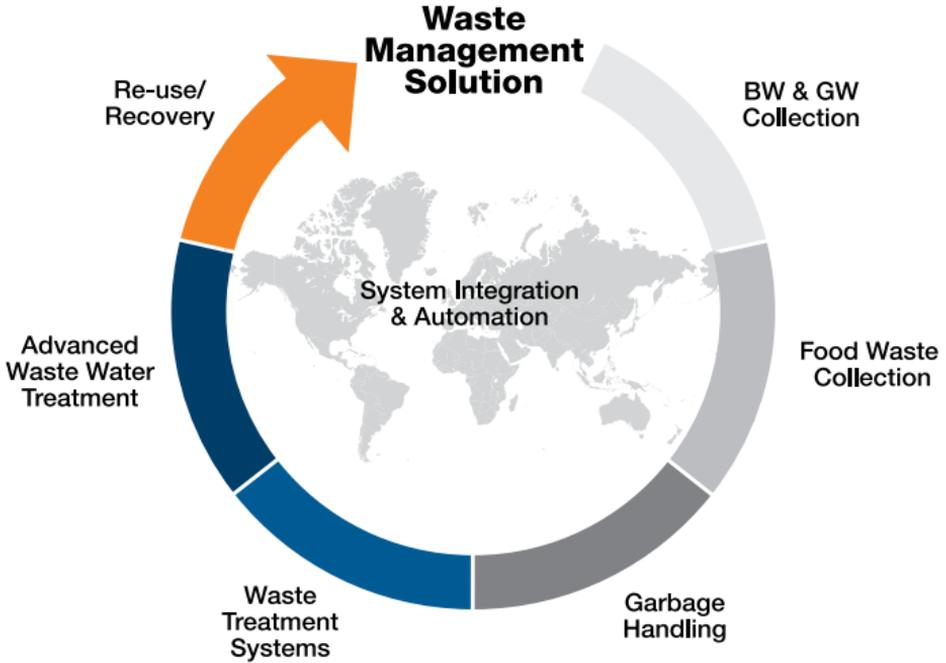
#### Key benefits

- 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



Wärtsilä MBR system

## Dry Waste



### **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.



Wärtsilä dryer

### 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.

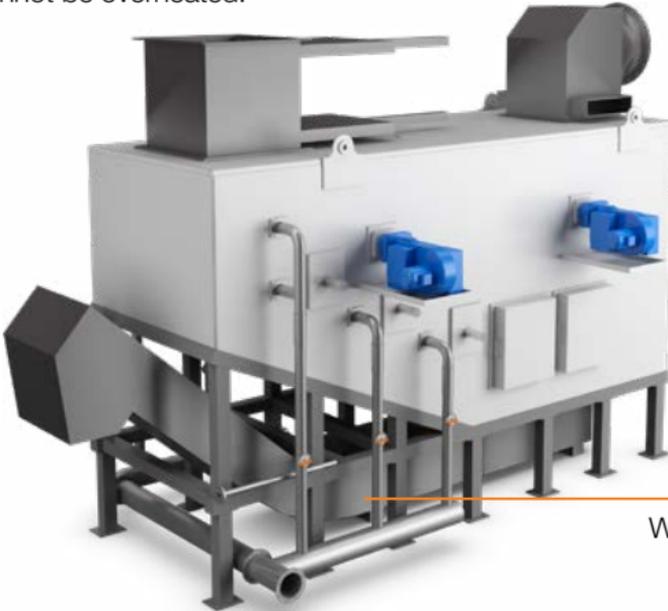
### Incineration

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

## Vacuum Systems

### ■ ■ 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



## Vacuum Systems



### ■ ■ 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 KHD, Deutz MWM, Stork Werkspoor Diesel, Bolnes, Sulzer A/S 4 stroke, Poyaud, SACM, Vasa 14/24, GMT, Vasa 22, Wichmann, Nohab and Crepelle. Our stock consists of nearly 5.5 million components for more than 50 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 targets are determined based on business demands and quantifiable performance indicators are set, we then guarantee that those targets are reached and maintained.



## Lifecycle solutions

**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.

**Learn more about our wide range of services and solutions**



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### Wärtsilä Netherlands B.V. Global Energy Business sales

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### Wärtsilä Netherlands B.V. QuantiParts BV - A Wärtsilä Company - Trading OEM spare parts mature Wärtsilä engine brands like Stork, Werkspoor, Diesel, Deutz MWM, Bolnes

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- 2) Portuguese

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

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