

Wärtsilä Solutions for Marine and Oil & Gas Markets

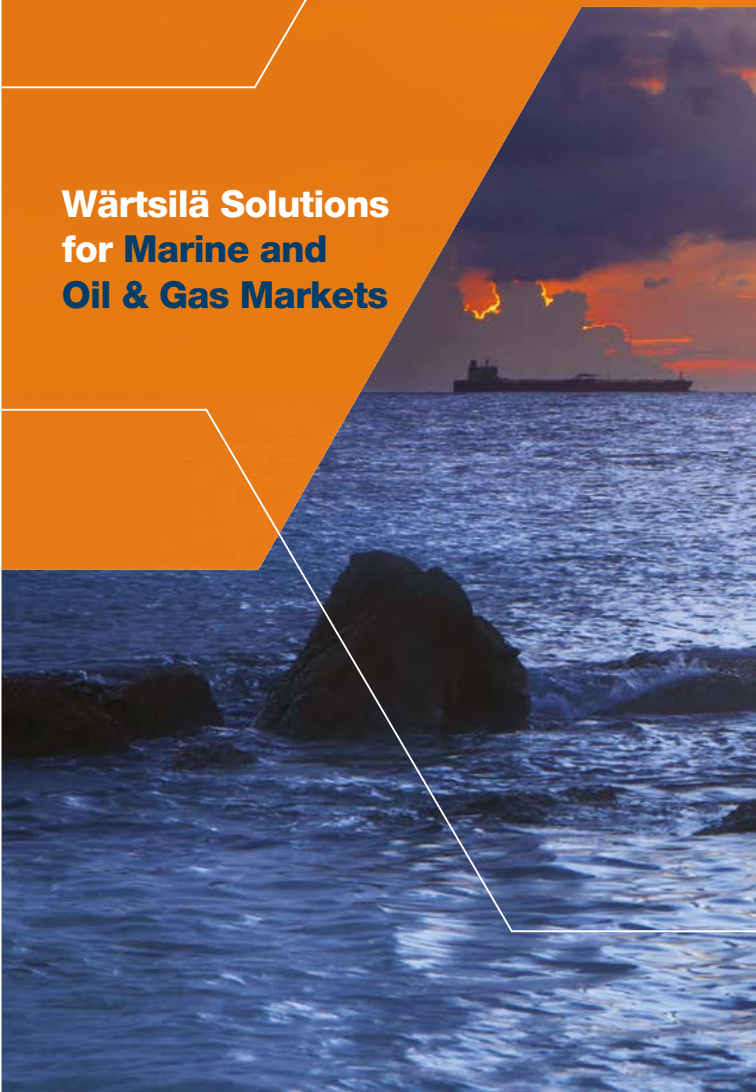


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■ Marine Markets**■ Oil & Gas Markets**



At Wärtsilä we understand the marine and oil & gas industries. We know the current regulations and anticipate those to come, we listen to our customers and appreciate their needs, we develop innovative leading technologies that move the industry forward, and we integrate our extensive range of products, systems and solutions to provide lifecycle reliability and efficiency. By connecting all these individual dots, we provide real value for our customers.

Our experience dates back to 1834. Over the years we have accumulated the world's most complete offering of marine solutions, ranging from ship design, to propulsion and power generating machinery, to complete electrical & automation systems, to vessel positioning solutions, to environmental and emissions control systems, to gas handling and much, much more. We continuously strive to develop innovative technologies that provide greater efficiency, lower operating costs, and that make compliance with environmental legislation easier to achieve.

Wärtsilä has become an established leader – not by chance, but by connecting the dots that bring greater value to our customers' businesses around the world.



Environmental Excellence

We design our products to be optimally efficient, both operationally and environmentally. Through efficient fuel consumption and by eliminating or reducing emissions of harmful pollutants, we enable our customers to operate without restrictions anywhere in the world.

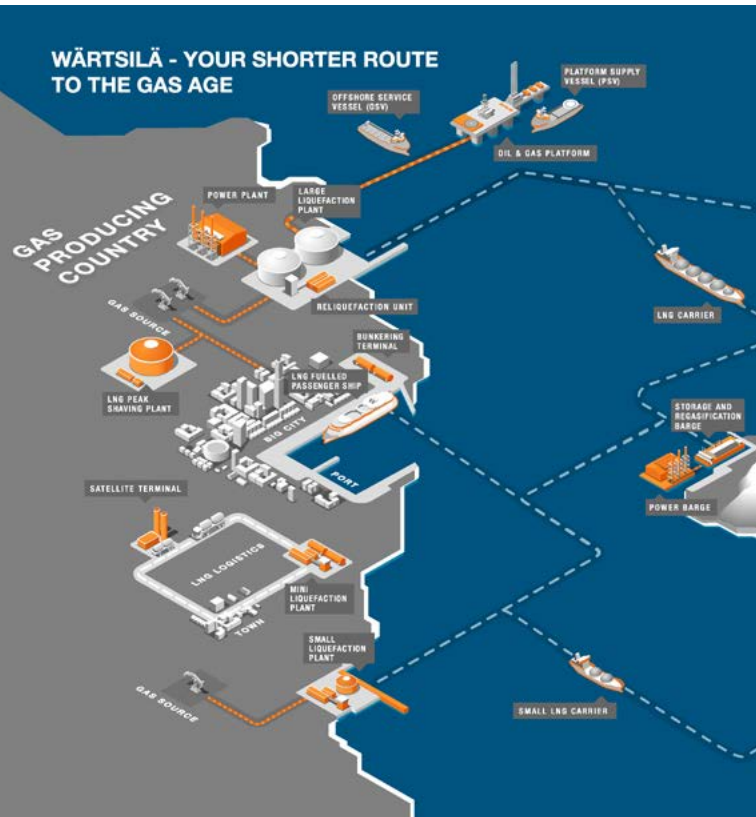
Wärtsilä offers a host of products and solutions that enhance environmental performance. We have led the way in making LNG a viable marine fuel, and we were the first company to be awarded a marine exhaust scrubber certificate. We offer leading technologies in ballast water treatment, and systems to manage sewage, oil and bilge.

Helping you maintain a safe and clean operating environment is part of our everyday service.

Fuel Flexibility

Natural gas is a clean burning fuel. At Wärtsilä we have long pioneered the technologies that today make it a viable, safe, and environmentally sustainable marine fuel.

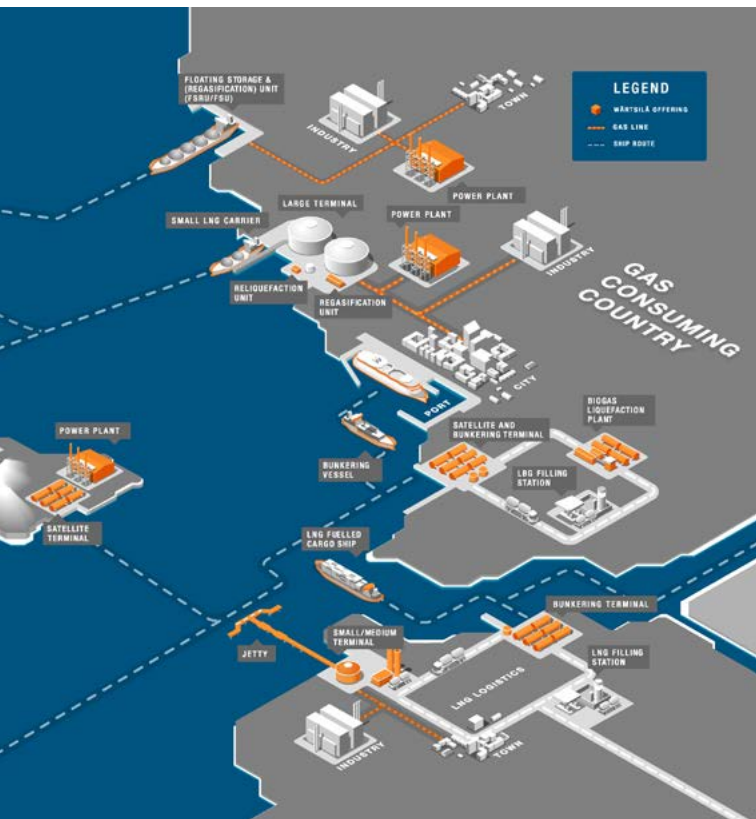
We were the first to introduce dual-fuel engine technology for marine applications, and we have continued to develop the use of a range of alternative fuels, such as ethane gas and bio fuels, that increase fuel flexibility. Our customers can select the fuel they need based on cost, availability and environmental restrictions.



Operational Efficiency

Through being a total solutions provider, Wärtsilä can integrate a vessel's propulsion, control, and automation systems to provide the most efficient overall result. We can even create highly efficient initial ship designs. We never forget that operational efficiency leads to our customers having lower operating costs and greater profits.

Wärtsilä's emphasis on efficiency is exemplified by the fact that Guinness World Records has recognised the Wärtsilä 31 as being the world's most efficient 4-stroke diesel engine.



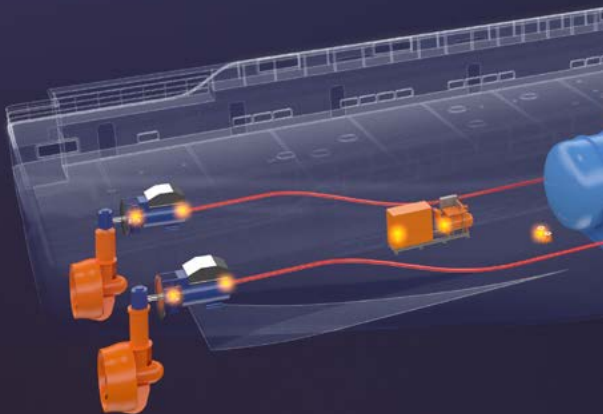
Lifecycle Support

Our global Wärtsilä Services business also serves to improve lifecycle efficiency by preventing the unexpected, lessening the environmental footprint, and optimising performance. Our unrivalled network covers the globe, 24/7.

Integrated Solutions

Wärtsilä's unique capabilities in harnessing innovation and digitalisation form the basis of our support for our customers as we enter a new age of shipping. It is no longer always enough to provide individual products or systems, since the essential global need for optimal efficiency and minimal risks demand that all these individual parts function together, as a single integrated, harmonious entity. When Wärtsilä talks about connecting the dots, integration of all the various elements that go into producing the most efficient and cost-effective operational performance is central to this concept.

No other company can match our portfolio of products, systems and solutions. It is this vastly broad offering, together with our 180 plus years of know-how and experience that makes Wärtsilä so very



capable in producing the best and most efficient integrated solutions. This single-supplier capability speeds and eases the design and procurement process, facilitates accurate and on-time logistics, and reduces project development and execution risks for shipyards and owners.



Ballast Water Management



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). Wärtsilä also offer a tailored installation package solution – AQUARIUS® READY. The engineering and onboard preparations can be made in advance, and the actual installation of the Wärtsilä AQUARIUS® BWMS can be planned as and when required.

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.

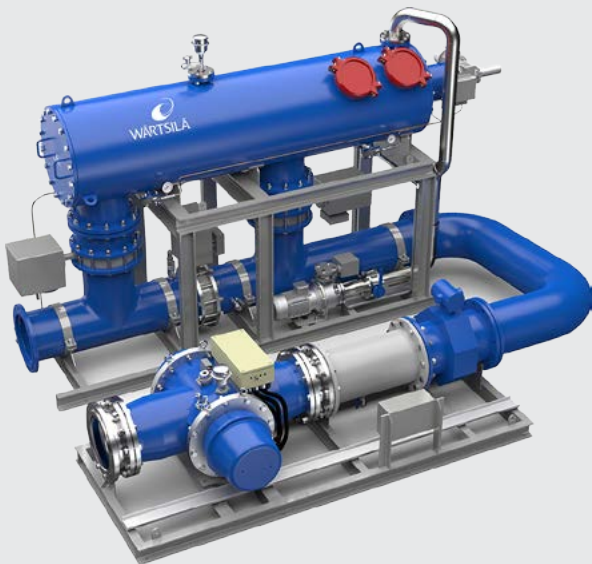


The Wärtsilä AQUARIUS® BWMS range offers the following advantages:

- Proven performance to meet D2
- Low total cost of ownership
- Fully automatic operation
- Condition-based monitoring – optional functionality
- Flexible upscaling and modular design
- Suitable for both new build and retrofit projects
- Technology choice

By virtue of Wärtsilä AQUARIUS® BWMS range modular design, the system's inherent flexibility allows application across the full range of ship types and sizes, for both the new build and retrofit markets. Wärtsilä offers customers a range of flexible supply options, from equipment only, to a full 'turnkey' service covering all phases, from the initial survey through to the project management, supply, installation, and commissioning of the hardware, and continuing with lifecycle after sales service and support.

Ballast Water Management



■ 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 modular design enabling it to be arranged to suit conditions onboard the ship. The system can be designed and supplied to

Wärtsilä AQUARIUS® UV system	Capacity (m ³ /h)	Total installed power (kW)
AQ-50-UV	0-50	19.0
AQ-80-UV	50-80	19.0
AQ-125-UV	80-125	19.0
AQ-180-UV	125-180	38.6
AQ-250-UV	180-250	40.1
AQ-300-UV	250-300	47.7
AQ-375-UV	300-375	47.3
AQ-430-UV	375-430	51.5
AQ-500-UV	430-500	62.6
AQ-550-UV	500-550	93.2
AQ-750-UV	550-750	92.2
AQ-850-UV	750-850	100.0
AQ-1000-UV	850-1000	100.0

Pressure drop	
Normal operation	0.3 barg
Backwash set point	0.8 barg

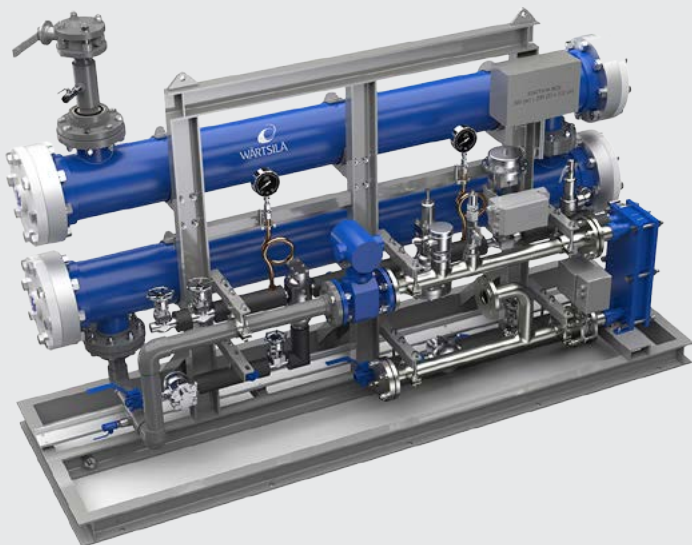
treat ballast water covering the full range of ballast pump sizes. There are 13 distinct Wärtsilä AQUARIUS® UV BWMS standard modules available with capacities ranging from 50 m³/h to 1000 m³/h. Capacities above 1000 m³/h up to 6000 m³/h are achieved by installing multiple modules in parallel.

Available in two configurations for installation in safe environments as well as an explosion proof version certified by DEKRA for hazardous areas. The flexible scope of supply can include standard modules or part kits that meet the individual requirements of our customers.

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

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

Ballast Water Management



■ 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 modular design enabling it to be arranged to suit conditions onboard the ship. The system can be designed and supplied to

Wärtsilä AQUARIUS® EC system	Capacity (m³/h)	Total Installed power (kW) Installed /Nominal
AQ-250-EC	0-250	25.9 / 22.6
AQ-300-EC	250-300	29.4 / 25.2
AQ-375-EC	300-375	34.6 / 28.9
AQ-430-EC	375-430	38.8 / 32.0
AQ-500-EC	430-500	44.5 / 36.4
AQ-550-EC	500-550	50.8 / 41.0
AQ-750-EC	550-750	60.6 / 48.2
AQ-850-EC	750-850	71.1 / 55.9
AQ-1000-EC	850-1000	85.8 / 68.3
AQ-1200-EC	1000-1200	110.4 / 87.0
AQ-1500-EC	1200-1500	123.0 / 96.9
AQ-2000-EC	1500-2000	167.9 / 126.2
AQ-2400-EC	2000-2400	216.1 / 159.5
AQ-3000-EC	2400-3000	264.8 / 193.1
AQ-3300-EC	3000-3300	319.7 / 233.2
AQ-3600-EC	3300-3600	365.5 / 264.7

Pressure drop	
Normal operation	0.3 barg
Backwash set point	0.8 barg

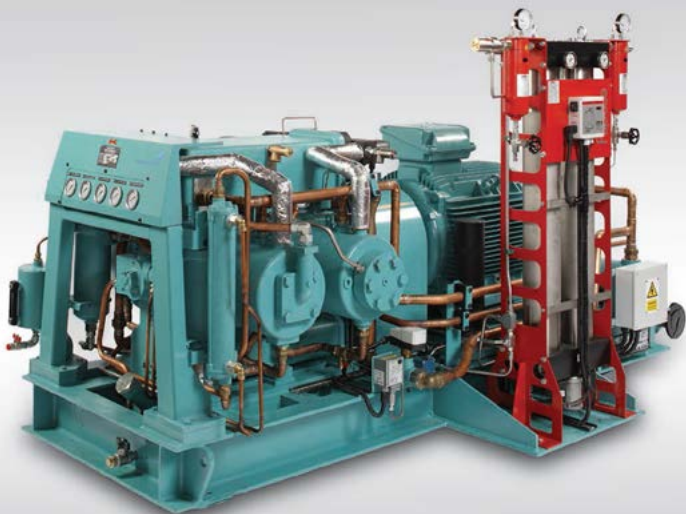
treat ballast water covering the full range of ballast pump sizes. There are 16 distinct Wärtsilä AQUARIUS® EC BWMS standard modules available with capacities ranging from 250 m³/h to 3600 m³/h.

System capacities above 3600 m³/h are achieved by installing multiple modules in parallel.

A flexible scope of supply includes standard modules or part kits to meet the customer's individual requirements.

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

All Wärtsilä AQUARIUS® EC BWMS units have been granted IMO Type Approval by The Ministry of Infrastructure and the Environment of The Netherlands in accordance with Resolution MEPC.174(58) G8, and have been tested to meet the D2 performance discharge standard. USCG AMS acceptance has been granted in accordance with the requirements of 33 CFR 151.2026.



■ Wärtsilä Hamworthy Air & Gas Compressors

Wärtsilä is an established supplier of compressor and ejector systems for the oil, gas and petrochemical industries. Our compressors can be configured to suit a diverse range of high pressure applications for both air and other gases: Argon, Biogas, Carbon Dioxide, Helium, Heliox, Hydrogen, Methane, Natural Gas, Nitrogen (both compression and generation).

We offer a range of options, from a basic compressor block to a fully integrated compressor package solution for high pressure air or gas. We are also able to incorporate ancillary items, such as nitrogen generation and air/gas driers, into the scope of supply. The units are designed to comply with European and other International standards for a range of industries and applications.

We offer 2, 3 and 4 stage compressors with inlet pressures up to 7 bar g, and discharge pressures up to 350 bar g.



■ Wäertsilä Hamworthy CNG Compressors

We offer biogas or natural gas solutions for CNG refueling stations to serve buses, trucks and other vehicles.

CNG is a more environmentally acceptable alternative than petrol, diesel, or propane/LPG, and is significantly lower in price. Our offering covers a range of options, from a basic compressor block to a fully installed and commissioned CNG refueling station that includes the compression module(s), cascade storage, priority panels and fuel dispensers. The units are designed to comply with European and International standards.

We provide systems for either 'fast fill' (temperature compensated) or 'timed fill' with 200 or 250 bar g filling pressures. The gas composition may be required to ensure correct compressor and material selection.

Compressors

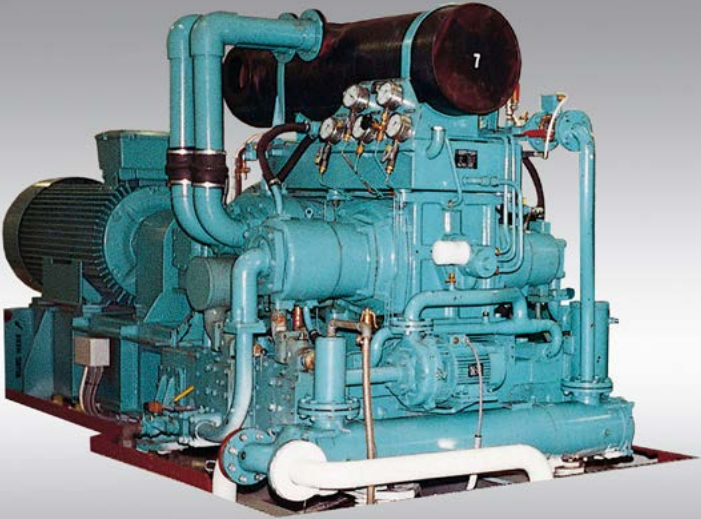


■ Wärtsilä Hamworthy Rig Tensioning Compressors

Our rig tensioning compressors and heave compensation compressor packages are fully integrated, lightweight, compact, and engineered for the offshore environment.

The combination of a 4 stage compressor, dryer, and filtration package with a contained cooling system, produces filtered and dry, high pressure air or gas suitable for riser tensioning and other offshore applications. The packages are designed to ensure that upgrades, refurbishment, and servicing can be easily carried out. We also offer high pressure nitrogen booster compressors, along with nitrogen generation systems, for riser tensioning, motion compensation, drill stream compensation and other applications.

These units can be supplied as integrated packages, fully assembled, tested and ready for installation. The module also meets the requirements of the major marine classification societies.



■ ■ Wärtsilä Hamworthy Seismic Compressors

Our seismic compressors offer an integrated and compact solution to your high-pressure needs.

Wärtsilä Hamworthy seismic compressors feature a low lift concentric valve and generous inter-stage cooling to minimise the amount of absorbed power. This results in very high overall efficiency. Each machinery package includes a choice of drive, skid base and control system, and is engineered to suit your seismic requirements.

The low unit noise and vibration improves reliability and reduces interference with survey results. Flexibility in vessel utilisation is available to contractors and operators via the containerised option. Thanks to the easy access features and simple modular construction, it enables low and easy maintenance. A multiple unit control system provides local and remote operation of two or more compressors.

Electrical & Automation (E&A)





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 products and solutions are state-of-the-art, 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, included related engineering, to complete system integration (the turnkey solution).



■ Integrated Vessel Control Systems

Wärtsilä offers a complete series of next-generation navigation, automation and control systems including dynamic positioning.

Based on identical software and hardware components and utilizing a common network, the system architecture supports the complete portfolio of navigation, automation and dynamic positioning. The use of modular components ensures unprecedented levels of usability and scalability. The design of the networked system architecture is flexible from small independent systems requiring limited integration through to the highly complex systems with unprecedented integration possibilities. Moreover, any system can be easily expanded, upgraded or modified to provide increased functionality.

The IP-radar, which by direct connection to the ship's IP network enables the complete radar image to be accessible from any workstation. An increased antenna speed provides consistent tracking of fast targets/ use on high-speed craft (HSC).

Consistency and tight integration between products secures a smooth installation and efficient life time support from one of the largest global suppliers.

All products are developed according to User Centered Design principles. In co-operation with the leading international Human Factors



institute, a very ambitious collaborative design process has been undertaken resulting 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
- Propulsion Control Systems
- Engine Governor Systems
- Engine Governor Systems
- HVAC/Fire Monitoring
- Emergency shutdown system
- Safety management system
- Information management
- Asset management
- Fleet management
- Vessel performance monitoring

Manoeuvring, Dynamic Positioning

- Thruster Control
- Joystick
- Dynamic Positioning

Navigation Products

- Radar
- ECDIS
- Conning
- Heading and Track
- Integration of radar, ECDIS, conning and even automation in one compact workstation
- VDR, AIS, BNWAS, sensors
- Integrated Bridge Systems (IBS)
- Integrated Navigation Systems (INS)

Remote Service enables service engineers to access the systems on board almost anywhere in the world. This simplifies the diagnosis of faults and problems, and the correct spare parts may be delivered to the nearest port in good time. In many cases, Remote Service Platinum 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 his system, the customer has access to a range of security functions to ensure his ships are protected against all relevant threats.

■ Diesel-electric Propulsion

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

- Low noise and vibration
- High redundancy
- Maximum payload capacity and optimal utilization 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

As a result of these features electrical propulsion systems are used on ships with special requirements, e.g for cruise liners, ferries, cable and pipe layers, research vessels, icebreakers, multipurpose vessels, patrol boats, supply and rescue vessels as well as for LNG tankers.

These systems are based on the principle of speed controlled AC motors driving the propeller directly or by gearing.

The most economical drive solution is to install synchronous or induction motors fed by frequency converters with LCI synchro-converters or with PWM converters, depending on the arrangement of the propulsion system



and on the operational profile of the vessel. Three level PWM converters could also reduce the noise and vibration level at the propulsion motor significantly.

LCI Converter System

Frequency converters with line controlled inverters (LCI = synchro-converters) are designed with direct current (DC) intermediate circuit and consist of thyristor rectifiers at the mains side, thyristor inverter at the motor side, DC reactor in the intermediate circuit, excitation converter and control system. LCI converters are provided for supply of synchronous motors. This is a well proven system for high power rates. The $\cos \phi$ in the mains is reduced linear with the propeller speed.

PWM Converter System

Frequency converters with pulse-width modulation (PWM converters) are self-controlled converters designed with direct voltage intermediate circuit and consisting (in the standard solution) of diode rectifier at the mains side, insulated gate bipolar transistor (IGBT) or integrated gate commutated thyristor inverter (IGCT) at the motor side, DC capacitors in the intermediate circuit and control system. For improved mains quality and for reverse power characteristics the diode rectifier at the mains side is replaced by an IGBT rectifier (active front end AFE design). PWM converters are provided for supply of asynchronous or synchronous motors.



Electrical & Automation (E&A)

■ ■ Wärtsilä Low Loss Concept

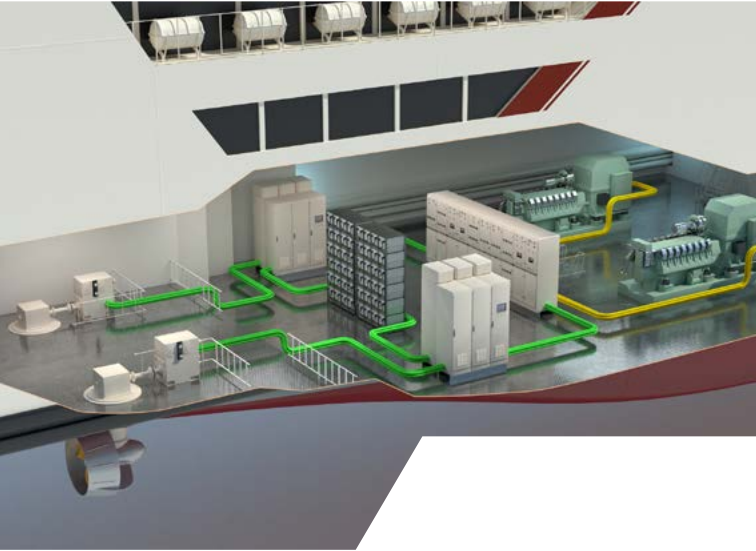
LLC is an energy efficient and highly redundant power distribution system for electric propulsion applications.

The Low Loss Concept (LLC) is a power distribution system comprising higher efficiency, lower weight and volume, and a high system redundancy. The basic motive for the design is to reduce and eliminate the need for supply (pulse) transformers to the frequency converters, especially those supplying electric propulsion.

LLC is available for both Low Voltage and Medium Voltage applications. It covers all power applications between 5 MW and 45 MW in both the Low Voltage and Medium Voltage versions. It is effective also in vessels with operating profiles that require variable speeds, such as OSVs.

The LLC power distribution system has been patented internationally by the Wärtsilä Group.





■ ■ Wärtsilä Hybrid

Since 2007 Wärtsilä has developed, manufactured and delivered sophisticated battery/hybrid systems. These systems includes energy management control, power electronics and battery integrations. Such systems have proven yearly fuel savings to between 10–20% depending on type of engines configurations.

Wärtsilä battery/hybrid technology ensures substantial reductions in emissions through utilization of optimized energy efficiency. The power and energy management system is designed to allow the power source (fuel cell, diesel/gas operated engine with battery packs combinations) to run at optimized loads and with the optimal utilization of energy storage through batteries that will absorb load fluctuations.

The power and energy capacity of the battery is designed to allow the engines to run at optimal loads.

A key element of the system is the hybrid control algorithm for load sharing, efficient power and energy management.

■ Wärtsilä Direct Electric Heating

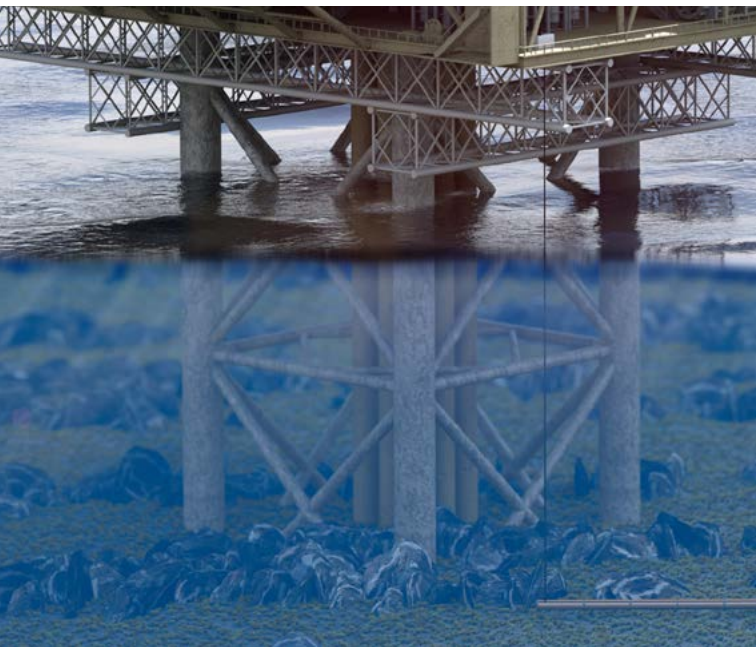
DEH is a cost efficient and environmentally sustainable flow assurance method that replaces the use of chemicals.

The presence of wax and hydrates in subsea flow lines is a major concern in the offshore industry. Wärtsilä DEH is based on using the thermally insulated flow line as part of the electric circuit, and allowing the electrical losses to heat the contents of the pipe.

Direct Electric Heating is today a mature technology that has been used for more than 15 years in Norwegian and West African installations. Wärtsilä has participated in the development of Wärtsilä DEH since the nineties, and today undertakes the design and supply of the complete topside Wärtsilä Direct Electric Heating package.

Wärtsilä Direct Electric Heating has been used for flow lines of up to 44 km, and with a power requirement of up to 12 MW.

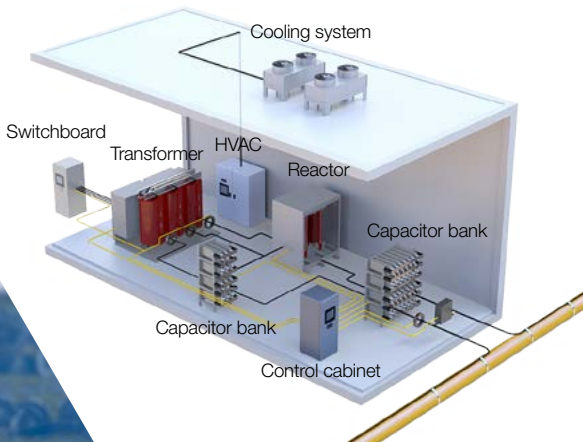
The topside package comprises tailor made medium voltage components that control the current in the flow line, convert the load from



single phase to a symmetrical 3-phase load, and compensate for the low power factor. Wärtsilä delivers electric and optical protection and control packages that have been specially developed for Wärtsilä DEH. The Wärtsilä Direct Electric Heating package can be installed in suitable indoor locations, or in outdoor locations within a steel or aluminium module with HVAC or water cooling. Wärtsilä DEH deliveries always include a special power system analysis to ensure its integrity with the platform system.

Wärtsilä can provide:

- FEED Studies (Front End Engineering & Design Key Benefits)
- Topside system design to meet subsea power requirement
- Power system analysis
- Tailor made Topside package
- Project execution
- Pre-commissioning/commissioning and start up assistance



■ Shaft Generator

Wärtsilä provides Shaft Generators (SG), driven by the main engine to supply power to the mains in the range 500 kW up to 8,000 kW. The power generation has to function properly also at changing speeds of the propulsion shaft, when the ship travels at different speed ranges, or in 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 in PWM technology is used.

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

- Reduction of maintenance costs
- Lowering of fuel and lubrication costs
- Return on investment in 3 to 4 years
- Safety for ship and crew
- Low noise power generation
- Smaller or less diesel generator sets
- Continuous parallel operation together (two SG systems) or with diesel generator sets

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

All requirements of a ship's mains are met unrestrictedly during shaft alternator operation:

- Unrestricted operation during main engine speed variations as the result of heavy seas and manoeuvring
- Continuous parallel operation together (if 2 shaft alternator 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 synchronization, in the same way and with the same operating controls as on 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 in the power range 3.0 MW up to 8.0 MW with 6.6 kV are required. But also 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 with MV application.





■ Power Distribution

Wärtsilä provides both, low voltage and medium voltage switchboards and meets 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 range 6.6 kV or 11.0 kV.

For protection and control of power supply systems, Wärtsilä integrates its own developed protection system. The microprocessor based protection system covers all necessary protection functions for low and medium voltage power supply systems, generator protection and consumer protection. On request a power management function for control of the power supply system is available. The protection system can be operated as stand-alone 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 visualization 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 with transformer, bus-tie-breaker and motor protection functions available



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^{EC} , Classification

■ Motor Control Center

Nominal voltage: up to 690 V 3AC

Bus bar system capability:

- Rated current I^N : up to 3150 A
- Rated peak current I^{pk} : up to 220 kA
- Rated short-time current I^{CW} 1sec: up to 100 kA

Protection grade: IP54, bottom open

- Ambient temperature: 45°C or 50°C acc. to class requirements
- Basic requirements: IEC, Classification

Plug-in motor starters

- Different sizes up to 630 A

■ 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

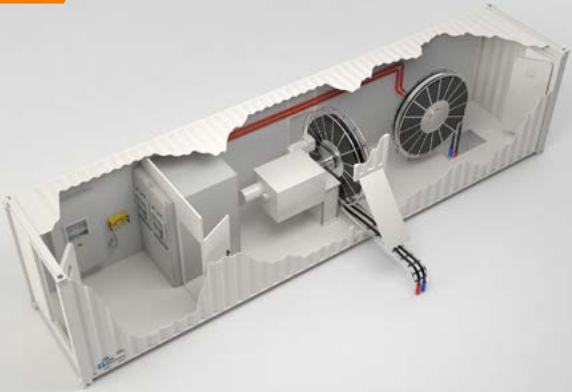
Special Boards

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

■ Protection System GPM 500

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

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



■ High Voltage Shore Connection

System design is essentially based on meeting port needs while also conforming to ICE/ISO/IEEE 80005-1 requirements. A configuration typically comprises key components such as cable reel, a medium voltage switchboard and a control and monitoring facility inclusive of an interface between ship and shore. A complete assembly can either be installed separately aboard a vessel or containerized for siting at a specific onboard location. On request we develop tailor-made solutions for all kind of vessels. We offer the full range of turnkey integration works.

■ Inductive charging technology

Inductive charging (wireless charging) uses an electromagnetic field to transfer energy between two conducting coils. A sending induction coil is used to create an alternating electromagnetic field and a second induction coil take the power from the electromagnetic field and converts it back into electric energy.

The system has presently a capacity transferring power of 1 MW within a range of 15-50 cm between the coils.

The inductive charging technology is very flexible to integrate and can be introduced in new market areas and applications.

Successful application of battery storage systems for plug-in hybrid vessels will require fast, safe and reliable power transfer from the onshore power system while the ship is docked.

Charging rates of about 2-3 times nominal its battery capacity are usual with the present battery technologies, but with high power battery chemistry the charging rates can be in the area of 6 times the battery capacity.

Electrical & Automation (E&A)

■ UPS Systems

Wärtsilä has a wide range of uninterruptible power supply systems for marine applications for all kind of ships. We provide reliable power distribution systems adapted to the needs of the customer. Whether automation, propulsion, navigation or communication, critical consumers are all dependent on a secure power network for a safe operation.

Wärtsilä's UPS systems are customized according to the particular ship category and has to consider special ship building codes of the respective classification society. The systems enable comfortable monitoring and easy servicing.

Marine UPS systems are available up to 200 kVA

- Wärtsilä JOVYSTAR OCEAN, 5-30 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 for a wide range of resistor types for marine applications, whether for bow thruster control on vessels, current controlled discharging of batteries on submarines, generator tests at harbor facilities and further more. We provide robust and reliable resistor systems adapted to the needs of the customers.

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 harbor facilities



Wärtsilä JOVYLOAD BRAKE



Wärtsilä JOVYLOAD CONPOWER

■ Wärtsilä JOVYPHASE GPC Converters

Wärtsilä provides shore power conversion for yachts, cruise liners and other vessels. The converter JOVYPHASE GPC with power rates 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 a short time. Furthermore the concept features a compact design and high efficiency up to 97%.



Electrical & Automation (E&A)

■ Wärtsilä Entertainment and Network 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

- The product scope covers Infotainment (IPTV) incl. BYOD
- SAT TV reception and head end distribution
- Digital signage
- Data networks
- Wireless network
- Cabin control
- Dimming systems

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 a long bill of materials in 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.

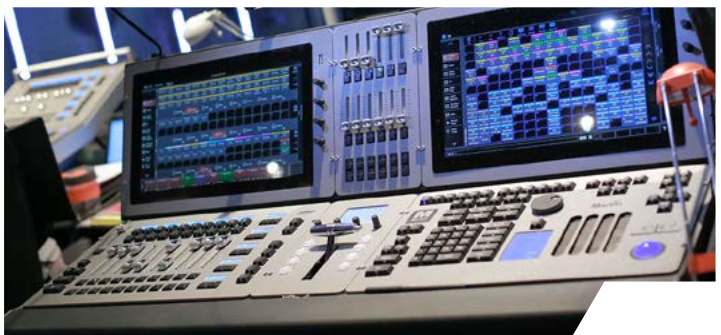


■ Wärtsilä Safety & Security

Safety is very important for each ship including all crew, passengers and goods in transport. Regulations by flag states and classification authorities demand continuously higher levels of safety. In addition security had also become a major task for every ship owner. Wärtsilä has the expertise and experience to design and integrate comprehensive highly integrated safety and security systems.

Wärtsilä safety and security technologies include:

- Fire detection
- Safety management (SMS)
- 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
- Access control
- Intruder detection
- People and object tracking
- Security monitoring & control centre



■ Underwater Technology – Sonars and Hydroacoustic Systems

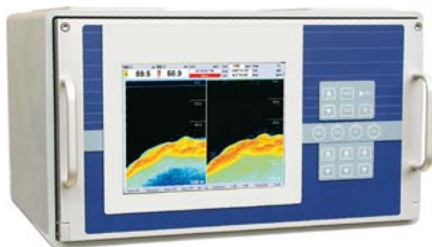
Wärtsilä's underwater product portfolio includes underwater communication and navigation systems as well as single und multibeam survey systems. The equipment provided by Wärtsilä can be used for navigation and control, data collection and transmission as well as for mapping the ocean floor. All products excel by their reliability, state-of-the-art technique and highly precise data acquisition.

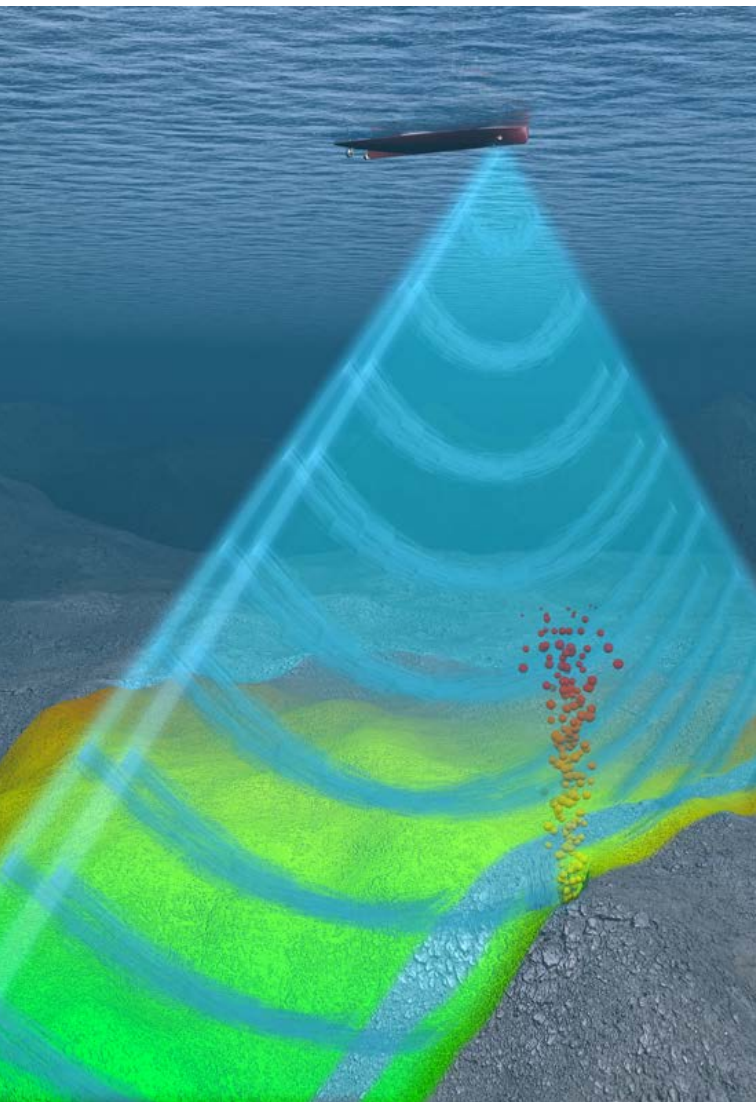
■ Underwater Communication Systems

The need for underwater communication has been rapidly growing for numerous applications within the last years.

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

Wärtsilä ELAC
HydroStar 4900





■ Survey Systems

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

Multibeam Systems

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

- Wärtsilä ELAC SeaBeam 1180 – multibeam system for shallow waters
- Wärtsilä ELAC SeaBeam 3050 – multibeam system for medium waters depths
- Wärtsilä ELAC SeaBeam 3030 – multibeam system, including multi-ping operation
- Wärtsilä ELAC SeaBeam 3020 – multibeam system for deep waters depths
- Wärtsilä ELAC SeaBeam 3020 ICE – Ice-hardened multibeam system for deep water depths
- Wärtsilä ELAC SeaBeam 3012 – deep-water multibeam system including multi-ping operation
- Wärtsilä ELAC SeaBeam 3012 ICE – ice-hardened deep-water multibeam system including multi-ping operation.

Single-Beam System

Wärtsilä ELAC HydroStar 4900 – Modular survey sounder for hydrographic and commercial survey vessels. Due to its digital signal processing, ELAC HydroStar 4900 allows exact bottom detection and bottom penetration.

■ Navigation Systems

Wärtsilä provides navigation echo sounder systems to guarantee a reliable detection of the seafloor from shallow to deep waters.

- Wärtsilä ELAC LAZ 5100 – Navigation Echo Sounder for shallow and deep water navigation
- Wärtsilä ELAC ST 30 – Sonar transponder for collision avoidance with submarines, offshore wind farms and offshore rigs.



Wärtsilä ELAC SeaBeam 3020

Electrical & Automation (E&A)

■ Turnkey Solutions

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

The turnkey solutions business unit offers the system integration competence and is acting in the sense of an EPC contractor for complete electrical packages – typically in a close partnership with shipyards. Your benefit is our systems engineering competence, creating more clever solutions with less cost and less installation time. Combining this service with the overall responsibility of detailed design for the electrical systems, our focus is in optimization the entire system on board. In this role, we also take care for the interfaces to all shipyard's subcontractors.



Our core competencies are in system integration, project management, procurement and site supervision. We are the shipyards single point of contact for the integration from bridge to propeller.

We provide

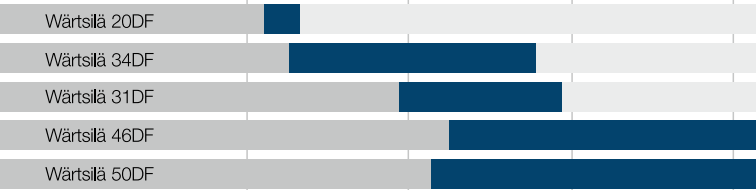
- Project Management
- System Integration
- Planning
- Cable engineering
- Cables and supports
- Cable installation
- Lighting system
- Testing and commissioning
- Procurement of sub systems
- Training
- Logistic support
- Service world wide



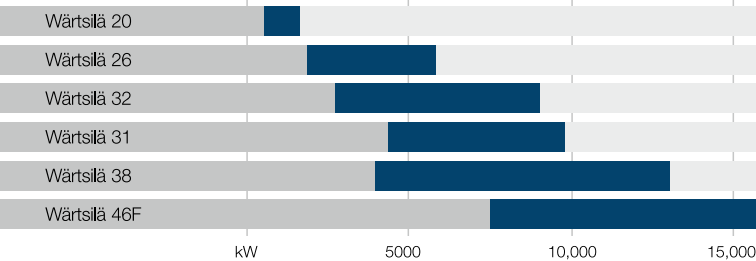
Engines and Generating Sets

Power range for Wärtsilä engines

Wärtsilä dual-fuel engines



Wärtsilä diesel engines



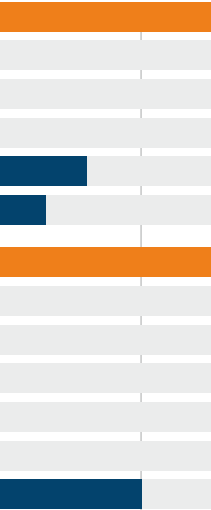
Wärtsilä Engines

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.



20,000



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.

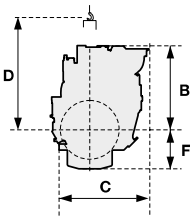
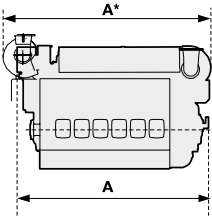
Engines and Generating Sets

■ ■ 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 8040 kJ/kWh	
Piston speed	11.2 m/s	BSGC 7850 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 59.



■ ■ 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 6990 kJ/kWh	
Piston speed	10.75 m/s		

Rated power

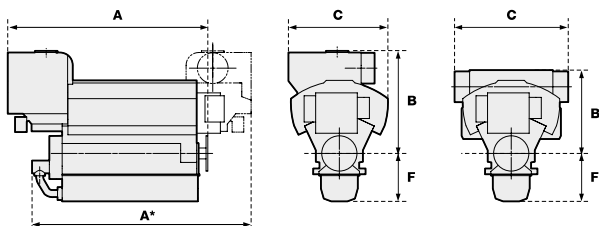
Engine type	kW
8V31DF	4 400
10V31DF	5 500
12V31DF	6 600
14V31DF	7 700
16V31DF	8 800

Engine dimensions (mm) and weights (tonnes)

Engine type	A*	A	B	C	F	Weight
8V31DF	6 180	5 585	3 205	3 100	1 500	56
10V31DF	6 820	6 225	3 205	3 100	1 500	62
12V31DF	7 500	6 905	2 550	3 500	1 500	71
14V31DF	8 140	7 545	2 550	3 500	1 500	77
16V31DF	8 780	8 185	2 550	3 500	1 500	85

*Turbocharger at flywheel end

For definitions see page 59.



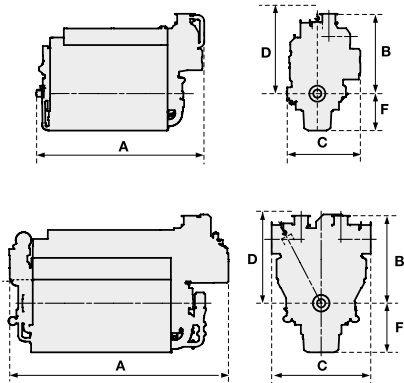
Engines and Generating Sets

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 7280 kJ/kWh	
Piston speed	10.0 m/s	BSGC 7200 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	5 325	2 550	2 380	2 345	1 155	35
8L34DF	5 960	2 550	2 610	2 345	1 155	44
9L34DF	6 870	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 59.



Wärtsilä 46DF		IMO Tier III, EPA T3	
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 7060 kJ/kWh BSGC 7020 kJ/kWh	
Piston speed	11.6 m/s		

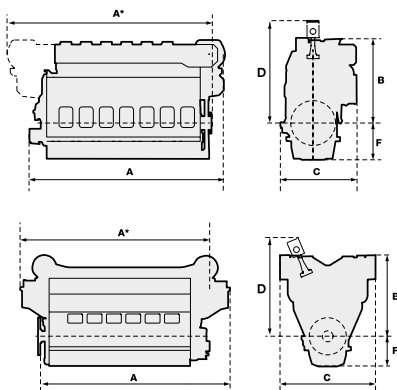
Rated power

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

Dimensions (mm) and weights (tonnes)

Engine type	A*	A	B	C	D	F	Weight
6L46DF	8 670	8 953	3 255	3 185	3 750	1 430	102
7L46DF	9 635	9 773	3 255	3 185	3 750	1 430	118
8L46DF	10 310	10 590	3 445	3 185	3 750	1 430	130
9L46DF	11 130	11 413	3 445	3 185	3 750	1 430	146
12V46DF	11 120	10 350	3 670	4 555	3 800	1 620	184
14V46DF	12 170	11 400	3 670	4 555	3 800	1 620	223
16V46DF	13 450	12 700	3 860	5 174	3 800	1 620	235

For definitions see page 59.



Engines and Generating Sets

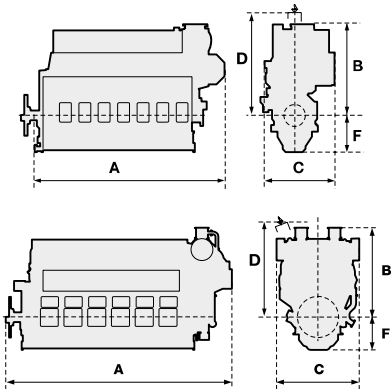
Wärtsilä 50DF		IMO Tier III, EPA T3	
Cylinder bore	500 mm	Fuel specification: Fuel oil	
Piston stroke	580 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	950, 975 kW/cyl	ISO 8217, category ISO-F-DMX, DMA and DMB	
Speed	500, 514 rpm		
Mean effective pressure	20.0 bar	BSEC 7150 kJ/kWh	
Piston speed	9.7, 9.9 m/s	BSGC 7110 kJ/kWh	

Rated power				
Engine type	50 Hz		60 Hz	
	Engine kW	Gen. kW	Engine kW	Gen. kW
6L50DF	5 700	5 500	5 850	5 650
8L50DF	7 600	7 330	7 800	7 530
9L50DF	8 550	8 250	8 775	8 470
12V50DF	11 400	11 000	11 700	11 290
16V50DF	15 200	14 670	15 600	15 050
18V50DF	17 100	16 500	17 550	16 940

Generator output based on a generator efficiency of 96.5%.

Engine dimensions (mm) and weights (tonnes)						
Engine type	A	B	C	D	F	Weight
6L50DF	8 115	3 475	3 270	4 000	1 455	96
8L50DF	10 230	3 920	3 505	4 000	1 455	128
9L50DF	11 140	3 920	3 505	4 000	1 455	148
12V50DF	10 410	4 055	3 810	3 600	1 500	175
16V50DF	13 085	4 400	4 730	3 600	1 500	220
18V50DF	14 180	4 400	4 730	3 600	1 500	240

For definitions see page 59.



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 kW/cyl	ISO 8217, category ISO-F-RMK 700	
Speed	1000 rpm	SFOC 185 g/kWh at ISO condition	
Mean effective pressure	27.3 bar		
Piston speed	9.3 m/s		

Rated power

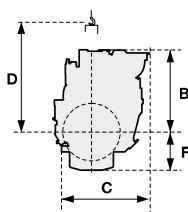
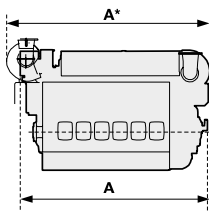
Engine type	kW
4L20	800
6L20	1 200
8L20	1 600
9L20	1 800

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 59.



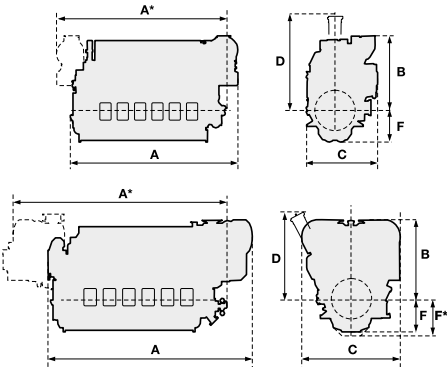
Engines and Generating Sets

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 181 g/kWh at ISO condition	
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	4387	4130	1882	1833	1960	2020	2430	818	950	17.0	17.2
8L26	5302	5059	2023	1868	2010	2107	2430	818	950	21.6	21.9
9L26	5691	5449	2023	1868	2016	2107	2430	818	950	23.3	23.6
12V26	5442	5314	2034	2034	2552	2602	2060	800	1110	28.7	29.0
16V26	6223	6025	2151	2190	2489	2763	2060	800	1110	36.1	37.9

*Turbocharger at flywheel end.
For definitions see page 59.



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 165 g/kWh at ISO conditions	
Mean effective pressure	30.1bar		
Piston speed	10.75 m/s		

Rated power

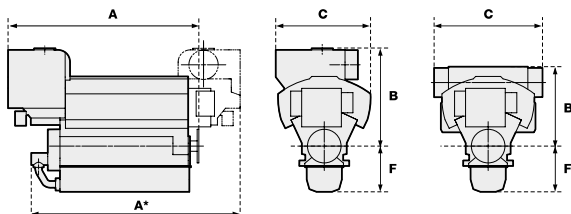
Engine type	kW
8V31	4 880
10V31	6 100
12V31	7 320
14V31	8 540
16V31	9 760

Engine dimensions (mm) and weights (tonnes)

Engine type	A*	A	B	C	F	Weight
8V31	6 180	5 585	3 205	3 100	1 500	56
10V31	6 820	6 225	3 205	3 100	1 500	62
12V31	7 500	6 905	2 550	3 500	1 500	71
14V31	8 140	7 545	2 550	3 500	1 500	77
16V31	8 780	8 185	2 550	3 500	1 500	85

*Turbocharger at flywheel end

For definitions see page 59.



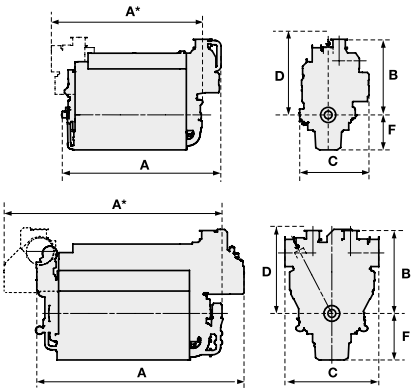
Engines and Generating Sets

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 174 g/kWh at ISO condition	
Mean effective pressure	28.9 bar		
Piston speed	10.0 m/s		

Rated power	
Engine type	580 kW/cyl
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	4 980	5 260	2 560	2 490	2 305	2 345	1 155	33.3
8L32	5 960	6 245	2 360	2 295	2 305	2 345	1 155	43.4
9L32	6 450	6 730	2 360	2 295	2 305	2 345	1 155	46.8
12V32	6 935	6 615	2 715	2 665	3 020	2 120	1 475	58.7
16V32	8 060	7 735	2 480	2 430	3 020	2 120	1 475	74.1

*Turbocharger at flywheel end.
For definitions see page 59.



Wärtsilä 38		IMO Tier II	
Cylinder bore	380 mm	Fuel specification: Fuel oil	
Piston stroke	475 mm	700 cSt/50°C	7200 sR1/100°F
Cylinder output	725 kW/cyl	ISO 8217, category ISO-F-RMK 700	
Speed	600 rpm	SFOC 176 g/kWh at ISO condition	
Mean effective pressure	26.9 bar		
Piston speed	9.5 m/s		

Rated power

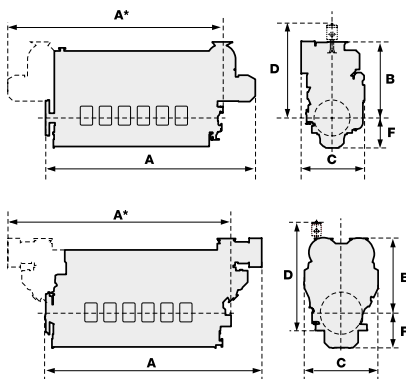
Engine type	kW
6L38	4 350
8L38	5 800
9L38	6 525
12V38	8 700
16V38	11 600

Dimensions (mm) and weights (tonnes)

Engine type	A*	A	B*	B	C	D	F	Weight
6L38	6 345	6 215	2 830	2 830	2 122	3 135	1 115	51
8L38	7 960	7 844	2 996	2 972	2 209	3 135	1 115	63
9L38	8 560	8 444	2 996	2 972	2 209	3 135	1 115	72
12V38	7 461	7 344	3 080	3 080	3 030	2 855	1 435	88
16V38	9 018	8 904	3 281	3 281	3 030	2 855	1 435	110

* Turbocharger at flywheel end.

For definitions see page 59.



Engines and Generating Sets

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 170 g/kWh at ISO condition	
Mean effective pressure	24.9 bar	Option: Lubricating oil module integrated on engine.	
Piston speed	11.6 m/s		

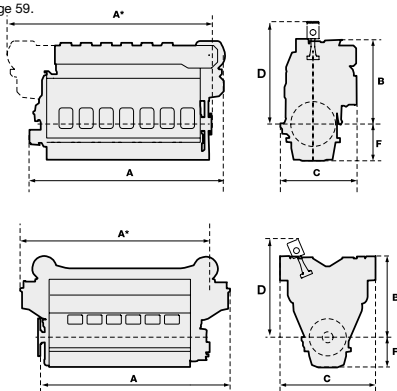
Rated power

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	D	F	Weight
6L46F	8 430	8 620	3 500	2 930	3 750	1 480	97
7L46F	9 260	9 440	3 800	2 950	3 750	1 480	113
8L46F	10 080	10 260	3 800	2 950	3 750	1 480	124
9L46F	10 900	11 080	3 800	2 950	3 750	1 480	140
12V46F	10 080	10 150	3 770	4 050	3 800	1 820	173
14V46F	11 650	11 729	4 243	4 678	3 800	1 820	216
16V46F	12 700	12 779	4 243	4 678	3 800	1 820	233

* Turbocharger at flywheel end.
For definitions see page 59.



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
- Lower calorific value of fuel 42 700 kJ/kg
- Tolerance 5%
- Without engine driven pumps
- Natural gas
- Methane number min. 80
- Lower heating value min. 28 MJ/Nm³
- Gas pressure 5.5 bar

ISO standard reference conditions

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

Engines and Generating Sets

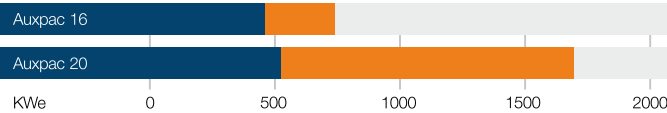


Wärtsilä Auxpac

wärtsilä Auxpac generating sets are available in a selected range as pre-engineered and pre-commissioned auxiliary generating sets. The common baseframe is optimised for the package, which together with the compact design of the engine and the selected generator, offers unmatched power-to-space and power-to-weight ratios. Other benefits of pre-engineering include readily available documentation, which also includes models in Tribon® format, and short lead-times. Auxpac generating sets are offered as 400 V/ 50 Hz and 450 V/60 Hz in the power range 500 kW to 1700 kW.

Pre-Engineered Medium-Speed Generating Sets			
Main data of generators	60 Hz	50 Hz	IMO Tier II or III
Voltage	450	400	Fuel specification:
Protection class	IP 23, IP 44 *	IP 23, IP 44 *	Fuel oil700 cSt/50°C
Temperature rise and isolation	Class F	Class F	ISO 8217, category ISO-F-RMK 55
Cooling	Air, water *	Air, water *	
			* Option

Power Range for Wärtsilä Auxpac



■ A16 – Dimensions (mm) and weights (tonnes)

60Hz	Output (kWe)	A	E	L	Weight
525W5L16	525	4 530	1 400	1 960	9.8
630W6L16	630	4 787	1 400	1 960	10.8
735W7L16	735	5 050	1 400	1 960	11.8
50Hz					
455W5L16	455	4 530	1 400	1 960	9.8
545W6L16	545	4 787	1 400	1 960	10.8
635W7L16	635	5 050	1 400	1 960	11.8

■ A20 – Dimensions (mm) and weights (tonnes)

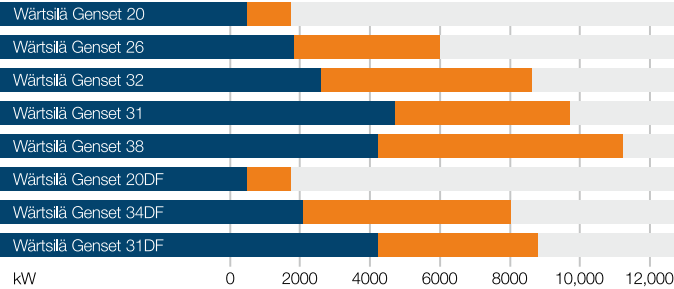
60 Hz	Output kWe	A	E	L	Weight
520W4L20	520	4 407	1 700	2 248	13.6
645W4L20	645	4 457	1 700	2 248	14.3
760W6L20	760	5 057	1 700	2 248	17.3
875W6L20	875	5 227	1 700	2 248	17.3
975W6L20	975	5 227	1 700	2 248	17.7
1050W6L20	1 050	5 227	1 700	2 248	18.0
1200W8L20	1 200	5 852	1 920	2 373	21.3
1400W8L20	1 400	5 852	1 920	2 373	22.4
1600W9L20	1 600	6 507	1 920	2 455	23.4
50 Hz					
520W4L20	520	4 399	1 770	2 248	13.3
670W4L20	670	4 407	1 770	2 248	13.4
790W6L20	790	5 007	1 770	2 248	16.4
860W6L20	860	5 057	1 770	2 248	16.9
1000W6L20	1 000	5 212	1 770	2 248	17.9
1140W6L20	1 140	5 212	1 770	2 248	18.1
1350W8L20	1 350	5 852	1 920	2 373	21.3
1550W9L20	1 550	6 507	1 920	2 373	22.8
1700W9L20	1 700	6 507	1 920	2 455	23.1

Engines and Generating Sets

Wärtsilä Gensets

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

Power Range for Wärtsilä Gensets



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 kW/cyl	Fuel specification: Fuel oil	
Speed	900, 1000 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	27.3, 28.0 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	8.4, 9.3 m/s	SFOC 186 g/kWh at ISO condition	

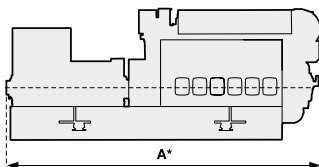
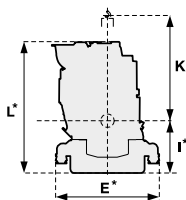
Rated power

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

Dimensions (mm) and weights (tonnes)

Engine type	A*	E*	I*	K	L*	Weight*
4L20	4 910	1 770/1920	990	1 800	2338	14.0
6L20	5 325	1770/1920/2070	895/975/1025	1 800	2243/2323/2373	16.8
8L20	6 030	1920/2070	1025/1075	1 800	2474/2524	20.7
9L20	6 535	2070/2300	1075/1125	1 800	2524/2574	23.8

* Dependent on generator type and size.
For definitions see page 71.



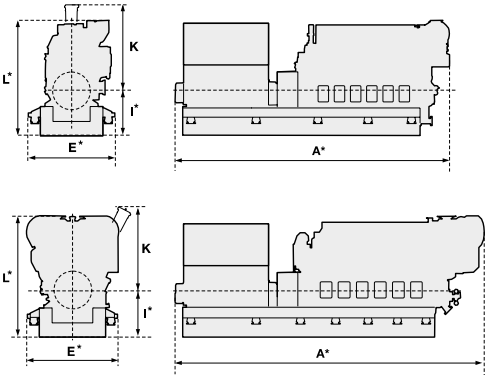
Engines and Generating Sets

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	23.0, 25.5 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	9.6, 10.7 m/s	SFOC 181 g/kWh at ISO condition	

Rated power				
Engine type	60 Hz		50 Hz	
	325 kW/cyl, 900 rpm		340 kW/cyl, 1000 rpm	
	Eng. kW	Gen. kW	Eng. 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 71.



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 165 g/kWh at ISO conditions	

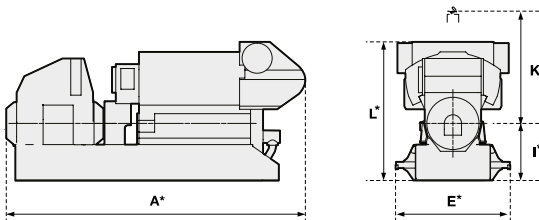
Rated power

Engine type	60 Hz		50 Hz	
	590 kW/cyl, 720 rpm		610 kW/cyl, 750 rpm	
	Eng. kW	Gen. kW	Eng. 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	3 110	1 700	2 390	4 880	90.0
10V31	9 750	3 110	1 700	2 390	4 880	101.0
12V31	10 150	3 500	1 700	2 390	4 350	115.0
14V31	10 800	3 500	1 700	2 390	4 350	120.5
16V31	11 400	3 500	1 700	2 390	4 350	131.0

* Dependent on generator type and size.
For definitions see page 71.



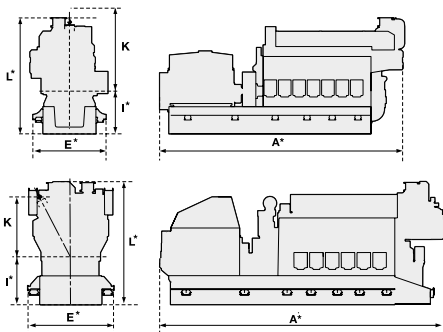
Engines and Generating Sets

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 174 g/kWh at ISO condition	

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	3480	3340
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	8 505	2 490	1 450	2 345	3 745	57
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 71.



Wärtsilä Genset 38			IMO Tier II
Cylinder bore	380 mm	Generator voltage	0.4–13.8 kV
Piston stroke	475 mm	Generator efficiency	0.95–0.98
Cylinder output	725 kW/cyl	Fuel specification: Fuel oil	
Speed	600 rpm	700 cSt/50°C	7200 sR1/100°F
Mean effective pressure	26.9 bar	ISO 8217, category ISO-F-RMK 700	
Piston speed	9.5 m/s	SFOC 176 g/kWh at ISO condition	

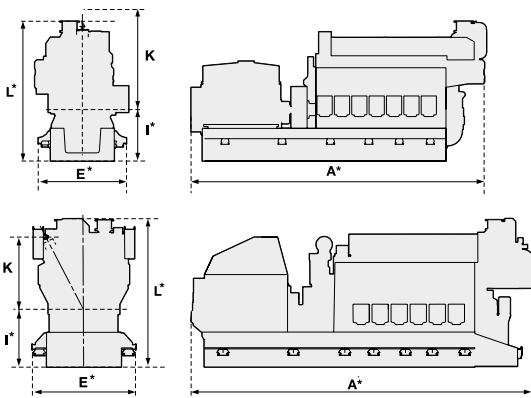
Rated power

Engine type	50 Hz, 60 Hz	
	Eng. kW	Gen. kW
6L38	4 350	4 200
8L38	5 800	5 600
9L38	6 525	6 300
12V38	8 700	8 400
16V38	11 600	11 200

Dimensions (mm) and weights (tonnes)

Engine type	A*	E*	I*	K	L*	Weight*
6L38	9 600	2 900	1 655	3 135	4 485	90
8L38	12 000	2 900	1 705	3 135	4 475	110
9L38	12 300	3 100	1 805	3 135	4 575	130
12V38	11 900	3 600	2 015	2 855	4 945	160
16V38	13 300	3 800	2 015	2 855	5 120	200

* Dependent on generator type and size.
For definitions see page 71.



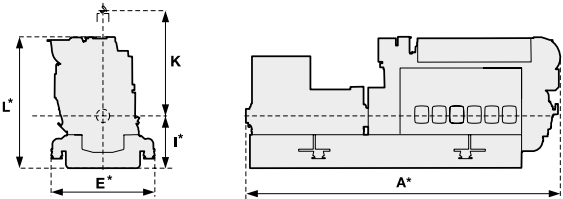
Engines and Generating Sets

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 7850 kJ/kWh BSGC 7680 kJ/kWh	
Piston speed	9.3, 11.2 m/s		
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 71.



Wärtsilä Genset 31DF			IMO Tier III
Cylinder bore	310 mm	Fuel specification: Fuel oil	
Piston stroke	430 mm	700cSt/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 6990 kJ/kWh at ISO conditions	
Piston speed	10.3, 10.75 m/s		
Generator voltage	0.4-13.8 kV		
Generator efficiency	0.95-0.97		

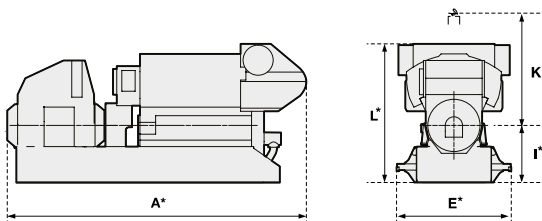
Rated power

Engine type	60 Hz		50 Hz	
	530 kW/cyl, 720 rpm		550 kW/cyl, 750 rpm	
	Eng. kW	Gen. kW	Eng. 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	3 110	1 700	2 390	4 880	90.0
10V31DF	9 750	3 110	1 700	2 390	4 880	101.0
12V31DF	10 150	3 500	1 700	2 390	4 350	115.0
14V31DF	10 800	3 500	1 700	2 390	4 350	120.5
16V31DF	11 400	3 500	1 700	2 390	4 350	131.0

* Dependent on generator type and size.
For definitions see page 71.



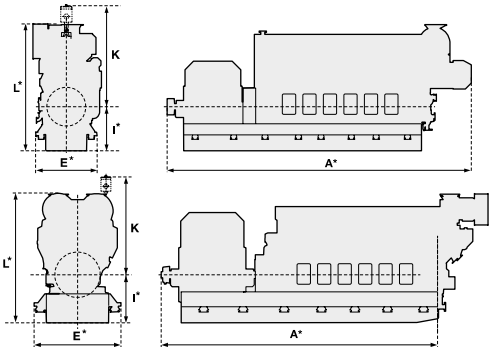
Engines and Generating Sets

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 7280 kJ/kWh BSGC 7200 kJ/kWh	
Piston speed	9.6, 10.0 m/s		
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	8 765	2 290	1 450	2 345	4 000	60
8L34DF	10 410	2 960	1 630	2 345	4 010	76
9L34DF	10 610	2 890	1 630	2 345	4 180	87
12V34DF	10 260	3 060	1 900	2 120	4 335	99
16V34DF	11 465	3 360	1 850	2 120	4 445	124

* Dependent on generator type.
Generator output based on a generator efficiency of 96%.
For definitions see page 71.



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
- Lower calorific value of fuel 42 700 kJ/kg
- Tolerance 5%
- Without engine driven pumps
- Natural gas
- Methane number min. 80
- Lower heating value min. 28 MJ/Nm³
- Gas pressure 5.5 bar

ISO standard reference conditions

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

Engines and Generating Sets

Engine auxiliary systems

All auxiliary equipment needed for the diesel 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 diesel 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.



Module consisting of preheater, cooling water thermostatic valves, lubricating oil automatic filter, pre-lubricating oil pump and fuel oil booster unit.



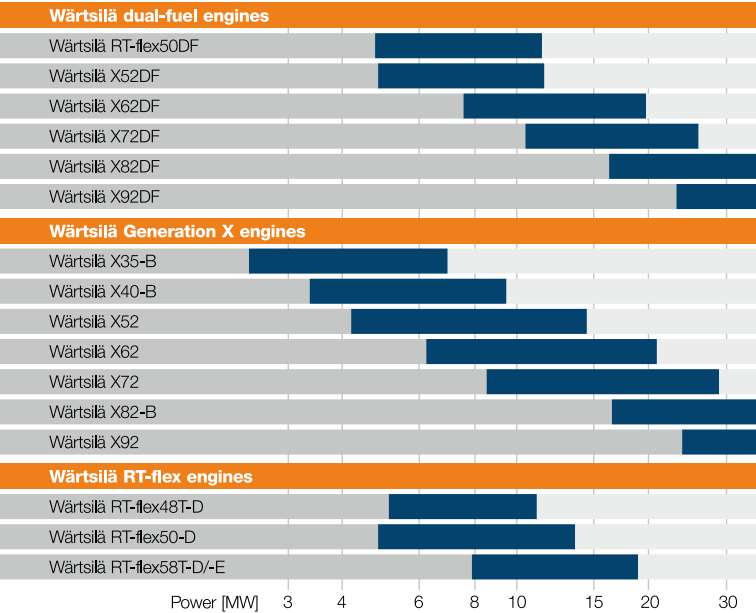
Oil mist separator module.



Fuel oil transfer pump module with heater.

Engines and Generating Sets

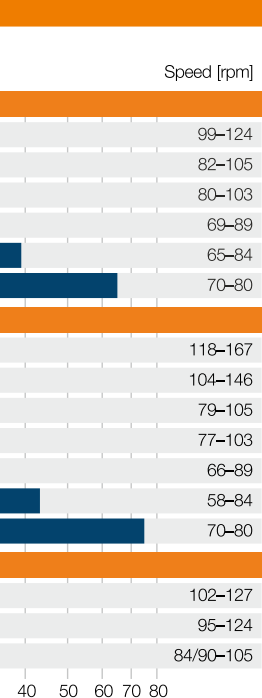
Power range for Wärtsilä low-speed engines



Wärtsilä low-speed engines

Wärtsilä low-speed, two-stroke engines are the optimal propulsion solution for merchant vessels with directly driven propellers. Wärtsilä’s well proven electronically-controlled common-rail technology plays a key role in enabling ship owners to reduce fuel and lubricants costs. The benefits to shipowners and operators may be summarised as:

- The optimal power and speed for every operational need
- Competitive capital cost
- Lowest possible fuel consumption over the whole operating range, especially in part-load
- Operate on high density fuel ISO F 8217:2012/RMK700
- Special tunings to suit particular sailing profiles
- Low cylinder oil feed rate
- Full compliance with NO_x emission control regulations
- Smokeless operation at manoeuvring and sailing conditions



- Low steady operational speeds
- Up to five years between overhauls
- Reduced maintenance requirements, resulting in low operational costs, higher reliability and durability

The following Wärtsilä brand RT-flex engines are available on request and supported by Winterthur Gas & Diesel.

- RT-flex50B 4 850–13 280 kW/95–124 rpm
- RT-flex58T-D_ER-3 5 400–14 245 kW/80–105 rpm
- RT-flex60C-B 8 450–21 780 kW/91–114 rpm
- RT-flex68D 10 950–25 040 kW/76–95 rpm
- RT-flex82T 21 720–40 680 kW/68–80 rpm
- RT-flex82C 21 720–54 240 kW/87–102 rpm
- RT-flex84T-D 14 700–37 800 kW/61–76 rpm
- RT-flex96C 24 000–80 080 kW/92–102 rpm

Engines and Generating Sets

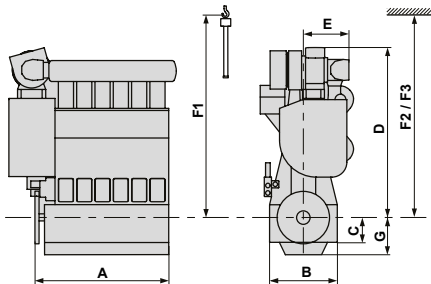
■ Wärtsilä X35-B	IMO Tier II/Tier III (SCR)
Cylinder bore	350 mm
Piston stroke	1550 mm
Speed	118–167 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.43

Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	167 rpm		118 rpm			
	R1	R2	R3	R4		
5	4 350	3 475	3 075	2 450	4 398	74
6	5 220	4 170	3 690	2 940	5 010	84
7	6 090	4 865	4 305	3 430	5 622	95
8	6 960	5 560	4 920	3 920	6 234	105

Dimensions (mm)	B	C	D	E
	2 284	830	5 556	1 605
	F1	F2	F3	G
	6 850	6 900	6 450	1 326

Brake specific fuel consumption (BSFC) in g/kWh					
Full load					
Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.8	21.0	16.8
BSFC	Standard Tuning	175	169	175	169
Part load, % of R1					
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	171.2	170.8	170.5	169.3	166.0

For definitions see page 95.



■ Wärtsilä X40-B		IMO Tier II/Tier III (SCR)
Cylinder bore	400 mm	
Piston stroke	1770 mm	
Speed	104–146 rpm	
Mean effective pressure at R1	21.0 bar	
Stroke / bore	4.43	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	146 rpm		104 rpm			
	R1	R2	R3	R4		
5	5 675	4 550	4 050	3 250	5 107	109
6	6 810	5 460	4 860	3 900	5 807	125
7	7 945	6 370	5 670	4 550	6 507	140
8	9 080	7 280	6 480	5 200	7 207	153

Dimensions (mm)	B	C	D	E
	2 610	950	6 335	1 734
	F1	F2	F3	G
	7 750	7 860	7 400	1 411

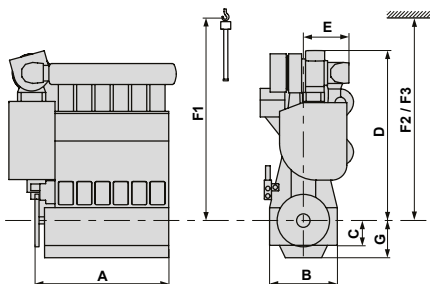
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.8	21.0	16.8
BSFC	Standard Tuning	174	168	174	168

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	170.2	169.8	169.5	168.3	165.0

For definitions see page 95.



Engines and Generating Sets

■ Wärtsilä X52	IMO Tier II/Tier III (SCR)
Cylinder bore	520 mm
Piston stroke	2315 mm
Speed	79-105 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.45

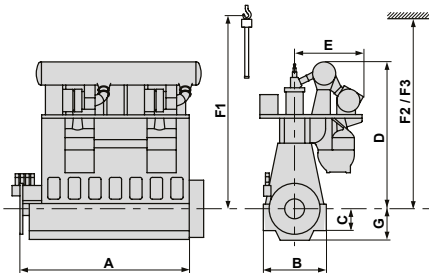
Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		79 rpm			
	R1	R2	R3	R4		
4	7 240	5 440	5 440	4 080	4 970	184
5	9 050	6 800	6 800	5 100	5 910	217
6	10 860	8 160	8 160	6 120	6 850	251
7	12 670	9 520	9 520	7 140	7 790	288
8	14 480	10 880	10 880	8 160	8 730	323

Dimensions (mm)	B	C	D	E
	3 495	1 205	8 444	2 146
	F1	F2	F3	G
	10 250	10 250	9 700	1 866

Brake specific fuel consumption (BSFC) in g/kWh					
Full load					
Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.8	21.0	15.8
BSFC	Standard Tuning	167	160	167	160

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2	162.8	162.5	161.3	158.0

For definitions see page 95.



■ Wärtsilä X62		IMO Tier II/Tier III (SCR)
Cylinder bore	620 mm	
Piston stroke	2658 mm	
Speed	77–103 rpm	
Mean effective pressure at R1/R1+	20.5/19.3 bar	
Stroke / bore	4.29	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	97 / 103 rpm		77 rpm			
	R1 / R1+	R2 / R2+	R3	R4		
4	10 640	8 000	8 440	6 360	5 895	270
5	13 300	10 000	10 550	7 950	7 000	325
6	15 960	12 000	12 660	9 540	8 110	377
7	18 620	14 000	14 770	11 130	9 215	435
8	21 280	16 000	16 880	12 720	10 320	482

Dimensions (mm)	B	C	D	E
	4 200	1 360	9 580	3 915
	F1	F2	F3	G
	11 670	11 670	10 800	2 110

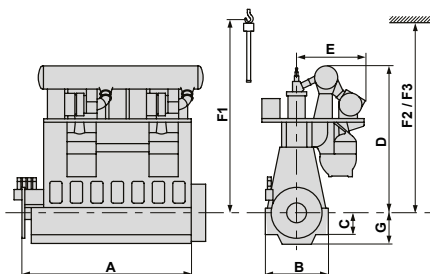
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		20.5/19.3	15.4/14.5	20.5	15.4
BSFC	Standard Tuning	167/166	160	167	160

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2/162.2	162.8/161.8	162.5/161.5	161.3/160.3	158.0/157.2

For definitions see page 95.



Engines and Generating Sets

■ Wärtsilä X72	IMO Tier II/Tier III (SCR)
Cylinder bore	720 mm
Piston stroke	3086 mm
Speed	66–89 rpm
Mean effective pressure at R1/R1+	20.5/19.4 bar
Stroke / bore	4.29

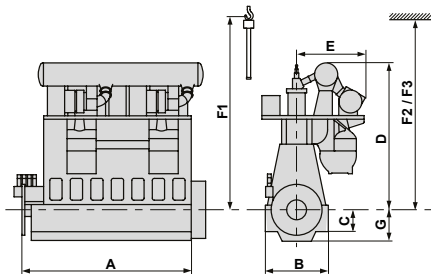
Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	84 / 89 rpm		66 rpm			
	R1 / R1+	R2 / R2+	R3	R4		
4	14 440	10 800	11 360	8 480	6 790	407
5	18 050	13 500	14 200	10 600	8 085	481
6	21 660	16 200	17 040	12 720	9 375	561
7	25 270	18 900	19 880	14 840	10 665	642
8	28 880	21 600	22 720	16 960	11 960	716

Dimensions (mm)	B	C	D	E
	4 780	1 575	10 790	4 710
	F1	F2	F3	G
	13 560	13 560	12 580	2 455

Brake specific fuel consumption (BSFC) in g/kWh					
Full load					
Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		20.5/19.4	15.4/14.5	20.5	15.4
BSFC	Standard Tuning	167/166	160	167	160

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	163.2/162.2	162.8/161.8	162.5/161.5	161.3/160.3	158.0/157.2

For definitions see page 95.



■ Wärtsilä X82-B		IMO Tier II/Tier III (SCR)
Cylinder bore	820 mm	
Piston stroke	3375 mm	
Speed	58–84 rpm	
Mean effective pressure at R1/R1+	21.0/19.0 bar	
Stroke / bore	4.12	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	76 / 84 rpm		58 rpm			
	R1 / R1+	R2 / R2+	R3	R4		
6	28 500	21 720	21 750	16 590	11 045	805
7	33 250	25 340	25 375	19 355	12 550	910
8	38 000	28 960	29 000	22 120	14 055	1 020
9	42 750	32 580	32 625	24 885	16 500	1 160

Dimensions (mm)	B	C	D	E
	5 320	1 800	12 250	5 400
	F1	F2	F3	G
	14 820	14 800	13 800	2 700

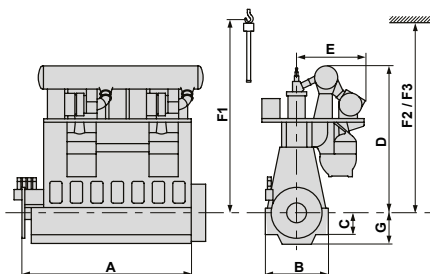
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		21.0/19.0	16.0/14.5	21.0	16.0
BSFC	Standard Tuning	165/163	158	165	158

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	161.2/159.2	160.8/158.8	160.5/158.5	159.3/157.3	156.0/154.3

For definitions see page 95.



Engines and Generating Sets

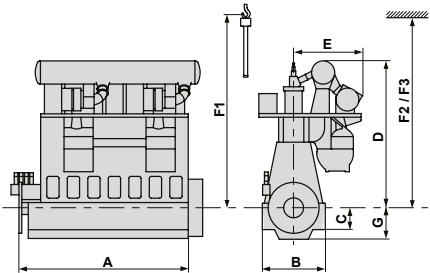
■ Wärtsilä X92	IMO Tier II/Tier III (SCR)
Cylinder bore	920 mm
Piston stroke	3468 mm
Speed	70–80 rpm
Mean effective pressure at R1	21.0
Stroke / bore	3.77

Rated power, principal dimensions and weights						
Cyl.	80 rpm		70 rpm		Length A mm	Weight tonnes
	R1	R2	R3	R4		
6	38 700	27 900	33 900	24 420	11 630	1 120
7	45 150	32 550	39 550	28 490	13 210	1 260
8	51 600	37 200	45 200	32 560	14 750	1 380
9	58 040	41 850	50 850	36 630	17 850	1 630
10	64 500	46 500	56 500	40 700	19 520	1 790
11	70 950	51 150	62 150	44 770	21 280	1 960
12	77 400	55 800	67 800	48 840	22 870	2 140

Dimensions (mm)	B	C	D	E
	5550	1900	12 950	6050
	F1	F2	F3	G
	15 420	15 450	14 240	2930

Brake specific fuel consumption (BSFC) in g/kWh					
Full load					
Rating point		R1	R2	R3	R4
BMEP, bar		21.0	15.1	21.0	15.1
BSFC	Standard Tuning	166	159	166	159
Part load, % of R1					
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	162.2	161.8	161.5	160.3	155.6

For definitions see page 95.



Wärtsilä RT-flex48T-D		IMO Tier II/Tier III (SCR)
Cylinder bore	480 mm	
Piston stroke	2000 mm	
Speed	102–127 rpm	
Mean effective pressure at R1	19.0 bar	
Stroke / bore	4.17	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	127 rpm		102 rpm			
	R1	R2	R3	R4		
5	7 275	5 100	5 825	5 100	5 314	171
6	8 730	6 120	6 990	6 120	6 148	205
7	10 185	7 140	8 155	7 140	6 982	225
8	11 640	8 160	9 320	8 160	7 816	250

Dimensions (mm)	B	C	D	E
	3 170	1 085	7 334	3 253
	F1	F2	F3	G
	9 030	9 030	8 790	1 700

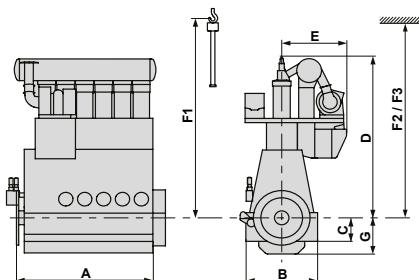
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		19.0	13.3	19.0	16.6
BSFC	Standard Tuning	170	164	170	166

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	166.2	164.5	165.5	163.0	159.9

For definitions see page 95.



Engines and Generating Sets

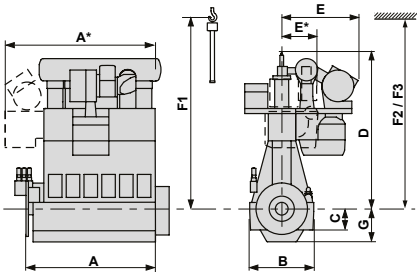
■ Wärtsilä RT-flex50-D	IMO Tier II/Tier III (SCR)
Cylinder bore	500 mm
Piston stroke	2050 mm
Speed	95–124 rpm
Mean effective pressure at R1	21.0 bar
Stroke / bore	4.10

Rated power, principal dimensions and weights							
Cyl.	Output in kW at				Length A mm	Length A* mm	Weight tonnes
	124 rpm		95 rpm				
	R1	R2	R3	R4			
5	8 725	6 650	6 700	5 100	5 576	6 793	200
6	10 470	7 980	8 040	6 120	6 456	7 670	225
7	12 215	9 310	9 380	7 140	7 336		255
8	13 960	10 640	10 720	8 160	8 216		280

Dimensions (mm)	B	C	D	E	E*
	3 150	1 088	7 646	3 570	1 900
	F1	F2	F3	G	
	9 270	9 270	8 800	1 636	

Brake specific fuel consumption (BSFC) in g/kWh					
Full load					
Rating point		R1	R2	R3	R4
BMEP, bar		21.0	16.0	21.0	16.0
BSFC	Standard Tuning	169	163	169	163
Part load, % of R1					
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	165.2	163.5	164.5	162.0	158.9

For definitions see page 95.



A*/E*: T/C at aft end.

Wärtsilä RT-flex58T-E		IMO Tier II/Tier III (SCR)
Cylinder bore	580 mm	
Piston stroke	2416 mm	
Speed	90–105 rpm	
Mean effective pressure at R1	21 bar	
Stroke / bore	4.17	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		90 rpm			
	R1	R2	R3	R4		
5	11 750	7 900	10 075	7 900	6 381	281
6	14 100	9 480	12 090	9 480	7 387	322
7	16 450	11 060	14 105	11 060	8 393	377
8	18 800	12 640	16 120	12 640	9 399	418

Dimensions (mm)	B	C	D	E
	3 820	1 300	8 822	3 475
	F1	F2	F3	G
	10 960	11 000	10 400	2 000

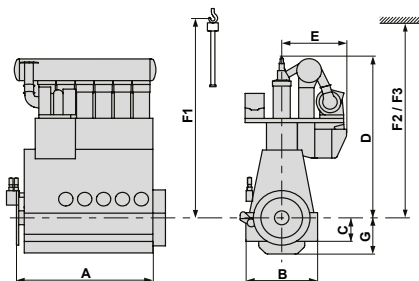
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1	R2	R3	R4
BMEP, bar		21.0	14.1	21.0	16.5
BSFC	Standard Tuning	168	162	168	162

Part load, % of R1	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	164.2	162.5	163.5	161.0	157.9

For definitions see page 95.



Engines and Generating Sets

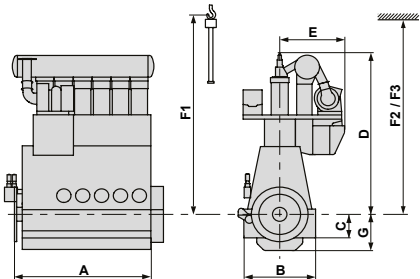
■ Wärtsilä RT-flex58T-D		IMO Tier II/Tier III (SCR)
Cylinder bore	580 mm	
Piston stroke	2416 mm	
Speed	84–105 rpm	
Mean effective pressure at R1	20.2 bar	
Stroke / bore	4.17	

Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		84 rpm			
	R1	R2	R3	R4		
5	11 300	7 900	9 050	7 900	6 381	281
6	13 560	9 480	10 860	9 480	7 387	322
7	15 820	11 060	12 670	11 060	8 393	377
8	18 080	12 640	14 480	12 640	9 399	418

Dimensions (mm)	B		C		D		E	
	3 820		1 300		8 822		3 475	
	F1		F2		F2		G	
	10 960		11 000		10 400		2 000	

Brake specific fuel consumption (BSFC) in g/kWh						
Full load						
Rating point		R1	R2	R3	R4	
BMEP, bar		20.2	14.1	20.2	17.7	
BSFC	Standard Tuning	169	163	169	165	
Part load, % of R1						
Tuning variant	Standard	Standard	Delta	Delta	Low-Load	
BSFC	165.2	163.5	164.5	162.0	158.9	

For definitions see page 95.





Engines and Generating Sets



Low-speed dual-fuel engines

Driven by emission regulations and recent fuel price developments, the interest in gas as fuel for shipping is increasing. Wärtsilä is the leading provider of medium-speed gas and dual-fuel engines since 2005. A major milestone was recently reached with 1400 engines sold, collectively logging more than 13 million running hours. Wärtsilä dual-fuel technology for 2-stroke engines is based on the pre-mixed lean burn combustion principle already proven for the Wärtsilä 4-stroke dual-fuel engines. The merits of this technology are:

- no additional NO_x reduction technologies are needed to fulfill the IMO Tier III requirements
- gas injection pressure < 16 bar
- simple, reliable and low cost gas supply system

DF-ready option

All Generation X engines can be converted to use LNG as fuel. For simplifying the future conversion WinGD has introduced the DF-ready version as an option. The DF-ready engines can be easily converted to dual-fuel, as no major structural components need to be modified. All parts, which are to be replaced at a later conversion, are either typical wear parts or specific X-DF components and systems. The DF-ready version is the recommended solution for LNG-ready ships.

Wärtsilä RT-flex50DF		IMO Tier III in gas mode
Cylinder bore		500mm
Piston stroke		2050mm
Speed		99–124rpm
Mean effective pressure at R1		17.3 bar
Stroke/bore		4.10

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A (mm)	Length A* (mm)	Weight tonnes
	124 rpm	124 rpm	99 rpm	99 rpm			
	R1	R2	R3	R4			
5	7 200	6 000	5 750	4 775	5 576	6 793	200
6	8 640	7 200	6 900	5 730	6 456	7 670	225
7	10 080	8 400	8 050	6 685	7 336		255
8	11 520	9 600	9 200	7 640	8 216		280

Dimensions (mm)	B	C	D	E	E*
	3 150	1 088	7 646	3 570	1 900
	F1	F2	F3	G	
	9 270	9 270	8 800	1 636	

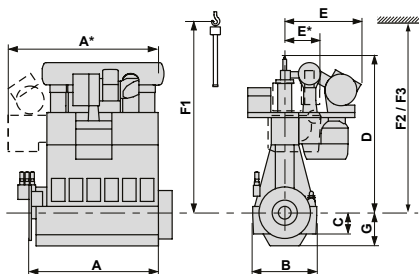
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 200	7 158	7 200	7 158
BSGC (gas)	g/kWh	142.7	141.6	142.7	141.6
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

For definitions see page 95.



A*/E*: T/C at aft end.

Engines and Generating Sets

■ Wärtsilä X52DF		IMO Tier III in gas mode
Cylinder bore	520 mm	
Piston stroke	2315 mm	
Speed	82–105 rpm	
Mean effective pressure at R1	17.3 bar	
Stroke / bore	4.45	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	105 rpm		82 rpm			
	R1	R2	R3	R4		
5	7 450	6 200	5 825	4 850	5 950	217
6	8 940	7 440	6 990	5 820	6 900	251
7	10 430	8 680	8 155	6 790	7 850	288
8	11 920	9 920	9 320	7 760	8 800	323

Dimensions (mm)	B		C		D		E	
	3 495		1 205		8 444		2 146	
	F1		F2		F3		G	
	10 350		10 350		9 800		1 866	

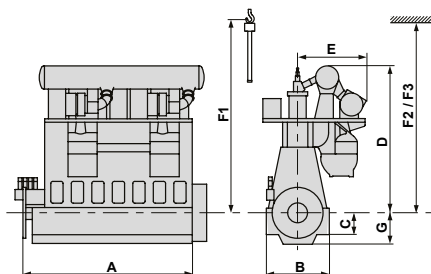
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 200	7 158	7 200	7 158
BSGC (gas)	g/kWh	142.7	141.6	142.7	141.6
BSPC (pilot fuel)	g/kWh	1.5	1.8	1.5	1.8

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	182.1	182.1	182.1	182.1

For definitions see page 95.



■ Wärtsilä X62DF		IMO Tier III in gas mode
Cylinder bore	620 mm	
Piston stroke	2658 mm	
Speed	80–103 rpm	
Mean effective pressure at R1	17.3 bar	
Stroke / bore	4.29	

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	103 rpm		80 rpm			
	R1	R2	R3	R4		
5	11 925	9 925	9 250	7 700	7 000	325
6	14 310	11 910	11 100	9 240	8 110	377
7	16 695	13 895	12 950	10 780	9 215	435
8	19 080	15 880	14 800	12 320	10 320	482

Dimensions (mm)	B	C	D	E
	4 200	1 360	9 580	3 915
	F1	F2	F3	G
	11 775	11 775	10 950	2 110

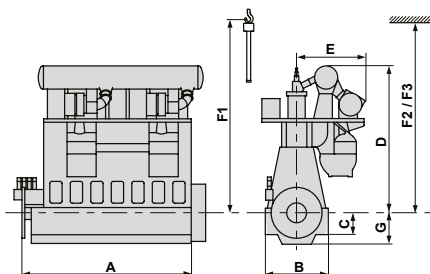
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 166	7 089	7 166	7 089
BSGC (gas)	g/kWh	142.5	140.8	142.5	140.8
BSPC (pilot fuel)	g/kWh	1.0	1.2	1.0	1.2

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0

For definitions see page 95.



Engines and Generating Sets

■ Wärtsilä X72DF		IMO Tier III in gas mode
Cylinder bore	720 mm	
Piston stroke	3086 mm	
Speed	69-89 rpm	
Mean effective pressure at R1	17.3 bar	
Stroke / bore	4.29	

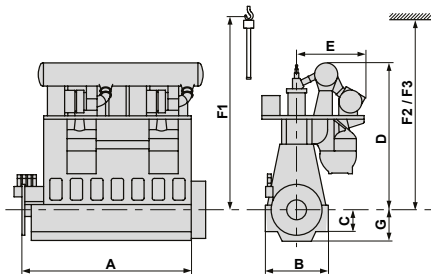
Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	89 rpm		69 rpm			
	R1	R2	R3	R4		
5	16 125	13 425	12 500	10 400	8 085	481
6	19 350	16 110	15 000	12 480	9 375	561
7	22 575	18 795	17 500	14 560	10 665	642
8	25 800	21 480	20 000	16 640	11 960	716

Dimensions (mm)	B		C		D		E	
	4 780		1 575		10 790		4 710	
	F1		F2		F3		G	
	13 655		13 655		12 730		2 455	

Brake specific consumptions in gas mode						
Rating point		R1	R2	R3	R4	
BSEC (energy)	kJ/kWh	7 149	7 059	7 149	7 059	
BSGC (gas)	g/kWh	142.3	140.3	142.3	140.3	
BSPC (pilot fuel)	g/kWh	0.8	1.0	0.8	1.0	

Brake specific fuel consumption in diesel mode						
Rating point		R1	R2	R3	R4	
BSFC (diesel)	g/kWh	180.0	180.0	180.0	180.0	

For definitions see page 95.



Wärtsilä X82DF		IMO Tier III in gas mode
Cylinder bore		820 mm
Piston stroke		3375 mm
Speed		65-84 rpm
Mean effective pressure at R1		17.3 bar
Stroke / bore		4.12

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	84 rpm		65 rpm			
	R1	R2	R3	R4		
6	25 920	21 600	20 070	16 710	11 045	805
7	30 240	25 200	23 415	19 495	12 550	910
8	34 560	28 800	26 760	22 280	14 055	1 020
9	38 880	32 400	30 105	25 065	16 500	1 160

Dimensions (mm)	B		C		D		E	
	5 320		1 800		12 250		5 400	
	F1		F2		F3		G	
	15 020		15 000		14 000		2 700	

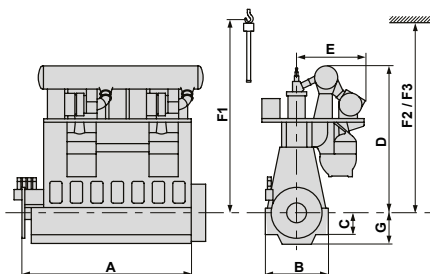
Brake specific consumptions in gas mode

Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 115	7 025	7 115	7 025
BSGC (gas)	g/kWh	141.8	139.9	141.8	139.9
BSPC (pilot fuel)	g/kWh	0.6	0.7	0.6	0.7

Brake specific fuel consumption in diesel mode

Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

For definitions see page 95.



Engines and Generating Sets

■ Wärtsilä X92DF		IMO Tier III in gas mode
Cylinder bore	920 mm	
Piston stroke	3468 mm	
Speed	70-80 rpm	
Mean effective pressure at R1	17.3 bar	
Stroke / bore	3.77	

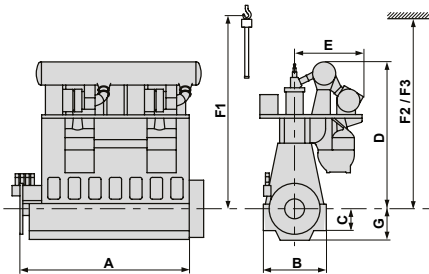
Rated power, principal dimensions and weights						
Cyl.	Output in kW at				Length A mm	Weight tonnes
	80 rpm		70 rpm			
	R1	R2	R3	R4		
6	31 920	26 580	27 930	23 250	11 630	1 120
7	37 240	31 010	32 585	27 125	13 210	1 260
8	42 560	35 440	37 240	31 000	16 350	1 460
9	47 880	39 870	41 895	34 875	17 850	1 630
10	53 200	44 300	46 550	38 750	19 520	1 790
11	58 520	48 730	51 205	42 625	21 280	1 960
12	63 840	53 160	55 860	46 500	22 870	2 140

Dimensions (mm)	B	C	D	E
	5 550	1 900	12 950	6 050
	F1	F2	F3	G
	15 620	15 650	14 440	2 930

Brake specific consumptions in gas mode					
Rating point		R1	R2	R3	R4
BSEC (energy)	kJ/kWh	7 089	7 000	7 089	7 000
BSGC (gas)	g/kWh	141.4	139.5	141.4	139.5
BSPC (pilot fuel)	g/kWh	0.5	0.6	0.5	0.6

Brake specific fuel consumption in diesel mode					
Rating point		R1	R2	R3	R4
BSFC (diesel)	g/kWh	178.9	178.9	178.9	178.9

For definitions see page 95.



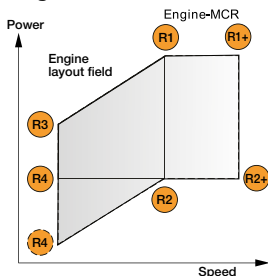
Definitions and Notes for Low-Speed Engines

ISO standard reference conditions

Total barometric pressure at R1	1.0 bar
Suction air temperature	25°C
Relative humidity	30%
Cooling water temperature before engine	25°C

Rating points for Wärtsilä low-speed engines

The engine layout fields for Wärtsilä low-speed engines are defined by the power/speed rating points R1, R2, R3 and R4 (see diagram to the right). In certain engines, the layout field is extended to the points R1+ and R2+. R1, or R1+ instead if applicable, is the nominal maximum continuous rating (MCR). Any power and speed within the respective engine layout field may be selected as the Contract-MCR (CMCR) point for an engine.



Dimensions and weights

- All dimensions are in millimetres and are not binding.

A Engine length up to coupling flange

B Width of engine

C Crankshaft to underside of foot flange

D Height of engine above crankshaft

E Distance from engine centreline to T/C flange

F1 Min. height for vertical removal

F2 Min. height for vertical removal with double-jib crane

F3 Min. height for tilted removal with double-jib crane

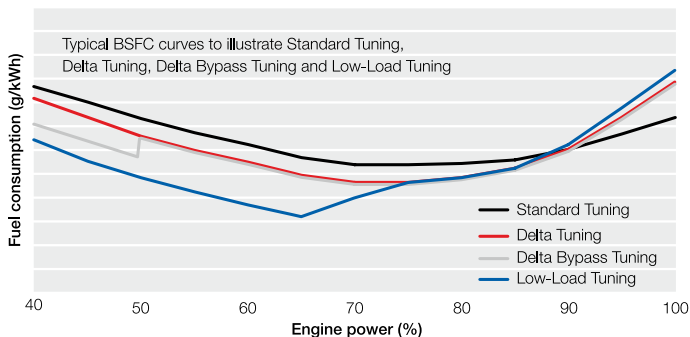
G Distance from crankshaft axis to the bottom of the oil pan

- The engine weight is net in metric tonnes (t), without oil and water, and is not binding.

Fuel/energy consumption

All brake specific fuel consumptions (BSFC) and brake specific pilot fuel consumptions (BSPC) are quoted for fuel of lower calorific value 42.7 MJ/kg. Brake specific gas consumptions (BSGC) are quoted for gas of lower calorific value 50.0 MJ/kg. Brake specific energy consumptions (BSEC) for dual-fuel engines are based on energy delivered to the engine as gas and pilot fuel for one kilowatt hour mechanical power output.

Engines and Generating Sets



For all Wärtsilä low-speed diesel and low-speed dual-fuel engines stepwise tolerances have been introduced for the brake specific fuel and energy consumption (BSFC/BSEC) guarantee, referring to ISO standard reference conditions (ISO 15550 and 3046):

- +5% tolerance for 100% to 85% engine load
- +6% tolerance for 84% to 65% engine load
- +7% tolerance for 64% to 50% engine load

The BSFC/BSEC guarantee is possible at up to three load points between 50–100%.

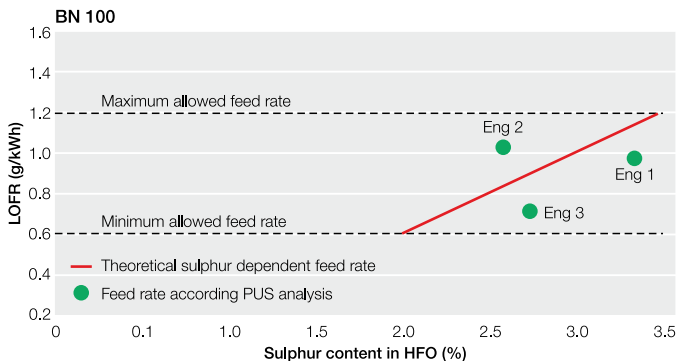
Standard Tuning, Delta Tuning, Delta Bypass Tuning and Low-Load Tuning are available for all Wärtsilä low-speed diesel engines to provide optimum fuel consumption for different engine loads. Delta Tuning and Low-Load tuning focus on reducing fuel consumption in the operating range below 90% or 75% engine load. Delta Bypass Tuning provides increased steam production between 50 and 100% engine power. By adding the advanced technology of Steam Production Control (SPC) the required steam amount can be produced with optimum fuel consumption.

Dual tuning is available on request and in cooperation with Classification Societies.

Wärtsilä X82 and X92 engines with multi-turbocharger configuration can be equipped with a TC cut off tuning that significantly reduces the engine's fuel consumption at low loads. The TC cut off tuning is designed for slow steaming operation and the application is customised on demand.

Cylinder lubrication

The Pulse Lubricating System is the standard for the 2-stroke engine portfolio. It electronically controls the injection timing and the load dependent feed rate.



The feed-rate set point can be adjusted between 0.6 g/kWh and 1.2 g/kWh. The actual feed-rate is dependent on the residual BN taken from the drain oil samples coming from the piston underside. This increases the safe operation of piston running performance against the negative influences from the Sulphur content in the fuel, ambient conditions, and other detrimental factors.

The graph below illustrates the theoretical sulphur dependent feed-rates based upon BN 100 cylinder lubrication oil. These three measured points represent various engine feed-rate settings, which have been adjusted according to the unique results from the piston underside drain oil analysis of each engine.

More detailed information on cylinder lubrication is available at Winterthur Gas & Diesel, Switzerland.

Emissions

Tier II solutions for 2-stroke diesel engine

All Wärtsilä low-speed engines included in this booklet are fully compliant with IMO Tier II NO_x limits specified in Annex VI of the MARPOL 73/78.

Tier III solutions for 2-stroke diesel engine

LOW PRESSURE DF SOLUTION

In order to achieve compliance with both the IMO Tier III NO_x standards and the requirements for SO_x control, a variety of solutions is theoretically conceivable, starting with the choice of fuel and fuel system, including conventional and more advanced tuning concepts, the addition of particular substances and, ultimately, the after-treatment. Switching from liquid to gas fuel is a viable solution for dealing with both challenges simultaneously. See the Wärtsilä 2-stroke dual fuel section in this booklet for more details.

Engines and Generating Sets

However, when considering liquid fuels only, various options need to be taken into account, combining the individual solutions to control the two key pollutants.

Pollutants	Measure 1	Measure 2
SO _x	Low-Sulphur Fuel	Scrubber
NO _x	SCR	Engine internal measures (EGR)

SCR SOLUTIONS

SCR technology is based on the reduction of nitrogen oxides (NO_x) by means of a reductant (typically ammonia, generated from urea) at the surface of a catalyst in a reactor.

The temperature of the exhaust gas is thereby subject to constraints both on the upper and the lower side. The latter is particularly an issue with fuels containing higher fractions of sulphur, such as those present in typical heavy fuel oil (HFO) qualities available today, which calls for even higher minimum temperatures in the catalyst.

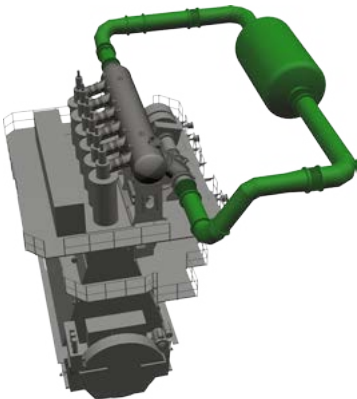
HIGH PRESSURE SCR

The SCR reactor is put on the high-pressure side, before the turbine. Integrating the SCR reactor before the turbine allows the reactor to be designed in the most compact way due to the higher density of the exhaust gas.

Wärtsilä has developed and is systematically deploying high pressure SCR solutions for the complete 2-stroke engine portfolio with single and multi-turbocharger applications. Further, Wärtsilä allows third party brand high pressure SCR suppliers to interface to the engine provided interface specifications are met.

LOW PRESSURE SCR

The SCR reactor is put on the low-pressure side, after the turbine. Wärtsilä has developed a 2-stroke engine interface specifications for low pressure SCR applications that complies with the known low pressure SCR system providers. Low pressure SCR is typically larger in volume and has the advantage of being less complicated to integrate into the exhaust stream.



EGR SOLUTIONS

Additional to Tier III dual fuel and SCR solutions, exhaust gas recirculating (EGR) concepts might be commercially viable for certain applications. Wärtsilä 2-stroke is further developing this concept and develops own EGR resolutions available upon request.

High-Efficiency Waste Heat Recovery (WHR)

Waste heat recovery is an effective technology for simultaneously cutting exhaust gas emissions and reducing fuel consumption. High-Efficiency Waste Heat Recovery plants can be installed with Wärtsilä engines. This enables up to 10% of the main engine shaft power to be recovered as electrical power for use as additional ship propulsion power and for shipboard services. These WHR plants thus cut exhaust gas emissions and deliver fuel savings of up to 10%.

Steam based WHR has already been successfully fitted in several installations to Wärtsilä low-speed marine engines. In the WHR plant, a turbo-generator combines input from a steam turbine and an exhaust gas power turbine to generate electrical power, while steam from the economiser is available for ship service heating. Steam based WHR is recommended for vessels with high installed power.

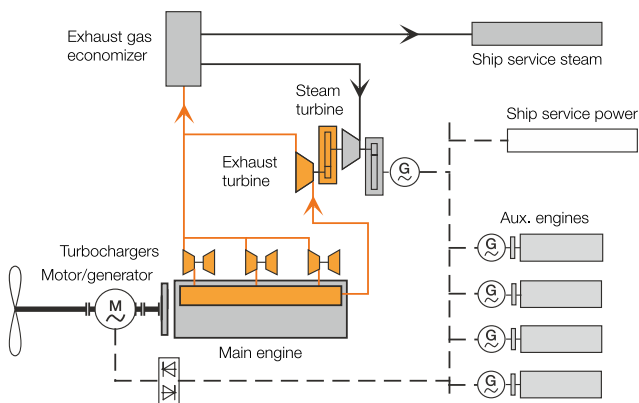


Diagram of a High-Efficiency Waste Heat Recovery plant typical for large container ships.

Exhaust Gas Cleaning

Due to existing and upcoming regulations on emissions to air, including MARPOL Annex VI from the International Maritime Organisation (IMO) and additional regulations from the European Union, marine industry operators need to decide on the best means for achieving compliance. Wärtsilä exhaust gas cleaning technology is an economical and environmentally friendly solution for tackling all new and existing rules and regulations. The systems are suitable for both new buildings and the retrofitting of existing vessels having either 2-stroke or 4-stroke engines, as well as for oil-fired boilers.

Having the largest installed base of any marine scrubber supplier and a dedicated test laboratory has enabled Wärtsilä to optimise their products to be reliable, easy to operate, and easy to install.

■ Scrubber System Designs

Wärtsilä has developed two kinds of standard scrubber designs to better meet the demands of our customers. Wärtsilä can offer the conventional venturi scrubber design, as well as the more compact inline scrubber system.

Both scrubber designs have benefits and drawbacks dependent on vessel type and layout, so it's important to look at the specific project needs. Both designs can be utilized for open loop, closed loop and hybrid scrubber systems.





■ Wärtsilä Hybrid Scrubber System

Wärtsilä provides hybrid scrubber system solutions which have the flexibility to operate in both open and closed loop using seawater to remove SO_x from the exhaust. This provides a flexibility of operation in low alkaline waters, as well as the open ocean.

When at sea the switch can be made to open loop using only seawater. The sulphur oxides in the exhaust react with the water to form sulphuric acid. Chemicals are not required since the natural alkalinity of seawater neutralizes the acid.

When required to switch to closed loop, for instance whilst entering a port in a low alkalinity area, the natural alkalinity of seawater is boosted by an alkali which uses caustic soda (NaOH) as a buffer.

Exhaust Gas Cleaning



■ Wärtsilä Open Loop Scrubber System

The Wärtsilä open loop scrubber systems are designed to remove SO_x from the exhaust and operates utilising seawater. The open loop scrubber system is our most straightforward scrubbing method. It utilizes the natural alkalinity in seawater for scrubbing, and does not need caustic soda. This method can be used in most seas around the world, where alkalinity levels are high.

Exhaust gas enters the scrubber and is sprayed with seawater, the SO_x in the exhaust reacts with water and forms sulphuric acid. Chemicals are not required since the natural alkalinity of seawater neutralises the acid. Wash water from the scrubber is treated and monitored to ensure that it conforms to MEPC.259(68) criteria and can be discharged into the sea with no harm to the environment.



■ Wärtsilä Closed Loop Scrubber System

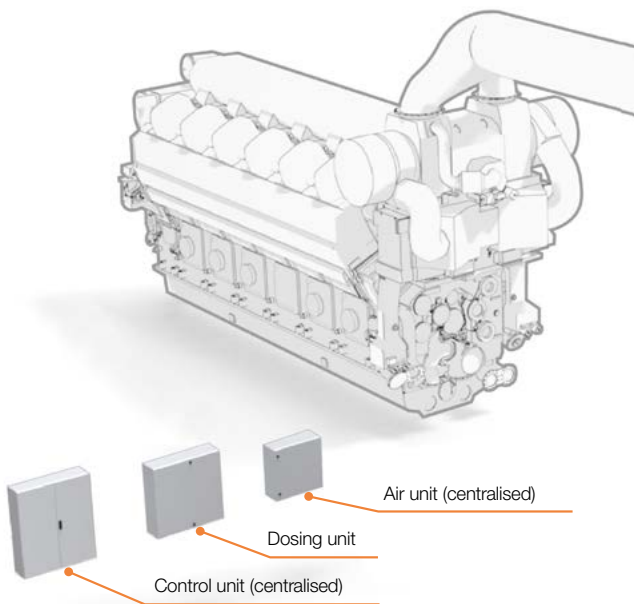
The Wärtsilä closed loop scrubber system is designed to remove SO_x from the exhaust and operates utilising wash water. The system works continuously in closed loop, which means no unnecessary concern regarding sea water alkalinity levels and is best suited for full time operation in low alkalinity areas (e.g. the Great Lakes).

In a closed loop scrubber system, the exhaust gas enters the scrubber and is sprayed with sea water that has been mixed with caustic soda (NaOH). The sulphur oxides in the exhaust react with this mixture and are neutralised. A small bleed-off is extracted from the closed loop and treated to fulfil IMO requirements. Cleaned effluents can be safely discharged overboard with no harm to the environment.

If operation in zero discharge mode is requested, the effluent can be led to a holding tank for scheduled and periodical discharge.

Exhaust Gas Cleaning

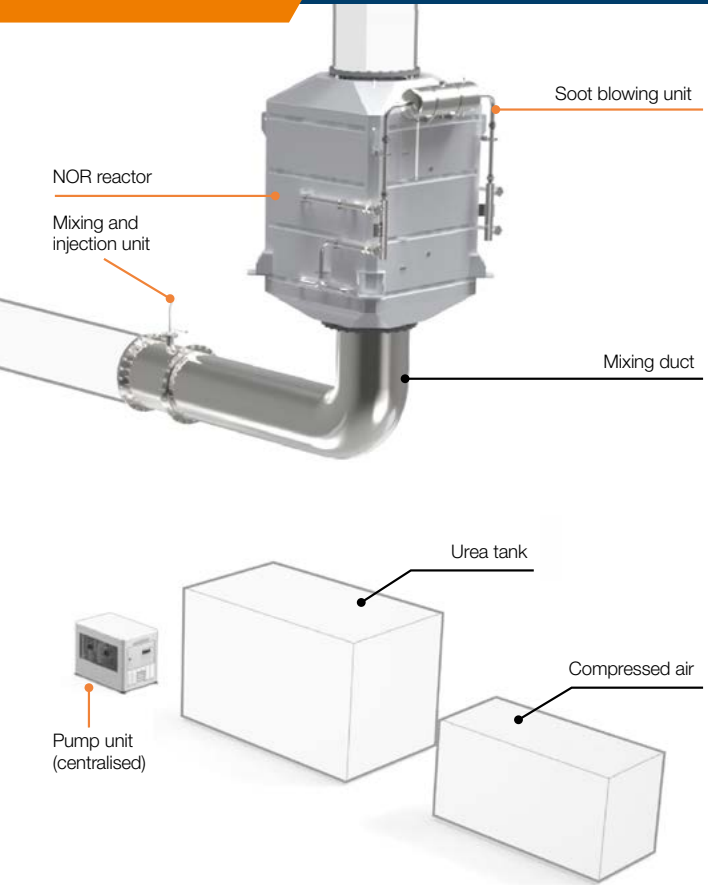
- Standard scope of delivery
- Optional or customer's scope



■ Wärtsilä NO_x Reducer (NOR)

The Wärtsilä NO_x Reducer (NOR) is an emission after-treatment system based on the Selective Catalytic Reduction (SCR) technology for Nitrogen Oxide (NO_x) reduction. The system is compliant with various NO_x emission reduction needs, such as the IMO Tier III rules.

The NOR is optimized and validated for medium speed engines in terms of reliability, flexibility and size. It is available for both newbuild and retrofits and is compatible for operation on both distillate and heavy fuel oils.



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 a Urea pump unit, a Urea dosing unit, an Urea Injection and mixing unit, an Air unit and the Control unit which controls the NOR operation by monitoring engine parameters. For the purpose of easy installation, several auxiliary units are centralized, so that same units can be utilized in case of multiple NOR installations.

Inert Gas Systems

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

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

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

Wärtsilä Moss 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.

■ Wärtsilä Moss Flue Gas

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

Wärtsilä Moss 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 Moss 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 ships pitching and rolling
- Internally coated with GRE and venturi tube in corrosion and heat resistant steel

Inert Gas Systems



■ Wärtsilä Moss Mult-Inert™ system

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

Wärtsilä Moss 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 Moss 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.

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

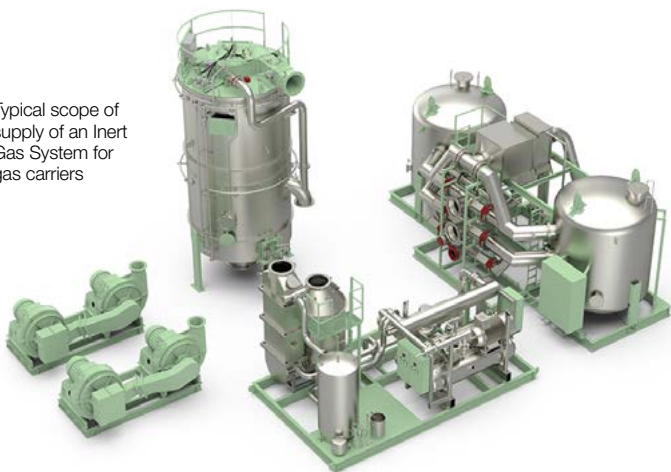
■ Wärtsilä Moss Inert Gas Generators for Gas Carriers

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 Moss 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 Moss inert gas generator system.

Typical scope of supply of an Inert Gas System for gas carriers



■ Wärtsilä Moss 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.

Inert Gas Systems

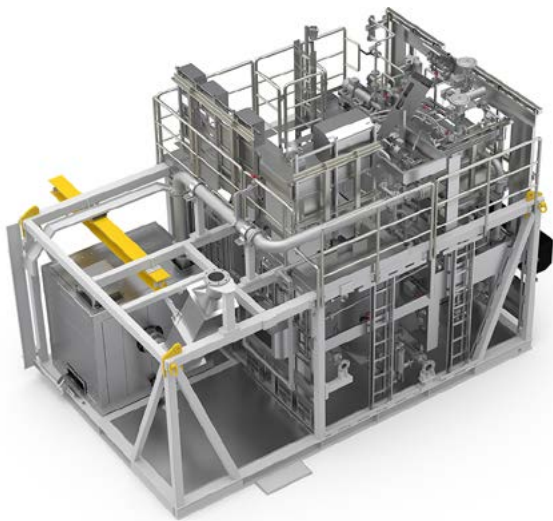
Our most recent developments include automatic regulation based on deck pressure setting. During off-loading the system optimizes the inert gas production to only produce the necessary quantum of Inert Gas to maintain the tank pressure. This system reduces oil consumption providing cost efficiency, as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

■ Wärtsilä Moss Offshore Inert Gas Packages

Our inert gas generator system ensures the correct atmosphere in the cargo tanks and pipes to minimize the risk of explosion onboard FPSOs and FSOs.

Based on more than 50 years of experience in the design and manufacturing of inert gas generator systems, the Wärtsilä Moss systems are known for their high inert gas quality and overall reliability.

High efficiency, low maintenance costs, and easy and safe operation, in combination with minimum space requirements, are important features of the unique design. The Wärtsilä Moss systems can be installed on new builds or as retrofits for existing vessels.



Offshore Inert Gas Package solution for SPAR platform



■ Wärtsilä Moss Nitrogen Generators

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

Wärtsilä Moss Nitrogen Generators are also designed to deliver various purities in the same system, giving our customers even greater flexibility. We supply niche, supplementary, small volume systems with capacities from 10 to 6 000 Nm³/h at purities from 95 to 99% nitrogen.

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



■ Wärtsilä Flare Gas Recovery system

Using the Wärtsilä Flare Gas recovery system will allow a safe and cost effective recovery of gas that can be used for a wide range of purposes:

- Export gas
- Fuel
- Re-injection into well
- Feed for boilers
- Recovered back to feedstock
- Used in any other system which needs gas.

Eliminating the need of continues flaring have many other positive effects:

- Substantially reduces emission of CO_2 and NO_x
- Creates a safer and healthier working environment
- Reduces noise from flaring
- Reduces radiation from flaring
- Increases flare tip lifetime, saving significant maintenance costs on shutdown and flare tip replacement
- Saves cost due to pollution taxation.

The Wärtsilä Flare Gas Recovery System is designed to handle gas that is normally flared during normal oil, gas, and petrochemical installation operations.

The system can be tailored for different process conditions and requirements (international, client and classification society). It can also be combined with Wärtsilä's hydrocarbon blanketing system, the Wärtsilä GasReformer and Wärtsilä's Flare Gas Ignition system.

■ Wärtsilä Flare Gas Ignition system

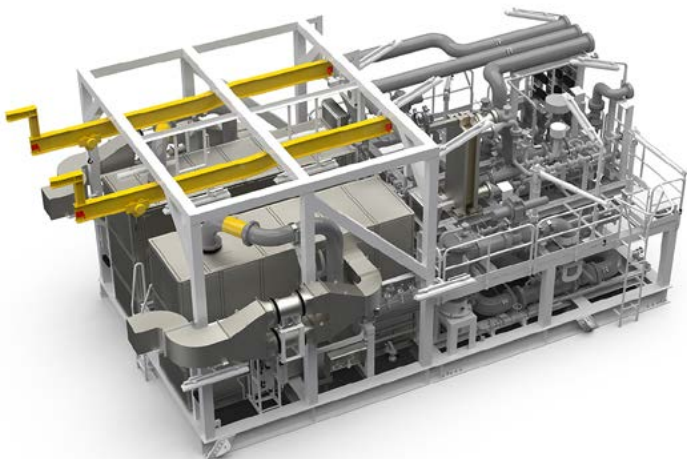
The Wärtsilä Flare Gas Ignition system is designed to handle gas that is normally flared in oil, gas, and petrochemical applications.

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

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

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





Our Hydrocarbon Gas Blanketing systems are already used onboard numerous projects in the North Sea and West Africa.

■ Wärtsilä Hydrocarbon Blanketing systems

The Wärtsilä Hydrocarbon Blanketing system is designed to use hydrocarbons as blanket gas for the cargo tanks during loading and offloading of the oil.

Using hydrocarbons as blanket gas allows:

- Reducing air emissions (hydrocarbons, CO₂, CO).
- Establishing a safer and healthier working environment by preventing the vent gas from cargo tanks falling onto the main deck.
- Increased profits thanks to reduced flashing of the oil during loading.

The system can be tailored for different process conditions and requirements (international, client and classification society). It can also be combined with Wärtsilä's Flare Gas Recovery, the Wärtsilä GasReformer, and Wärtsilä's Flare Gas Ignition systems.



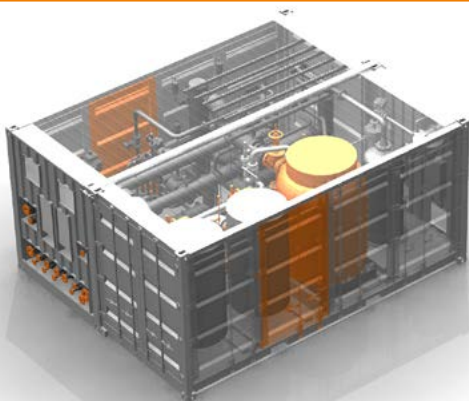
The first VOC condensation system with zero emissions was installed on the shuttle tanker Stena Alexita, operated by ExxonMobil in the North Sea oil fields.

■ Wärtsilä 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 is then fed to the 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.



■ Wärtsilä GasReformer

This solution makes it possible to utilise gaseous fuels that either contain large amounts of heavier hydrocarbons or vary in their composition. Gases that were previously considered as waste can now be converted into a valuable resource of energy. Together with Wärtsilä dual-fuel (DF) engines, this is the most efficient and flexible solution for utilising associated gas, stranded gas, natural gas liquids, LPG or volatile organic compounds (VOCs) or off-spec gases recovered from oil and gas industry.

The main application area is in offshore oil and gas production, but also power plant and other onshore applications are potential. Wärtsilä GasReformer has been developed and designed to meet the standards of the offshore industry and is the first of its kind in the world. Wärtsilä GasReformer received the Approval in Principle from DNV-GL for Shuttle Tankers (marine) in 2015.

The technology is based on steam reforming (SR), a catalytic process known from the petrochemical industry and refineries, where traditionally hydrogen is produced from various hydrocarbon feeds. The Wärtsilä GasReformer exploits the same catalytic process but operates under different conditions. In the Wärtsilä GasReformer the methane number (MN) of any fuel gas is improved up to 100 ± 5 by converting the heavier hydrocarbons to synthesis gas ($H_2 + CO$) and finally to methane (CH_4).

Environmental excellence

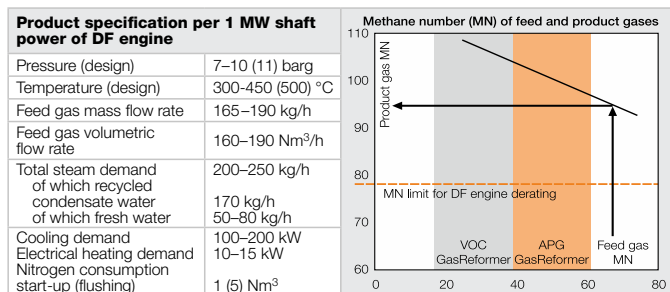
Offshore gas flaring is increasingly recognised as a major environmental problem, causes 400 million tons of CO_2 in annual emissions, not to mention the valuable resources that go to waste.

The associated gas, separated from crude oil, is traditionally flared and not utilised because it varies in composition, and contains a lot of heavier hydrocarbons. Generally it is considered as waste or an unreliable source of energy.

With the Wärtsilä GasReformer, this undesired gas can be reliably and efficiently utilised by Wärtsilä dual-fuel engines. When utilising associated gas or recovered VOCs from tankers as a reliable source of energy, the operator can achieve self-sufficiency in terms of energy supply and thus the need for fuel bunkering, a costly operation in offshore locations, decreases. With a Wärtsilä 10 MW APG GasReformer combined with a DF engine, the operator can reduce the need for bunkered fuel oil by around 35–39 tons per day and the system produces electricity with an overall efficiency of up to 44.5%.

Key benefits

- Reduction of CO₂ and VOC emissions
- Flare gas and vented VOCs can be utilised for power production
- No need for flaring
- Reduced fuel consumption, storage and fuel bunkering
- Low NO_x emissions from proven dual-fuel engines
- Dual-fuel engines can operate at full load and efficiency
- Operator can change gas source during operation
- Decreased carbon footprint for operating company.



Dimensions (mm) and weights (tonnes)					
GasReformer capacity	Application	Consists of	Footprint (L x W)	Height	Weight
4 MW (LVOC)	Marine / Shuttle tankers	2 modules	7175 x 4150	4600	25
10 MW (APG)	Offshore / Onshore	2 containers	6058 x 4876	2896	30
25 MW* (APG)	Power plant / Onshore	4 modules	9752 x 6058	4800	40
*Conceptual design	LVOC = liquid volatile organic compound, APG = associated petroleum gas				

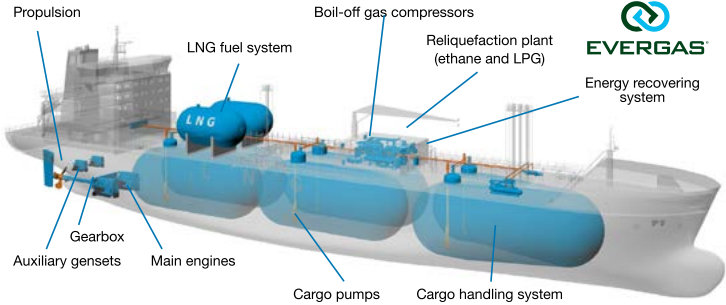
■ Wärtsilä Cargo Handling for Small LNG Carriers

There is a growing demand for the small-scale transport 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 from the extensive experience that Wärtsilä Gas Solutions has accumulated in delivering such systems for LPG, LEG and LNG carriers. The scope available 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 4,000 and 40,000 m³.





■ 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.



■ Wärtsilä Cargo Handling System for Semirefrigerated Gas Carriers

The semi refrigerated segment covers the range from 4,000 m³ to 30,000 m³. Wärtsilä 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 m³ to 13,000 m³. Wärtsilä 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 of to 98% with design figures for SW and air temperature. The Qi Cool design enables the achievement of cost savings and higher revenues.

■ Wärtsilä Cargo Handling System for Fully Refrigerated Vessels

For many years already, Wärtsilä Gas Solutions has been the preferred cargo handling equipment supplier for many of the leading owners of fully and semi refrigerated vessels. When transported in these ships the LPG is normally kept at its coldest temperature (atmospheric pressure) and the required equipment has, therefore, to be extremely reliable. Our innovative and energy efficient solutions, together with the broadest portfolio of reliquefaction configurations, have given us a leading position in this market. This extensive offering is supported by Wärtsilä's unmatched global service network.

■ 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 200–205.



■ Small/Mid-scale LNG terminals

An LNG terminal is a liquid gas processing plant the main purpose of which is to receive, store and further distribute natural gas. Wärtsilä's portfolio consists of terminals with various functions combined with a storage capacity in the range of 100 m³ to 160,000 m³. Both bullet tanks and flat-bottom tanks are offered as storage alternatives. Regasification is available in any capacity up to 1000 TPH.

- Specifically adapted for the requirements of small scale LNG through elimination of complexity and increase of flexibility
- Single use (e.g. providing fuel for a power plant) or multi use (e.g. gas send-out, ship bunkering, truck loading)
- Available for both hub and spoke operations
- Onshore and near shore (barge) concepts
- Stringent safety regulations during both construction and operation
- Through Operations & Maintenance, we can offer our customers guaranteed performance and predictability of maintenance costs
- Wärtsilä can also offer an LNG terminal and power plant in one EPC package. Synergies between these facilities are often considerable.

Wärtsilä believes that complete Engineering, Procurement, Construction (EPC) is the delivery method that provides the best value to customers. With EPC, the customer does not need to commit as much time and resources to administration, legal consultations and contractual setup. More importantly, it also significantly reduces the customer's risk by offering a guaranteed price, delivery date and performance. Having eliminated these risks is often a pre-requisite for the bankability of the project.



For more information scan this page
or see the LNG Catalogue 2016 on
www.wartsila.com

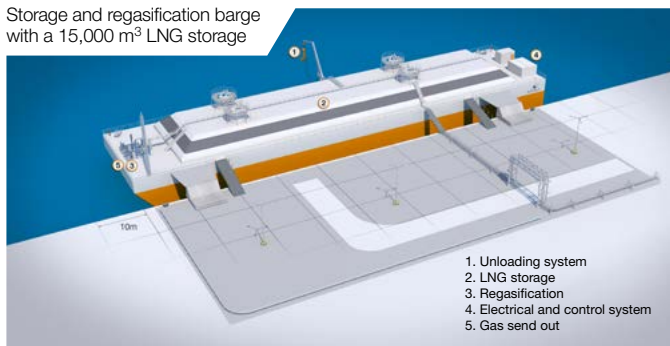
■ Wärtsilä Mobile LNG – Storage and regasification barges

The smallest FSRUs today are around 120,000 m³. There are no small LNG carriers available that can be converted to FSRUs. Wärtsilä has created a solution for this problem by designing a barge containing storage tanks (1000–30,000 m³) and regasification systems. These can be an attractive alternative to onshore satellite and bunkering terminals. The LNG barge can be equipped with the similar processes as the land-based solution. The process can also be split between the barge and land. This can be done, for example, by locating the LNG storage on the barge and process equipment and support facilities onshore.

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

Storage and regasification barge
with a 15,000 m³ LNG storage





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

■ 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 biogas liquefaction plant was delivered to the municipality of Oslo. For this plant, Wärtsilä also delivered a mole sieve adsorption system for CO₂ cleaning stage.

■ LNG plants – mini scale liquefaction technology

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 m²
- Delivery time: 12 months
- Standard capacities: 10, 17 and 25 ton LNG/day.
- Using standard and robust components.

Wärtsilä provides the basic complete process package, to which can be added civil engineering and construction services. The complete plant 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.

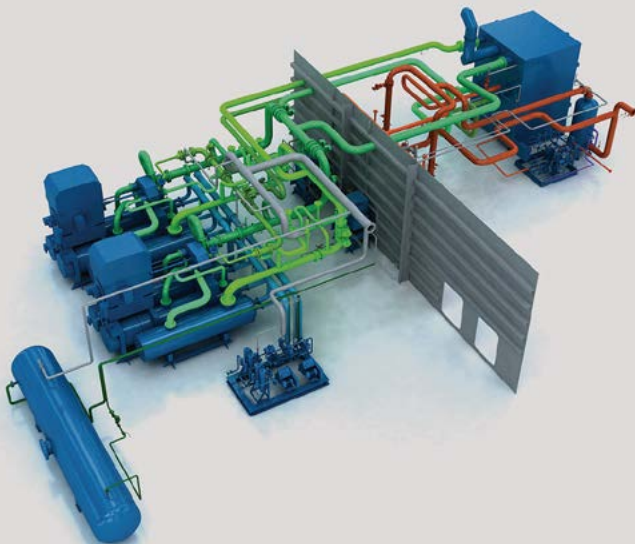


■ ■ Wärtsilä LNG Regasification

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.



■ ■ 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 fleet. Similar solutions could also be installed with onshore LNG terminals.

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



■ ■ Wärtsilä LNGPac™

Wärtsilä LNGPac™ is a complete fuel gas handling system for LNG fuelled ships and includes the bunkering station, LNG tank and related process equipment as well as the control and monitoring system. The LNG fuel system can be offered as a standalone product, as well as a part of a complete propulsion system. Wärtsilä can deliver LNG systems for propulsion and power generation for any applicable types of ship or engine.

Complete solution

The Wärtsilä LNGPac™ system is based on IMO type C LNG storage tank with either double walled vacuum or single walled polyurethane insulation. Bunkering takes place from the bunkering station to the LNG tank via an insulated pipe. All necessary process equipment is installed in a separate unit which can be either mounted directly to the LNG tank or placed remotely from the LNG tank. The main process equipment ensures correct gas temperature and pressure for the engines and other gas consumers. The LNGPac system can be customised to the needs of each project on a case to case basis. Dedicated engineering is conducted from the beginning of the project to match the specific operational requirements, safety and classification society requirements.

Features

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

INTEGRATED AIRLOCK

The Airlock can be integrated with the LNGPac™. This reduces the floor foot print, increases safety aspects and makes the installation for the yard much easier.



INTEGRATED CONTROL CABINET

The Control Cabinet can be integrated with the LNGPac™. This innovation 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 during complete vessel life cycle. One supplier for automation design, project execution, commissioning work and services – reducing project risk and minimizing delays in communication.

INTEGRATED GAS VALVE UNIT (GVU)

The functional components of the GVV can be integrated as part of the LNGPac™. By combining the LNGPac™ and the GVV into a single system, considerable space can be saved. The solution will also save installation time and costs for the yard.

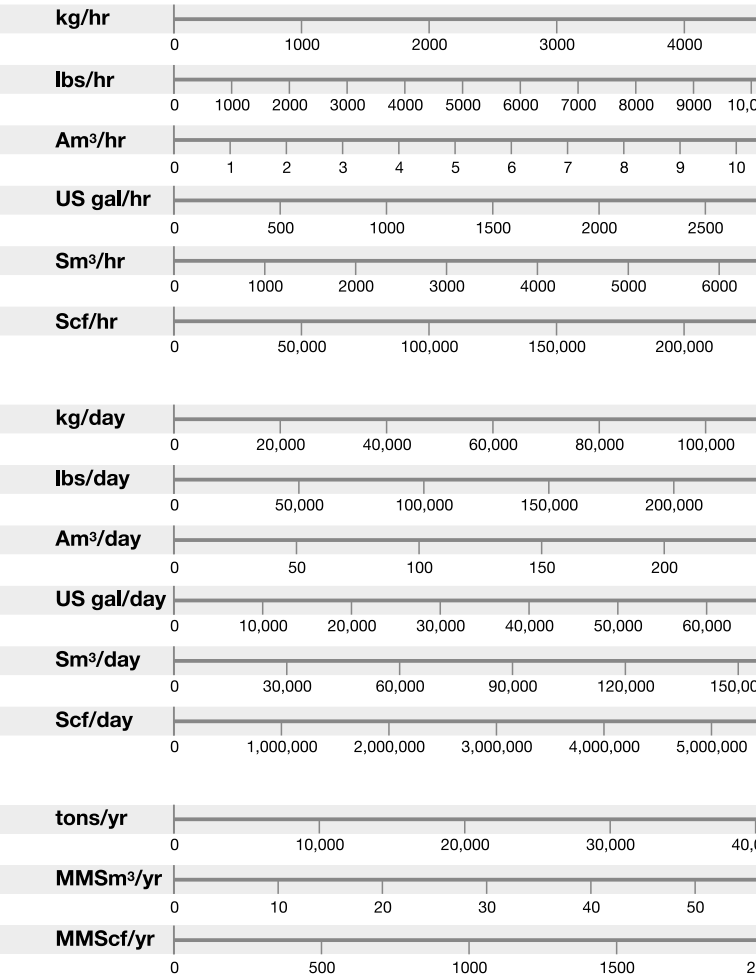
REMOVAL OF THE HEATING MEDIA SKID New evaporator type allows the engine LT-water to be directly connected to LNGPac without the need of an intermediated heating media circuit. This leads to fewer interfaces and installation work is required.

MAINTENANCE ORIENTED DESIGN

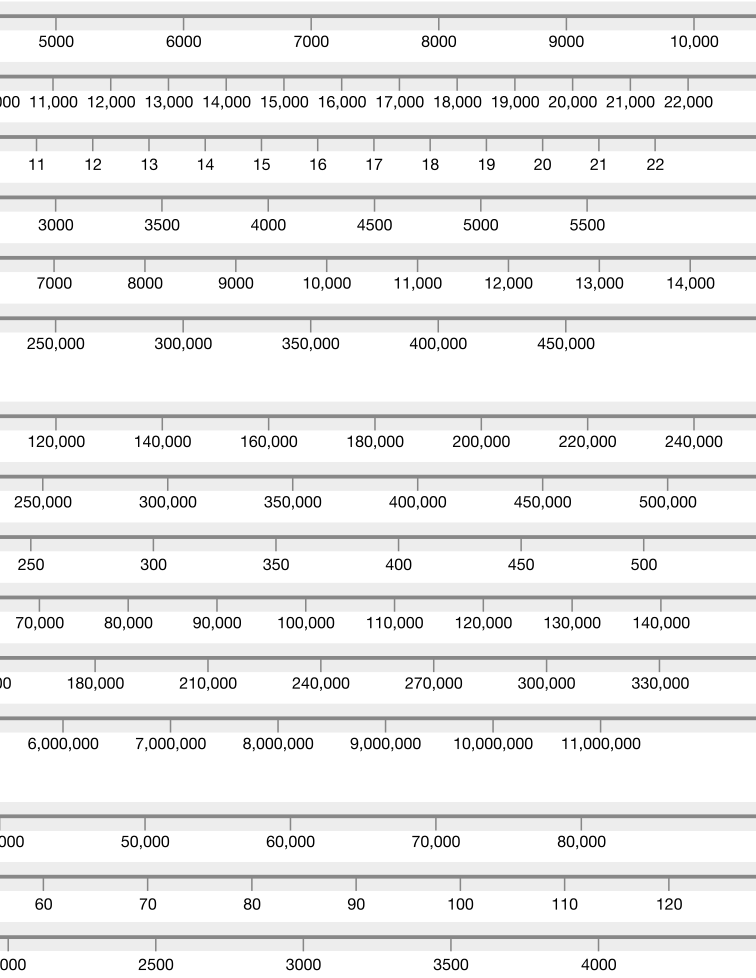
LNGPac™ design focuses on enabling safe service and maintenance of all core equipment related to the operational functionality of LNG bunkering and gas consumption without emptying the tank.

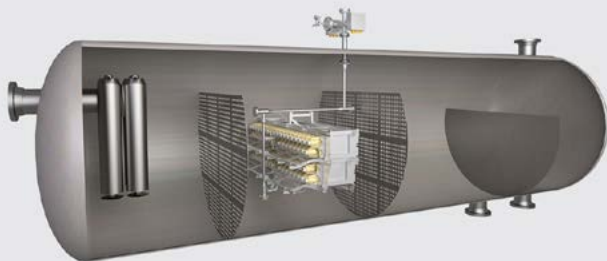
Gas Solutions

LNG quantity converter



Note: Volumetric values are based on saturated LNG of approximately 96.2% C1, 3.7% C2, 0.4% C3, 0.15% C4 and 0.55% N2 (at -161.8 °C, 1.1 bara)





■ Wärtsilä Vessel Internal Electrostatic Coalescer (VIEC®)

The Wärtsilä Vessel Internal Electrostatic Coalescer (VIEC) is a field proven solution for separation of water from oil, improving production capacity, eliminating emulsion issues, reducing heating and chemical dosage demand as well as space and weight requirements.

VIEC enables operators CAPEX and OPEX savings as well as being a preferred tool for de-bottle necking and solving emulsion issues.

Concept

VIEC is a technology for enhancing liquid-liquid separation by using alternating high voltage electrical fields.

Modular construction consisting of several electrodes, where each electrode is electrically insulated and has its own dedicated transformer for transforming a low voltage feed to high voltage.

Tolerates 100% water and 100% gas without short circuiting or arcing, making it ideally suited for use in any three-phase separator to speed up separation of water dispersed in oil and/or to resolve stable oil-continuous emulsions.

Benefits

- Increase crude oil production capacity
- Reduce weight and space requirements
- Reduce cost of production fluid heating
- Reduce consumption of chemicals
- Improve heavy oil separation
- Guaranteed separator performance (total BS&W output)

Features

- Fully insulated electrodes and low voltage penetration and feeding
- Suitable for both new builds and retrofits
- Installation through 18" – 24" manhole
- Field proven technology
- UL and CE marked equipment

■ Wärtsilä iPhase®

The Wärtsilä iPhase® profiler measures the oil-water interface, providing accurate measurements of water conductivity and thereby the oil in water profile inside hydrocarbon separators.

Several independent sensors are located above each other in order to measure a vertical profile of the separator contents. Each sensor measures the bulk properties of the surrounding fluid. The measurement is conducted without electrodes and over a large volume which makes it less sensitive to deposits.

The Wärtsilä iPhase® electronic module is located on the top of the separator vessel and is connected to the Wärtsilä iPhase® Measurement Rod, located inside the vessel. It performs all calculations onboard and can directly be accessed by the plant control system via MODBUS RTU or 4–20 mA signaling.

Measurement principle

The Wärtsilä iPhase® profiler measures the electrical conductivity of the water/oil mixture surrounding each sensor. Dispersed oil droplets are non-conductive compared to the surrounding water. The overall conductivity will therefore decrease with increasing concentration of oil. The Wärtsilä iPhase® sensors utilize the conductivity difference to provide the oil in water profile.

The conductivity is measured by setting up an electric field and measure the current flowing. The electric field is an induced field and is therefore very tolerant to deposits.

Features

- Inductive measurement principle
- Tolerant to deposits
- High accuracy oil/water interface determination
- Separator water profiling
- Detection of sand build-up
- Integrated temperature sensor
- Intrinsically safe electronics
- No active components inside vessel
- Control system interface MODBUS RTU (RS485)
- 4–20 mA for interface signaling
- Certifications: ATEX Ex ia IIB T4, IECEx, EMC, UL
- No export restrictions





■ ■ Wärtsilä Tank Control Systems for Whessee Products

If your product is LNG, LPG or ammonia, Wärtsilä Tank Control Systems can provide an application-specific solution for your business needs. Today, the liquid gas industry is driven by the economics of operational scale. In order to apply efficient business management, while adhering to stringent safety regulations, operations personnel must have access to correct information.

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

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

Marine gauging **LNG secondary tank gauging systems**

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

Product and chemical carriers

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

Total LNG tank gauging system

- 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.

■ ■ Liquefied petroleum gas (LPG)

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.

Propulsors & Gears

Wärtsilä Gears

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

Gear configurations

- Single input gears: gears with single input and single propeller speed. Wärtsilä designation SCV for vertical offset, and SCH for horizontal offset.
- Double gears: gears with twin input and single propeller speed. Wärtsilä designation TCH.
- 2-speed gears: gears with single input and 2 propeller speeds. Wärtsilä designation SCV/2 for vertical offset, and SCH/2 for horizontal offset.

All Wärtsilä gears can be supplied with built in multi-disc clutches.

Power take-off (PTO)

All Wärtsilä gears can be supplied with one or more PTOs for driving the shaft alternator, compressor or pump.

- A primary driven PTO is rotating whenever the engine is rotating.
- A secondary driven PTO is rotating whenever the propeller shaft is rotating.

For single vertical and horizontal gears, the standard PTO is primary driven. For double gears, the PTO is optionally primary or secondary driven.

Power take-in (PTI)

Most Wärtsilä gears can be supplied with a combined PTO/PTI. In PTI mode the shaft alternator can also be used as an electric motor.

PTI is normally used for the following operation modes:

- PTI “booster” mode is used to increase the peak propulsion power for demanding operations. For this mode, no clutches are required on the gear.
- PTI “take me home” mode is used in case of emergency, if the prime mover is out of operation. For this mode a minimum of 2 clutches are required on the gear.

Integrated or separate hydraulic system for gear and controllable pitch (CP) propeller

Most Wärtsilä gears are purpose-designed with an integrated hydraulic system for both the gear and the CP propeller. As the separate hydraulic power unit for the CP propeller is superfluous, both installation costs for the yard and operational costs for the owner are reduced. For safety reasons the gear mechanically drives the main pump for the propeller. All gears can also be interfaced to a separate hydraulic power unit.

■ Wärtsilä 2-speed gear

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

The key feature of the 2-speed gearbox is the option to reduce the propeller speed at a constant vessel speed, resulting in fuel savings of up to 15% when compared to a single speed mechanical propulsion system.

This fuel saving is the result of the propeller being more efficient when running closer to its optimized design pitch. In the meantime the speed of the engine and PTO are unchanged when switching seamlessly between gear step 1 and 2.

At the same time, nitrogen oxide (NO_x) and sulphur oxide (SO_x) emissions are similarly lowered.

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 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 onboard comfort and ecological friendliness

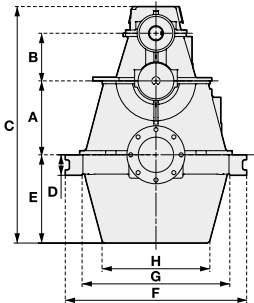
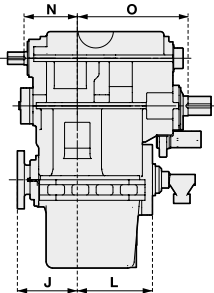


Propulsors & Gears

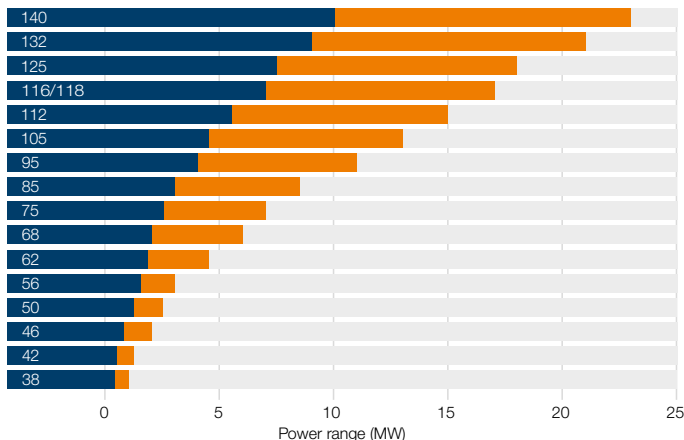
Single input gears, vertical offset, dimensions (mm)

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



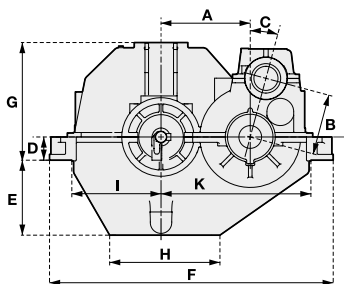
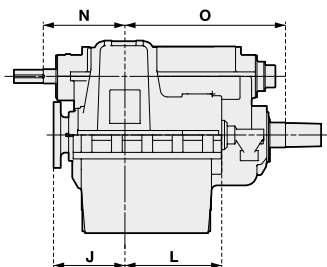
Single input gears, power range



Single input gears, horizontal offset, dimensions (mm)

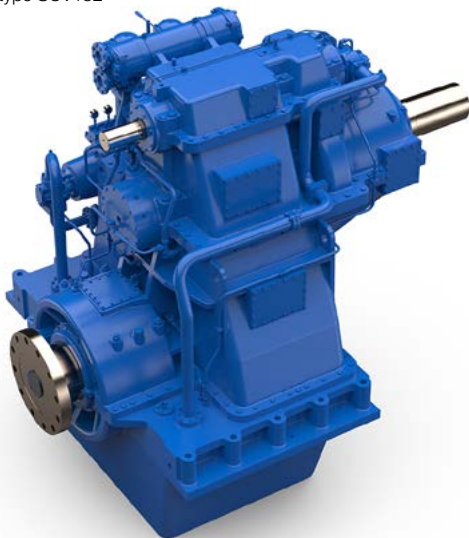
Gear type/ size	A	B	C	D	E	F	G	H	I	J	K	L	N	O SCH/ SH	Weight tonnes*
SCH68	680	510	0	100	700	2000	840	650	515	570	1095	730	500	1245	8.0
SCH75	750	530	15	280	885	2230	1220	865	735	660	1115	800	515	1670	11.5
SCH85	850	580	15	320	1000	2495	1440	970	830	730	1245	915	550	1800	15.0
SCH95	950	580	15	450	750	2710	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

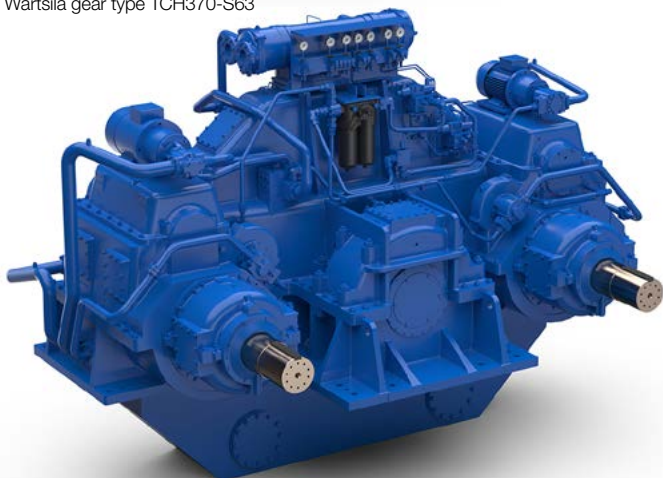


Propulsors & Gears

Wärtsilä gear type SCV132



Wärtsilä gear type TCH370-S63

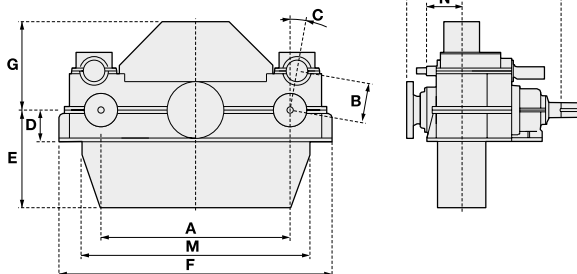


Double input gears, dimensions (mm)

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

Propulsors & Gears

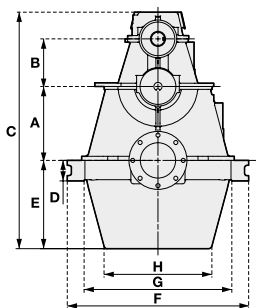
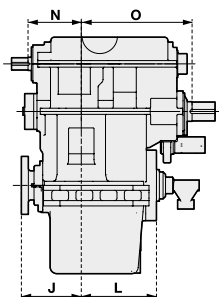
2-speed gears, vertical offset, dimensions (mm)

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

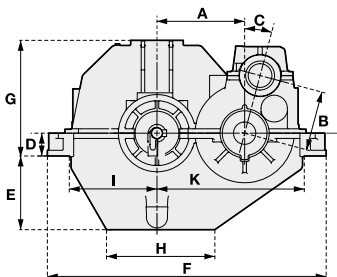
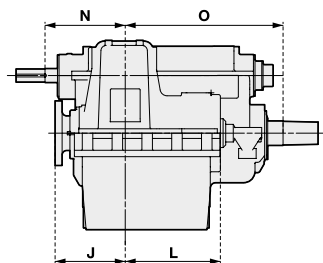
2-speed gears, horizontal offset, dimensions (mm)

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

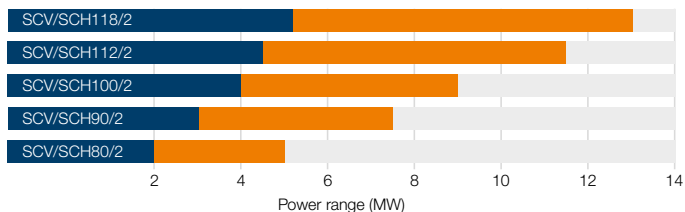
Vertical offset



Horizontal offset



2-speed gears, power range



Wärtsilä gear type SCV90/2-PDC58



■ 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 is often 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.



A Wärtsilä Controllable Pitch (WCP) propeller system is a fully customized combination of a hub, propeller blades, shafting, hydraulics and a control system, as well as any further accessories needed to meet the customer's needs. Wärtsilä's hydrodynamic experts tailor the propeller for each application to achieve the optimum balance between fuel consumption and comfort levels as set by the customer.

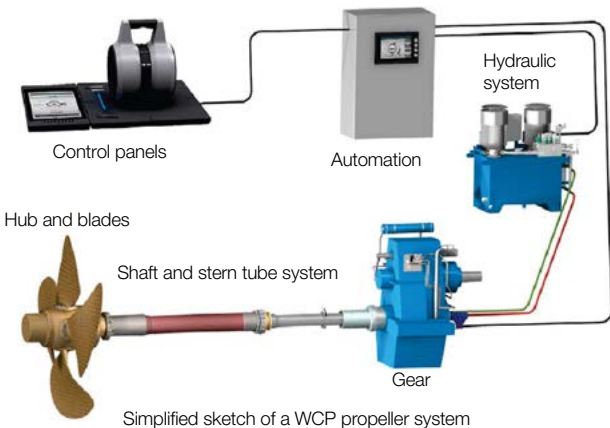
Technical data

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.

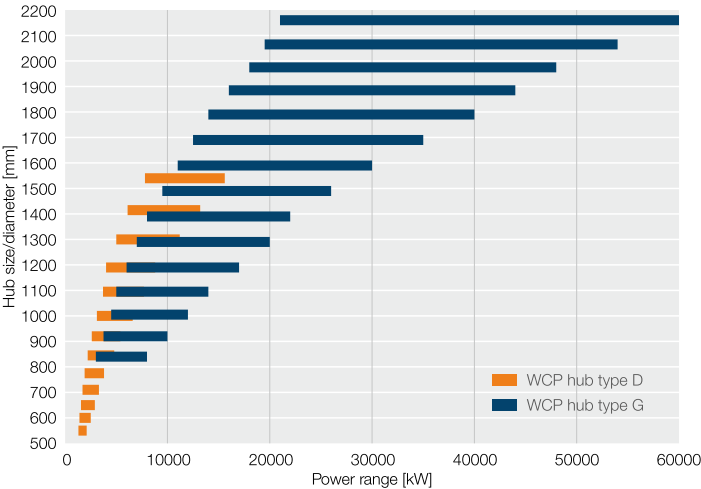
Options

- US EPA Vessel General Permit 2013 compliance
- Zero pollution sterntube
- Under water replacement of propeller blades
- Full blade feathering for reduced drag
- Navy requirements for low noise signature
- Energopac rudder for increased efficiency
- Continuous oil monitoring for increased reliability
- Wärtsilä High Performance (HP) Nozzle.



Propulsors & Gears

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



Wärtsilä has the unique market position 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 a high power or a highly loaded propeller. With these hub types Wärtsilä manages to successfully cover the complete market segments that requires controllable pitch propellers.

WCP hub type D



WCP hub type G

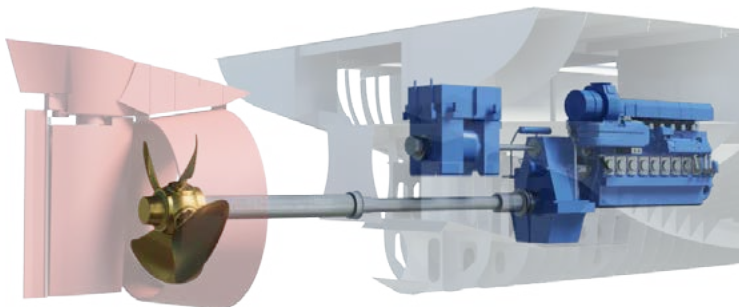


■ Wärtsilä propulsion package

Wärtsilä provides an unrivalled range of leading products such as 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 right through the process from initial design to construction and operation.

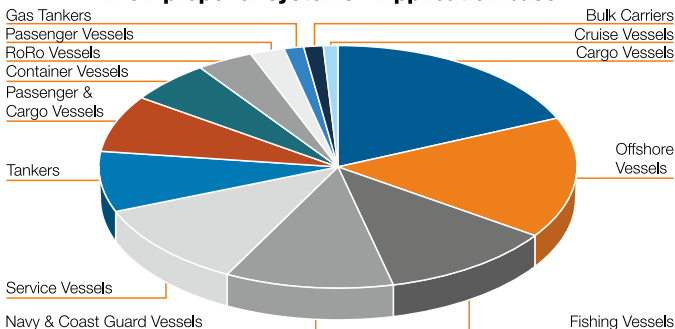
The benefits of integrated packages comprising a WCP system include:

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



Wärtsilä integrated package for a trawler. WCP-1095 propeller system, SCV 112/2 gear, W9L32 engine and control system

WCP propeller systems – Application base

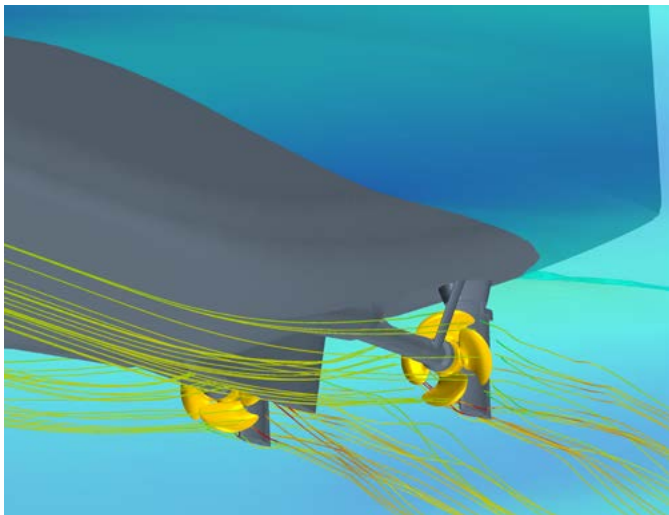


■ Wärtsilä's hydrodynamic design

The hydrodynamic design covers propellers for many types of vessels, from heavy-duty vessels such as AHTS to high-speed passenger ferries, and from small fishing boats to enormous ice classed container vessels. Wärtsilä's long history and experience in designing propellers, provides extensive hydrodynamic knowledge. 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. In the past the flow along the aft ship and the propeller were separately optimised. The interaction between ship and propeller, was assumed not to change for different propeller designs. With modern Computational Fluid Dynamics (CFD) tools it is now possible to calculate the ship and the propeller together, to find the most economical propeller design.



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



■ Wärtsilä Fixed Pitch Propellers

Wärtsilä fixed pitch propellers are manufactured by the Wärtsilä CME Zhenjiang Propeller Co., Ltd joint venture company. At this facility fixed pitch propellers with diameters from 1 to 12 meters and up to 120 tons of 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.

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

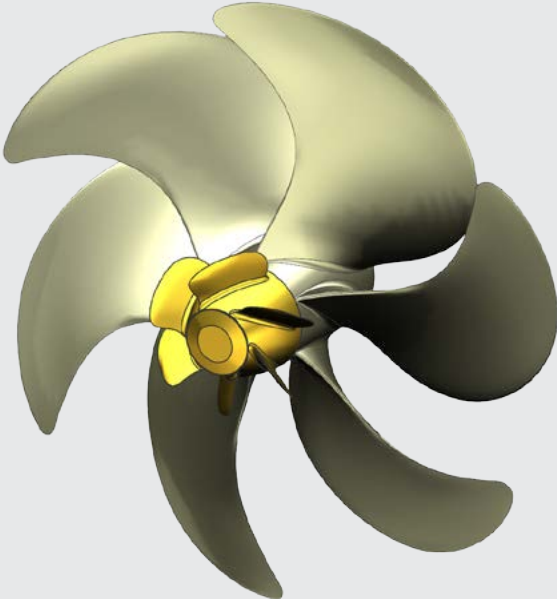
Redesigning and replacing existing propellers using Wärtsilä state-of-the-art design tools can achieve notable efficiency improvements. For example, by designing a Fixed Pitch Propeller to accommodate slow steaming at reduced vessel speed and power levels, efficiency improvements of up to 15% are possible.

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

EnergoproFin

The Wärtsilä EnergoproFin is an energy saving propeller cap with fins which are connected to the rotating propeller. It improves propulsive efficiency by weakening the hub vortex, and by recovering kinetic energy from the rotating flow aft of the propeller blades.

The EnergoproFin provides average fuel savings of 2%, with payback times of less than one year.



■ 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 without interruption to the normal operating service.

The BUPs are supplied in stainless steel or bronze. Connection towards the propeller shaft is with a flange and fit bolts. Most BUPs are delivered with 4- and 5-blades 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 that operate in ice infested waters or operational areas with increased risk of propeller damage. Long interruptions of the vessel operating schedule are avoided due to the fast (under water) replacement of blades. Limited replacement time enables the vessel to maintain its schedule, which is beneficial for vessels with a fixed operating schedule such as cruise vessels and ferries.

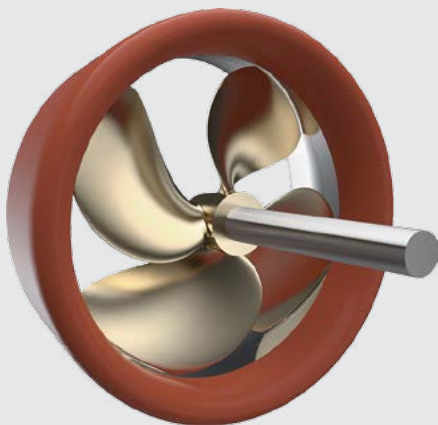




■ Coastal and Inland Waterways Propellers

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

Coastal and Inland Waterway Propellers are available in bronze or stainless steel. They are tailor-made with 3, 4, 5, 6 or 7 blades. The accuracy can be according to ISO class II, I or S. Wärtsilä has the capability to deliver fixed pitch propellers for any diameter above 1000 mm, although for the coastal and inland waterway segment they are seldom larger than 3500 mm.



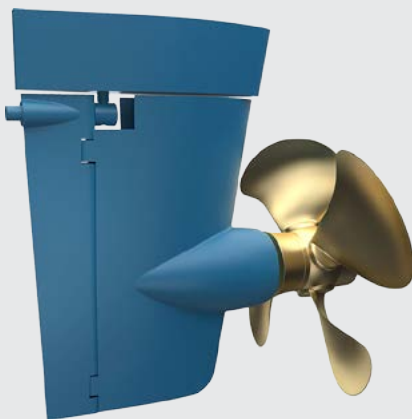
■ Wärtsilä High Performance Nozzle

Fitting a nozzle increases the thrust at relatively low ship speeds. This allows for significant savings to be achieved in terms of fuel consumption, depending on the number of revolutions and the capacity of the engine. The improved Wärtsilä High Performance nozzle, 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 propeller and rudder. Each Energopac is designed to fit the intended vessel and to meet its specific requirements; this allows Energopac to be optimised fully for energy efficiency, whilst not compromising on either manoeuvrability or comfort levels.

- Improved propulsive energy efficiency
- Reduced fuel consumption
- Excellent maneuverability
- Lower vibration levels and higher on-board comfort
- Reduced levels of emissions
- Integrated propeller and rudder design.



Fuel savings

Energopac reduces fuel consumption because it effectively reduces the flow separation behind the propeller hub. Extended studies show that for the same course-keeping capabilities, Energopac will create less drag than conventional rudder systems.

Typical applications

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

Cost savings

The reduction in fuel consumption depends very much on the vessel type, its operational profile, and on the reference propeller and rudder. For any application, the power savings can be estimated by Wärtsilä. The estimate is based on the vessel design, its operational profile and other requirements. Proven savings in the power required for a vessel's trial speed vary between 2 and 9% with Energopac.

■ ■ 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 from the standard steerable thruster series. Together they form a steerable thruster range that covers the most advanced ship design options.

The Wärtsilä Thruster series:

- Steerable Thrusters
- Retractable Thrusters
- Under Water Mountable Thrusters.

Wärtsilä Steerable Thrusters

The Wärtsilä Steerable Thruster (WST) series is intended for tug or offshore support vessel application and river-sea going vessels. These thrusters have a light ice class capability and can be combined with high-speed engines 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. The Wärtsilä Steerable Thruster (WST) series replaces the Wärtsilä LCT series for tugs and similar vessel types. For certain executions, such as L-drive layouts, the LCT type of thrusters can be offered on request.

Wärtsilä Retractable Thrusters

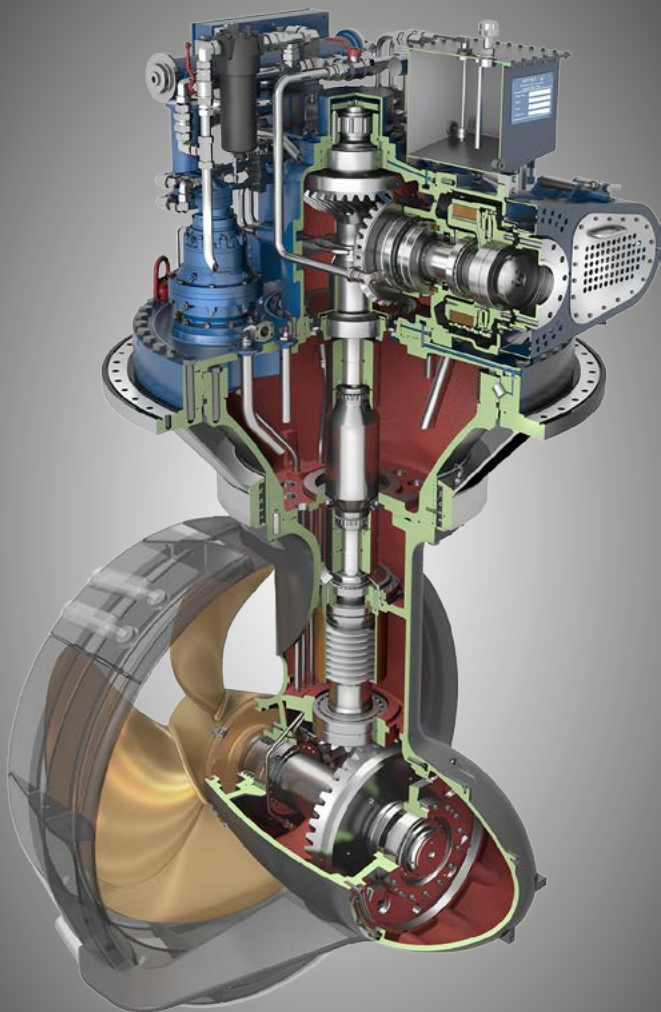
Wärtsilä Retractable Thrusters are available up to 6500 kW. The upper part of the range is covered by the WST-65RU retractable underwater mountable thruster, a thruster of which the outboard part can be exchanged under water to optimize maintenance when docking of the vessel is not possible. Wärtsilä Modular Thrusters (LMT) with a modular and flexible design are the basis for the retractable thrusters up to 4500 kW.

Wärtsilä Underwater Mountable Thrusters

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

Special thruster designs

The LMT thrusters are also used in special thruster designs, such as inboard demountable thrusters or Z-drive configurations above 3000 kW. The LMT series can be applied in a wide range of offshore applications.



Propulsors & Gears

■ ■ Wärtsilä Steerable Thrusters

Thruster type	Engine power ⁽²⁾ (kW)	Input speed (rpm)	Propeller diameter (mm)	Bollard pull ⁽¹⁾ (tonnes)
WST-11	900	750 1000 1200 1600 1800	1600	30
	1050		1800	36
WST-14	1150		1800	39
	1275		1900	43
	1350		2000	46
WST-16	1400		2000	47
	1600		2200	55
WST-18	1700		2200	57
	1800		2400	63
WST-21	2050		2400	69
	2100		2600	73
WST-24	2400	720 1000 1200	2600	80
	2400		2800	84
WST-28	2800		2800	94
	2800		3000	97
WST-32	3200		3000	107
	3200		3200	111

1) Based on two installations, 100% power, nozzle designed for bollard pull and 2% thrust deduction

2) In case of ice class notation, maximum power level is reduced

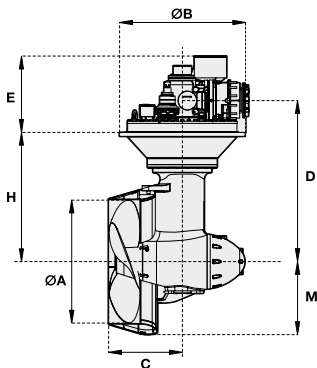
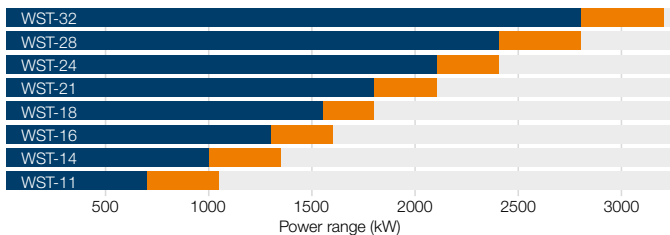
Key benefits

- 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.
- 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 720 rpm to 1800 rpm (intermediate ratios available on request).
- Integrated power take off for steering, lubrication, clutch and pitch hydraulics (DM variant).
- 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 clutch (slipping range up to 50% engine rpm) or CP propeller with dry 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.
- Multiple installation options: bolt-in, weld-in, can-mounted or split installation.

Wärtsilä Steerable Thrusters range



Wärtsilä Steerable Thrusters dimensions (mm)

Thruster type	Dimensions in mm						Weight ⁽¹⁾ (kg)
	A	Weld-in	Bolt-in	Well diameter	PAL options D		
		B					
WST-11	1600	1992	1948	2000	2400	2700	10000/11800
	1800						
WST-14	1800	1992	1948	2000	2500	2800	10900/12860
	2000						
WST-16	2000	2367	2326	2375	2800	3150	17050/20400
	2200						
WST-18	2200	2367	2326	2375	2900	3250	18600/21950
	2400						
WST-21	2400	2542	2512	2550	3200	3500	24800/27500
	2600						
WST-24	2600	2692	2660	2700	3500	3800	28500/31500
	2800						
WST-28	2800	2868	2825	2875	3925	4200	32800/36100
	3000						
WST-32	3000	3042	3000	3050	4000	4500	37000/41000
	3200						

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

Wärtsilä Retractable Thrusters

Thruster type		LMT CS/FS175		LMT CS/FS200		LMT CS/FS225		LMT CS/FS250	
Power	kW	1000		1200		1500	1600	2000	
Frequency	Hz	50	60	50	60	50	60	50	60
Input speed	rpm	1000	1200	1000	900	1000	900	750	720
Propeller diameter	mm	1700		1900		2100		2400	
Propeller speed	rpm	378	380	341	307	302	308	276	265
Max. thrust at zero knots									
With nozzle	kN	165		200		260		320	

The information in the table is valid for L-drive configurations

Thruster type			1510	2510	3500		WST-65RU	
Power (input speed)	Z-drive	kW	2145	3250	3650	4500		
		rpm	1200	900	900	720		
	L-drive	kW	2435	2850	3850	4500	5500	6500
		rpm	720	720	720	470	720	600
Propeller diameter (in nozzle)		mm	2500	3000 3200	3400 3600	4200		

Other input speeds and power levels for LMT type retractable thrusters available on request

Remarks

The propellers are designed for bollard pull condition at 100% MCR power level and valid for uni-directional Dynamic Positioning (DP) application.

Final selection depends on the chosen classification society. Selections are not valid for classification with ice class.

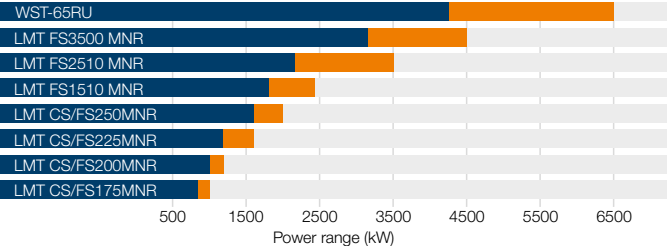
Benefits

- 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-RU type)
- 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 (LMT type FS2510/3500)
- L- and Z-drive with horizontal floating shaft and quick connect clutch (LMT type)
- Fixed pitch (FP) or controllable pitch (CP) propeller (LMT types CS/FS 175/200/225/250)
- 3° tilted nozzle (standard) or 0° nozzle (LMT type)
- 8° tilted propeller shaft (WST-RU type)
- Hull closing plate (LMT type)

Wärtsilä Retractable Thrusters range



Thruster type		Dimensions (mm)								Weight ⁽²⁾
		A	B	C	D	E	F	H _{min} ⁽¹⁾ L-drive	motor height	kg
LMT FS/ CS175MNR	FS	1700	2700	2950	4050	2200	2400	7700	1850	18000
	CS		2850							19000
LMT FS/ CS200MNR	FS	1900	2850	3050	4160	2450	2700	8600	1900	20000
	CS		3000							21000
LMT FS/ CS225MNR	FS	2100	3300	3590	4625	2650	3000	9000	2000	22000
	CS		3450							23000
LMT FS/ CS250MNR	FS	2400	3710	3666	4625	3000	3370	10000	2200	34000
	CS		3710							32000

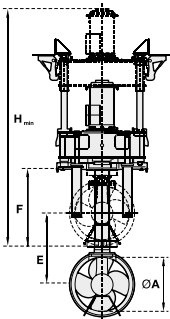
1) Minimum total height of the thruster unit depends on the selected electric motor

2) Indicative weight for L-drive execution excluding the E-motor and oil, actual weight can vary depending on project specific customizations

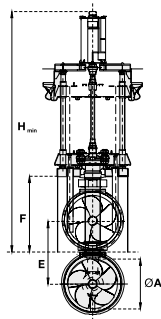
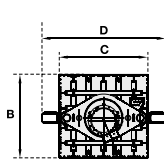
Thruster type		Dimensions (mm)										Weight ⁽²⁾
		A	B ⁽¹⁾	C	D	E	F	H _{min}		PAL Z-drive	Estimated motor height	kg
								L- drive	Z- drive			
LMT FS1510 MNR		2500	3570	3695	4745	3200	3714	10960	8756	6894	2160	55000
LMT FS2510 MNR		3200	4900	4500	4805	4105	4770	14460	11573	8854	3150	110000
LMT FS3500 MNR		3600	5845	4770	4770	4720	5540	16745	14232	10372	3190	132000
WST-65RU		4200	5550	5980	—	5750	7200	20100	—	—	3250	212500

1) Dimension includes space for nozzle removal (except WST-RU type)

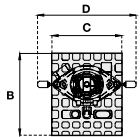
2) Indicative weight for Z-drive execution (except WST-65RU types) excluding the E-motor and oil, actual weight can vary depending on project specific customizations



LMT FS/CS175-200-225-250MNR



LMT FS1510-2500-2510-3500MNR



Wärtsilä Underwater Mountable Thrusters

Main technical data				
Thruster type	Power ⁽¹⁾ (kW)	Input speed (rpm)	Propeller diameter (mm)	Tilt
LMT FS1510NU	2435	720	2600	3° ⁽²⁾
LMT FS2510NU	3500	539	3200	3° ⁽²⁾
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 ⁽¹⁾	R	Outboard part ⁽²⁾		Recept- acle ⁽³⁾
										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	3055
Thruster type	A	B	C	M	L	H				Outboard part ⁽²⁾		Well ⁽⁴⁾
										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

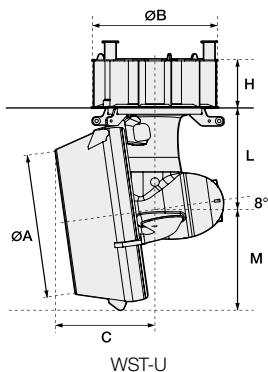
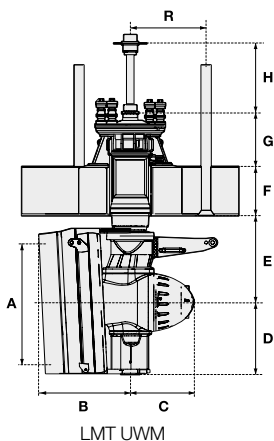
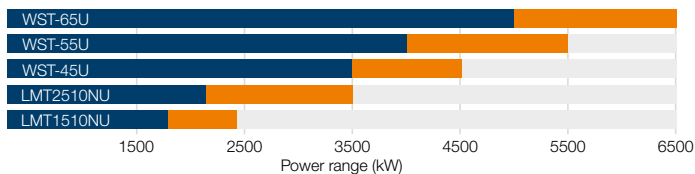
Key benefits

- Exchangeable underwater for vessels that do not have access to dry docking facilities
- 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
- Compact and light design
- Easy installation

Options

- Condition monitoring (PCMS)
- Oil condition monitoring
- Redundant lubrication and steering hydraulic systems

Wärtsilä Underwater Mountable Thrusters range



Propulsors & Gears

■ ■ Wärtsilä Transverse Thrusters

Bevel-gear driven propeller in a transverse tunnel.

- Controllable or fixed pitch propeller
- Maximum thrust with small diameter
- Robust reliable design
- Easy installation
- Standard and demountable versions available
- Applications for dynamic positioning and manoeuvring purposes

Wärtsilä Transverse Thrusters dimensions

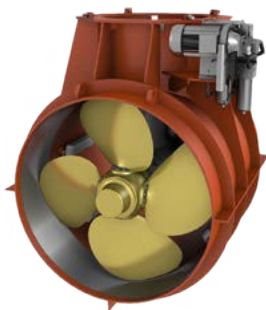
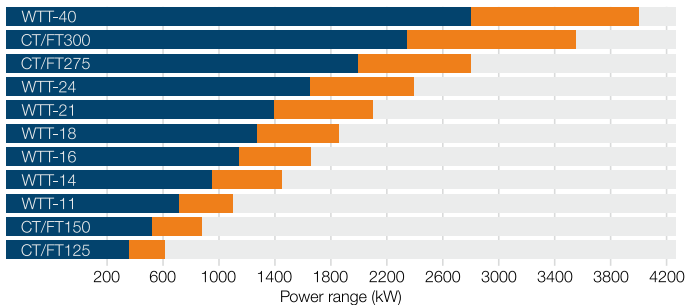
Thruster type	Electr. Freq.	Input speed	Max. power (kW) ¹		D	L	Mass ²
	(Hz)	[rpm]	Manoeuvring	Dynamic positioning	(mm)	(mm)	(kg)
CT/FT125 H	60	1775	614	603	1250	1550	2800
	50	1475	516	501			
CT/FT150 H	60	1780	880	789	1500	1800	4200
	50	1480	735	656			
WTT-11	60	1185	1100	1000	1750	1970	6240
	50	1485	1100	-			
	50	985	1100	1000			
WTT-14	60	1185	1450	1300	2000	2195	8050
	50	990					
WTT-16	60	1180	1650	1500	2200	2100	11300
	50	980					
WTT-18	60	1180	1850	1825	2200	2275	12250
	50	980					
WTT-21	60	1180	2100	1825	2400	2275	12975
	50	980					
WTT-24	60	880	2400	2150	2600	2345	14200
	50	980					
CT/FT275 H	60	890	2532	1745	2750	2800	17800
	50	990	2805	1941			
CT/FT275 M	60	890	2569	2075	2750	2704	15600
	50	740	2145	1725			
CT/FT300 H	60	890	3145	2225	3000	3000	22700
	50	740	2625	1850			
CT/FT300 M	60	710	3405	2578	3000	2916	22500
	50	740	3550	2687			
CT/FT300 Z	60	600	-	3000	3000	2916	22500
	50	600	-	3000			
WTT-40	60	710	3900	3500	3400	3520	30500
	50	735	4000	3600			

1 Maximum power level is valid for uni-directional rotation (CPP).

Depending on propeller type and class society, lower power levels may apply.

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

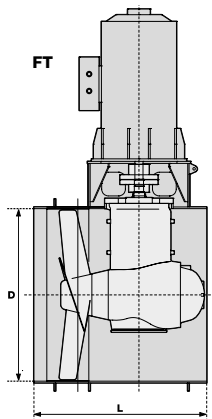
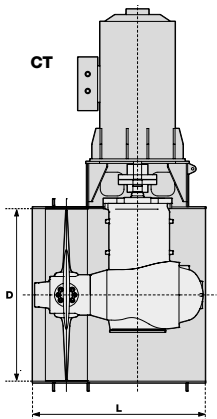
Wärtsilä Transverse Thrusters range

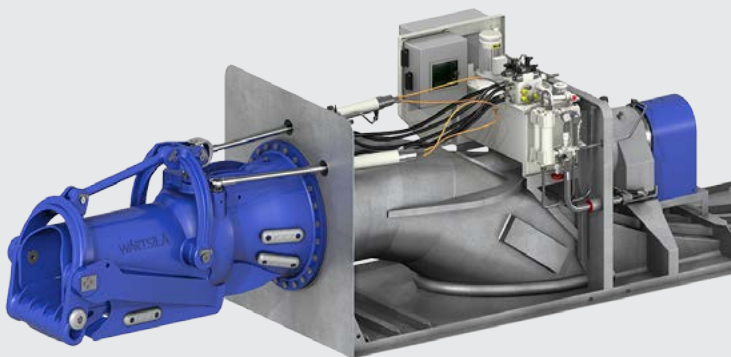


WTT-11 CP



WTT-11 FP





■ Wärtsilä Midsize Waterjets

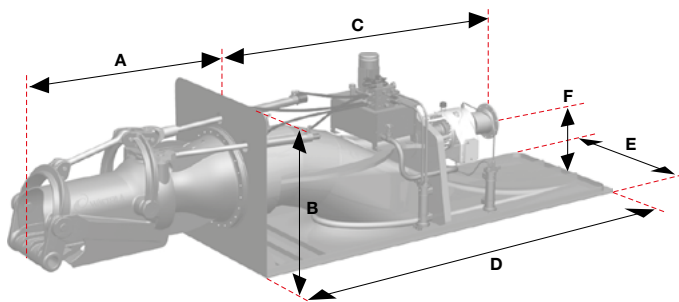
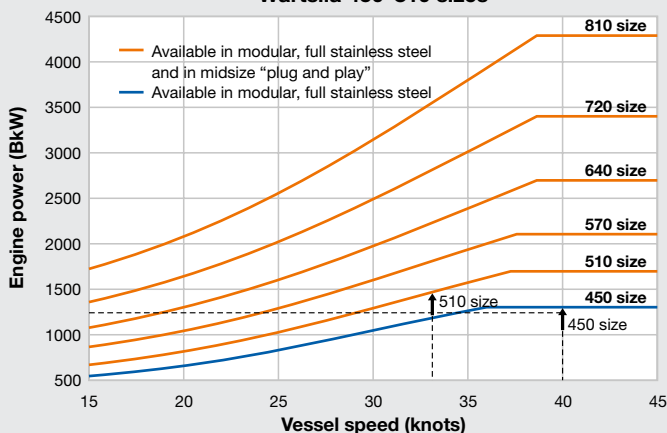
- A compactly designed axial pump with excellent efficiency, cavitation and noise characteristics.
- The waterjet unit is completely pre-assembled, thereby reducing installation time.
- High performance components in stainless steel to prevent wear and corrosion.
- The water lubricated bearing in the 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.

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 450–810 sizes**

Propulsors & Gears

■ Wärtsilä Modular Waterjets

- The modular design allows flexibility in the scope of supply.
- A compactly designed axial pump with excellent efficiency, cavitation and noise characteristics.
- High performance components in stainless steel to prevent wear and corrosion.
- The water lubricated bearing in the stator bowl provides an environmental 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.
- Tailor-made inlet design based on the shape and operational profile of the vessel.

Key Benefits

Wärtsilä axial waterjets provide an average reduction of 25% in transom occupation.

For naval architects this creates the possibility to apply a larger power density onto narrower hulls for achieving top vessel performance.

Jet sizes are indicated by the front side diameter of the impeller seat ring. Unlike a non-axial design, the Wärtsilä axial design waterjet does not expand in radial direction downstream.

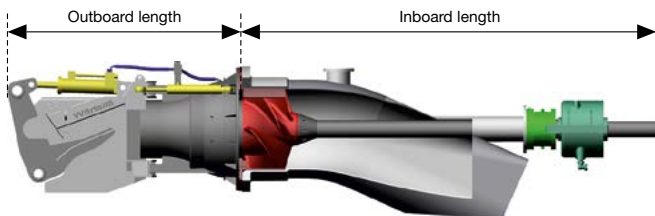


Photo courtesy of Incat

Weight & dimensions table

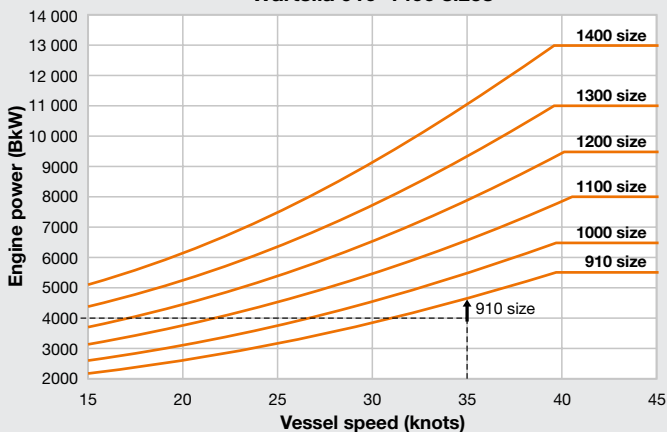
Size	Outboard lenght (mm)	Inboard lenght (mm)	Transom flange (mm)	Weight steerable (kg)	Weight booster (kg)
510	1 390	2 285	655	700	500
570	1 550	2 495	730	960	700
640	1 710	2 865	820	1 400	1 100
720	1 960	3 155	920	1 900	1 350
810	2 195	3 550	1 035	2 700	1 900
910	2 475	4 020	1 165	3 700	2 450
1 000	2 710	4 350	1 280	4 600	3 350
1 100	3 000	4 735	1 405	6 200	4 200
1 200	3 250	5 095	1 535	7 900	5 700
1 300	3 520	5 625	1 665	10 100	6 900
1 400	3 790	6 005	1 790	12 000	8 100
1 500	4 050	6 370	1 920	14 500	10 000
1 620	4 350	6 965	2 075	17 900	12 500
1 720	4 655	7 340	2 200	21 200	15 100
1 880	5 070	7 910	2 405	27 800	18 900
2 020	5 465	8 530	2 585	32 800	23 200
2 180	5 880	9 120	2 790	40 500	27 700
2 350	6 325	9 710	3 005	49 500	33 800

⁽¹⁾ Inboard lenght may vary depending on the optimized shape of the inlet duct.

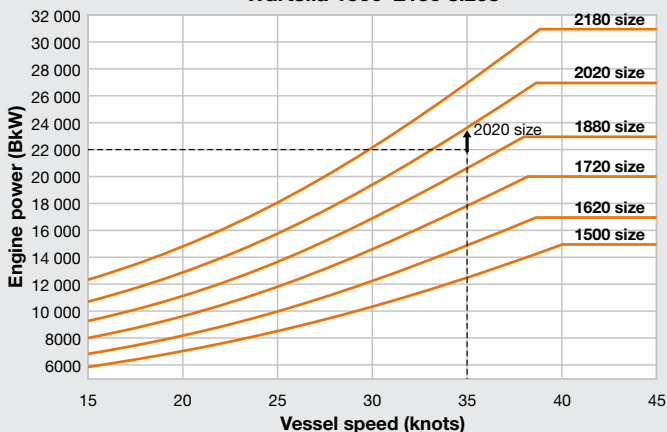


Propulsors & Gears

Wärtsilä 910–1400 sizes



Wärtsilä 1500–2180 sizes



Waterjet size selection

The selection graphs indicate the jet size required based on the relation between the engine power and the design speed of the vessel. 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, please contact Wärtsilä in the earliest design stages. Please contact us for an optimised jet selection based on specific vessel design parameters, operating 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 times.

Propulsors & Gears



■ 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 whole system footprint is reduced significantly allowing optimisation for ergonomic needs and meeting functional requirements.

Modularity/flexibility: The extended modularity of hardware and graphic user interfaces offers a flexible solution for any vessel layout. The system fits all the propulsion products and, as a result, all types of vessels.



Safety: the system improves safety, both at sea and in port by removing the visual challenge of finding critical information, it provides the user the relevant information when needed

User friendly, intuitive operations: By the means of the modern displays, with touchscreen technology, the operator can easily get all the functions and information handy. The system will guide the user when a more complex sequence or action is required. Also, the system can support any language.

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

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

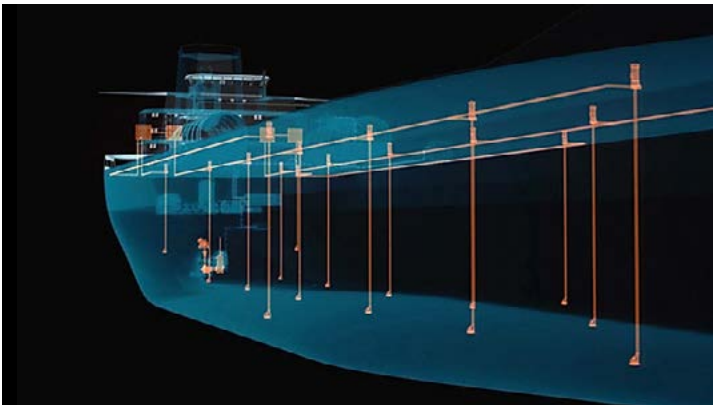
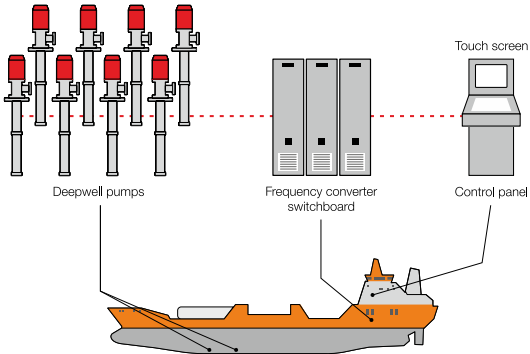
■ Wärtsilä Svanehøj Deepwell Cargo Handling Systems

For safely offloading a wide range of liquid cargoes, we offer the most flexible and environmentally sound solutions.

Our high quality deepwell cargo pump systems are powered by efficient electric drives that are fast and easy to install.

We specialise in competitively priced full cargo and ballast systems including drive systems, switchboards and accessories.

Around the world, we create custom-made turnkey solutions for any tanker, with full project management from start to safe on-time delivery and installation.



■ Wärtsilä Svanehøj Deepwell Gas Pumps

When absolute confidence in offloading safety and efficiency are critical, Wärtsilä Svanehøj is the natural choice among gas carriers worldwide for deepwell and cargo booster pumps. Our dedicated project teams deliver solutions for vessels from the smallest fully pressurized push barges and dedicated CO₂ carriers to the largest fully refrigerated VLGCs.

Our pumps handle all types of cargo at all temperatures and gravities without any component changes, offering potentially huge cost savings. Our range spans:

- Fully pressurised tankers, cargo at ambient temperature, tank pressure up to 18 bar.
- Fully refrigerated atmospheric tankers, cargo cooled to saturation temperature (typically -48°C).
- Semi-refrigerated tankers, cargo liquefied by cooling/pressure process down to -104°C.
- We lead in long-shafted pumps for LNG at -163°C.

Wärtsilä Svanehøj
deepwell gas pump



Pumps & Valves

■ ■ Wärtsilä Deepwell Offshore Process and Cargo Pumps

Based on Wärtsilä's world-renowned deepwell pump technology, our Offshore Process and Cargo (OPC) pumps have been specially developed to meet the extreme demands and specifications of the offshore industry.

Our high efficiency electrically driven explosion-proof pump systems deliver the highest standards of energy efficiency, safety and reliability the offshore industry demands such as 25,000 MTBR as per API 610.



Wärtsilä deepwell offshore
process and cargo pump

Testing and inspection

Wärtsilä is well established in the offshore sector and can perform a number of tests and inspections prior to delivery, such as;

- **Material inspections:** Visual inspections, liquid penetrant testing, radiographic testing, material certificates and welding log.
- **Performance tests:** Hydrostatic pressure tests, Q/H performance test, NPSH test, 4 hours mechanical run test and complete unit test. The final product can be delivered with detailed documentation specifying welding procedures, preservation procedures, surface coating, weight procedure and traceability record. Furthermore the final documentation may include noise, vibrations and temperature data sheets for the various tests performed.

■ ■ Wartsilä Svanehøj Deepwell Ballast Pumps

Wartsilä is the leading manufacturer of high quality deepwell in-line centrifugal ballast pumps for demanding offshore applications.

Our pumps offer outstanding reliability, low noise and efficiency for floating production units of all sizes.

The environmentally sound pump is designed for direct on-line starting, or alternatively with variable speed regulation available through a frequency converter.



Wartsilä Svanehøj
deepwell ballast pump

Pumps & Valves

■ Wärtsilä Seawater Lift Pumps

Wärtsilä's range of robust, efficient sea water lift pumps are designed specifically for the demanding offshore market. Our range of sea water lift pumps are based on well-known technology, offer safe operation and low maintenance cost.

Wärtsilä in-line
sea-water lift pump



Seawater Vertical Deepwell Pumps

The well proven and expertly engineered vertical suspended packages for vertical electrical submersible pumps and vertical line shaft pumps (API 610 VS1) are designed for MTBR of 25000 reliable operational hours, and are optimized for high efficiency and low NPSH. The design incorporates features to protect the caisson against scuffing and crevice corrosion hence minimising galvanic corrosion. Engineered hypochlorite dosing rings and air release valves are available, and the pumps can be delivered in duplex and super duplex material.

Vertical Electrical Submersible Pumps The vertical suspended multi-stage pumps are driven by a submersible motor. The pump assembly is generally designed according to AP1610 recommendations.

All cables and hoses are carefully fastened and supported along the column, and are spirally wrapped along the pump bowl assembly to allow safe installation. The well proven Indar submersible water/glycol motor has enhanced internal cooling circulation and a positive pressure header tank arrangement.

Capacity range: 400–3500 m³/h

Differential heads up to 200 mlc

Motors up to 1.5 MW and 6.6 kV

Vertical Line Shaft Pumps (API 610 VS1) Vertically suspended, single casing diffuser line-shaft driven pumps with discharge through the column and driven by a dry mounted electrical motor which is configured to operate in harsh environments. VS1 design according to API 610 11th edition with open shaftline, carbon sleeve shaft bearings, enclosed impellers and single mechanical seal - API and non-API compliant seals are available.

Capacity range 50–3500 m³/h

Differential head up to 200 mlc

In-Line Seawater Lift Pumps

Low NPSHr to meet stringent offshore specifications, configurations of inlet and outlet nozzles to suit every piping installation. Either directly coupled to an electric motor within a safe area or through a cardan shaft installed in the pump room. We supply a range of high quality casing and impeller materials including nickel, aluminium, bronze or super duplex.

Capacity range: 400–5000 m³/h

Differential pressure: 08–10 bar



Electrical submersible
seawater lift pump

■ Wärtsilä Svanehøj ECA Fuel Pump

Wärtsilä Svanehøj deepwell cargo pumps have proven their reliability for more than 50 years at sea. All the benefits of the existing larger Wärtsilä Svanehøj deepwell cargo pumps have now been attributed to the Wärtsilä Svanehøj ECA fuel pump.

The Wärtsilä Svanehøj ECA Fuel Pump (EFP) offers the advantages of no tank connections below liquid level, no electrical components inside the tank and hardly any contribution to Boil Off Gas generation. It is independent of weather, sloshing and thermal conditions and ensures a steady, reliable fuel gas supply with a fast response time.

The EFP model was developed in close cooperation with designers of LNG fuel gas systems to support highly efficient, environment friendly LNG fuelled engines driven by the implementation of Emission Controlled Areas (ECAs). It is also prepared for other fuel types such as Ethane and Methanol.

Main design criteria:

- Safety & Reliability
- 5 year service intervals or 25,000 operating hours
- Contingency: safe handling in emergencies.

Wärtsilä Svanehøj
ECA Fuel Pump (EFP)



■ ■ Wärtsilä Pump Room Systems

When offloading flammable liquid cargo, it must be done safely, smoothly and efficiently. Wärtsilä has 50 years of experience and the know-how to optimise any kind of pump room system, from end-to-end.

For tankers carrying less than four different segregations, our pump room solution is optimal since the cargo pumps can take suction from any cargo tank. All wear components of our pump room installed equipment are easily accessible and can be replaced at sea, and the entire Wärtsilä concept is maintenance friendly. Our expertly designed heavy duty centrifugal pumps are made of superior materials from own foundry. These are installed in the pump room together with our unique stripping system

Using superior materials, robust testing and our renowned pump technology, we can make any system as reliable, efficient and cost-effective as possible.

We can advise on and supply any prime mover arrangement that will optimise your efficiency, including high efficiency, low noise, low emissions electric systems and variable speed control to maximise flow rates and use less power.

Versatile driver option

ELECTRIC DRIVE

- Vertical or horizontal
- Single speed or two speed
- VFD/VSD solutions.

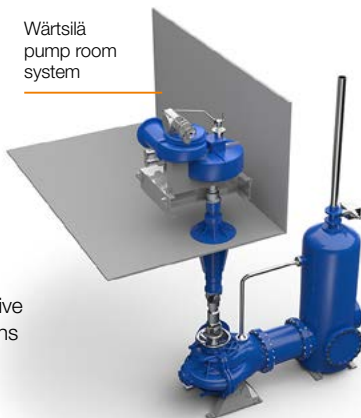
STEAM TURBINES

- Vertical or horizontal
- Single stage or multi stage.

DIESEL ENGINE DRIVE

- Horizontal with clutch direct drive
- Vertical with angle gear solutions
- Combined solutions for pump drive and gensets.

Wärtsilä
pump room
system



Performance stripping systems

Through our pioneering expertise with Eureka systems, we invented in stripping systems are remain specialists in maximising cargo offloading efficiency, speed and reducing risk. Priming and capacity regulating systems convert any centrifugal pump into a self-primed unit for optimal discharge and stripping performance. Systems consist of air/gas separators with built-

Pumps & Valves

in strainers, auto stop/start vacuum pump units, capacity regulating valves and the latest within PLC based all electric control units for minimum cargo wastage and maximum profits.

Control systems

Control systems put full pump room control in one convenient place. PLC based all electric control system for control and monitoring of all functions required for the scope within our system. We also provide remote valve control system solutions where all cargo and ballast valves with actuators are included in addition to the required hydraulic power pack and solenoid rack. Our control system can integrate optional functions like load calculator, level gauging system and vapor emission recovery systems.

The electric signals indicating pressures, temperatures, and vibration, as well as the automation required for our stripping system are transferred by transmitters via Zener barriers located in our interphase cabinet to the cargo control room, where the actual cargo handling control takes place.

The pump room pumps are connected to drivers located in the engine room through gas tight type approved flexible power transmission units.

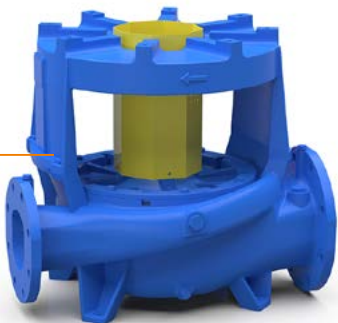
■ ■ Wärtsilä Engine Room Pumps

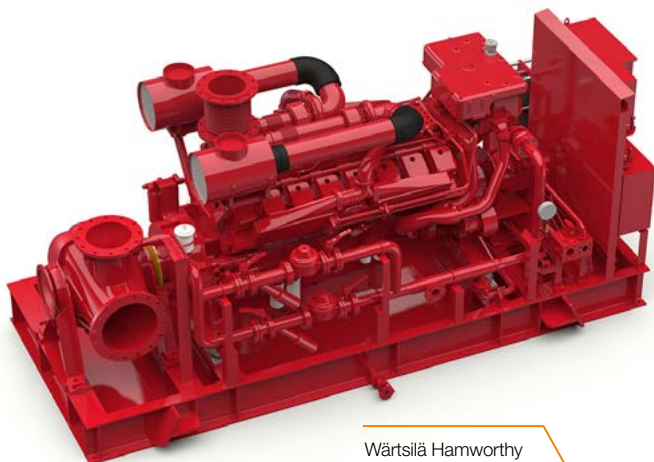
Engine room pumps are critical for your operations. The costs of pump failures, such as loss of engine cooling water, are high. That's why Wärtsilä pumps are built for ultimate reliability in the toughest operating conditions.

Highest quality materials, proven simplicity of design and responsive support add up to pumps you can trust absolutely – as thousands of vessels around the world do.

Our broad range is built on the world-renowned reliability of the Eureka and Dolphin centrifugal pump series. Whatever you need from engine room pump technology, talk to Wärtsilä.

Wärtsilä Hamworthy engine room pump (model C2G)





Wärtsilä Hamworthy
firewater pump package

■ Wärtsilä Firewater Pump Packages

Fire Water Pump Packages are safety critical for offshore operators. Wärtsilä designs system solutions to the highest NFPA 20 standards, with the reassurance of high quality Wärtsilä pump technology at the heart of the system.

Our range of in-line centrifugal pumps or deepwell submerged pumps is available with a wide choice of drives and configurations, either contained or open for fire compartments.

We work with you throughout, from pre-FEED to Detail Design stages, to create your optimum custom solution for complete peace of mind.

■ Wärtsilä External Fire Fighting Pumps

Wärtsilä's fire fighting pumps are custom-designed for every customer and easy to install on any type of vessel large or small. They meet every major compliance and quality approval. With full quality control over raw materials from our foundry, we guarantee systems you can trust completely.

Pumps & 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, steel and composite materials for the global energy industries:

- Offshore Oil and Gas
- Floating Production Systems
- Petro-Chemical
- Power Generation
- LNG
- Naval Marine
- Marine Services
- Pipelines.

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

■ ■ Shiphm Valves

THE WORLD'S PREFERRED VALVE SOLUTIONS PARTNER

Shiphm Valves manufactures non-ferrous, high alloy and composite valve solutions for handling sea water and other corrosive media. For 80 years a key supplier to the British Royal Navy and Ministry of Defence, Shiphm 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.

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

Speciality materials – ‘our standard’

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



Shipham Valves

ESTABLISHED 1798

a Wärtsilä product

John Mills Valves

BESPOKE VALVE SOLUTIONS FOR OFFSHORE,
MARINE & INDUSTRIAL APPLICATIONS

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

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

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



a Wärtsilä product

Cort Valves

PIPELINE BALL & GATE VALVES

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

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



a Wärtsilä product

Seals, Bearings & Sterntubes

Wärtsilä Seals, Bearings, Sterntubes & Others

Our Seals & Bearings product portfolio is the most comprehensive in the market, and we continuously develop innovative, environmentally compliant and longer lasting new products. At the same time, our global service network can provide the fastest response in the business, providing expertise anywhere in the world at very short notice when necessary.

Ship owners and operators are looking for solutions to reduce their maintenance costs in the highly contested shipping market. On one hand this means a growing price consciousness regarding spare parts. But on the other hand it also means that ship owners and operators are increasingly looking beyond the initial outlay and searching for longer lasting performance and lifecycle cost efficiency.

Lifecycle efficiency

As the seals & bearings solution provider with the widest range of products, both oil and water lubricated, Wärtsilä is uniquely positioned to help ship owners find solutions for improving lifecycle efficiency. Our complete product portfolio, technology know-how, constant innovation and a global service network means that we can always find the ideal solution for the customer instead of being forced to push a single technology for every need.

Risk reduction

The positive, agile and flexible attitude adopted in Wärtsilä Seals& Bearings, is our way to ensure we can say yes to customers' requests and offer the fastest service in the industry. The ability to be positive comes from an agile and flexible way of organising our operations. With our shipyard customers this means having our technological know-how in the frontline so that they can get quick answers to their questions, requests for quotations etc. For ship owners and operators it is a matter of knowing that, when needed, they can count on our global field service network's fast response to get uptime on their vessels.

Environmental leadership

Developments in environmental legislation are leading to a growing demand for environmental upgrades for existing vessels. Wärtsilä is able to answer these needs and assume full responsibility for service and maintenance over the entire vessel lifecycle. With the needed service capability and resources in place globally and armed with a deep understanding of different ship systems, we are ready to take on even large conversion projects involving extensive dismantling of the vessel.

Wärtsilä Sealing Solutions

Wärtsilä stern tube seals – oil lubricated

STANDARD

Fwd	Inland Waterways & Coastal
	Wärtsilä Sternguard OLS2 compact lip seal, (136–362 mm)
	Wärtsilä Sternguard E series face seal, (50–320 mm)
	Conventional Commercial
	Wärtsilä Sternguard OLS2 lip seal, (80–1172 mm)
	Special & offshore
Aft	Wärtsilä Sternguard Sequal face seal, (205–1004 mm) fully and partially split options available
	Wärtsilä Sternguard Sequal face seal, (66–1029 mm)
	Inland Waterways & Coastal
	Wärtsilä Sternguard OLS3 compact lip seal, (136–362 mm)
	Wärtsilä Sternguard In water serviceable seal, (95–1065 mm)
	Wärtsilä Sternguard E-series face seal, (50–320 mm)
Aft	Conventional Commercial
	Wärtsilä Sternguard OLS3 lip seal, (80–1172 mm)
	Wärtsilä Sternguard OLS4 lip seal, (286–1172 mm) (extra redundancy-stand-by)
	Wärtsilä Sternguard In water serviceable seal, (95–1065 mm)
	Special & offshore
	Wärtsilä Sternguard In water serviceable seal, (95–1065 mm)

ANTI-POLLUTION

Aft	Merchant
	Wärtsilä Airguard OLS3A lip seal, (286–1172 mm)
	Wärtsilä Airguard OLS4A lip seal, (286–1172 mm) (extra redundancy)

ABRASION RESISTANT

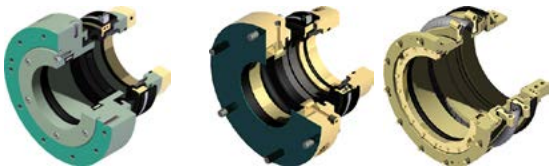
Aft	Inland Waterways & Coastal
	Wärtsilä Sternguard E-series face seal, (50–320 mm)
	Dredgers
	Wärtsilä Sandguard OLS3W lip seal, (286–1172 mm)
Aft	Wärtsilä Sandguard OLS4W lip seal, (286–1172 mm) (extra redundancy)



**Wärtsilä
Sternguard**

Seals, Bearings & Sterntubes

Wärtsilä
Enviroguard



Wärtsilä stern tube seals – water lubricated

OPEN WATER LUBRICATION (70–1040 MM)

Fwd	Commercial & Military
	Wärtsilä Enviroguard PSE face seal, (70–450 mm) (standard and composite options available)
	Wärtsilä Enviroguard MG4 face seal, (460–820 mm)
	Wärtsilä Enviroguard MD face seal, (150–1040 mm) (shock compatible)
	Wärtsilä Enviroguard MA face seal, (150–1040 mm) (shock compatible)
	Wärtsilä Enviroguard M9 face seal, (250–900 mm) (shock compatible with packing)

CLOSED WATER LUBRICATION

Ice class
Wärtsilä Iceguard FWD face seal, (320–1140 mm)
Wärtsilä Iceguard AFT face seal, (320–1140 mm)

Wärtsilä
Floodguard

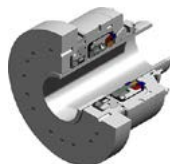


Wärtsilä bulkhead seals

STANDARD & HIGH SPEED

Commercial & Military
Wärtsilä Floodguard standard bulkhead seal, (50–680 mm)
Wärtsilä Floodguard high speed bulkhead seal, (50–680 mm)

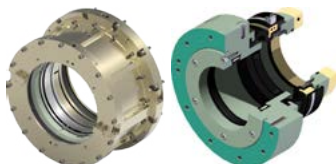
**Wärtsilä
Diveguard**



SUBMARINE

Fwd	Wärtsilä Diveguard single barrier face seal, (200–700 mm)
	Wärtsilä Diveguard tandem barrier face seal, (200–700 mm)

**Wärtsilä
Jetguard**



WATERJETS

Commercial	
Wärtsilä Jetguard PSE face seal, (110–410 mm) (standard and composite options available)	
Military	
Wärtsilä Jetguard ANW face seal, shock compatible, (120–380 mm) (standard and composite options available)	

**Wärtsilä
Oceanguard**



Wärtsilä special applications seals

Wärtsilä has extensive experience with customers having both specialised and original requirements. This has allowed us to develop our expertise in the creation and validation of bespoke sealing solutions. The fields of application are widespread, and include industrial, renewable power generation, and heavy lift vessel applications.

TIDAL TURBINES

Aft	Wärtsilä Oceanguard face seal, (125–1000 mm)
	Wärtsilä Sternguard OLS4 lip seal, (286–1172 mm)

Seals, Bearings & Sterntubes

**Wärtsilä
Sternguard**



**Wärtsilä
Steerguard**



Wärtsilä thruster/pod seals

THRUSTERS

Aft	Standard
	Wärtsilä Sternguard OLS3 compact lip seal, (136–362 mm)
	Wärtsilä Sternguard OLS3 lip seal, (80–1172 mm)
	Wärtsilä Sternguard A-series face seal, (205–1004 mm)
	Wärtsilä Sternguard in-water serviceable seal, (95–1065 mm)
	Anti-Pollution
	Wärtsilä Airguard OLS3 lip seal, (286–1172 mm) (extra redundancy stand-by)
	Wärtsilä Oceanguard face seal, (125–1060 mm)

ELECTRIC PODS

Aft	Standard
	Wärtsilä Sternguard OLS4 lip seal, (286–1172 mm)
	Abrasion Resistant & Anti-pollution
	Wärtsilä Ocenguard face seal, (400–760 mm)

Wärtsilä rudder/stabiliser seals

RUDDER STOCKS (155–710 mm)

Oil lubricated
Wärtsilä Steerguard KLR2 lip seal, (155–710 mm)
Wärtsilä Steerguard KLR3 lip seal, (155–710 mm) (extra redundancy)

RUDDER STOCKS & STABILISERS (50–1300 mm)

Grease or water lubricated
Wärtsilä Steerguard ER standard face seal, (50–1300 mm)

**Wärtsilä
Envirosafe**



**Wärtsilä
Sternsafe**



**Wärtsilä
Steersafe**



Wärtsilä Bearing Solutions

Wärtsilä sterntube bearings (oil & water)

OIL LUBRICATED

Commercial

Wärtsilä Sternsafe white metal bearing, (136–1172 mm)
(un-split oil lubricated white metal bearing)

Wärtsilä Sternsafe composite bearing, (70–1100 mm)
(un-split oil lubricated composite bearing, mainly retrofits)

WATER LUBRICATED

Commercial & Military

Wärtsilä Envirosafe composite bearings, (70–1100 mm)
(one piece, split bearing, split housing)

Wärtsilä rudder/stabiliser bearings

STANDARD

Commercial & Military Rudder

Wärtsilä Steersafe oil lubricated composite bearing, (70–1200 mm)
(un-split)

DRY RUNNING CAPABILITY

Commercial & Military Rudder

Wärtsilä Steersafe oil lubricated composite bearings, (70–705 mm)
(un-split)

Seals, Bearings & Sterntubes



Wärtsilä Intermediate shaft bearings

STANDARD

Commercial (up to 0.8 Mpa)

Wärtsilä Sternguard intermediate shaft bearing, (126–825 mm)
(self-aligning and forced lubrication)

Wärtsilä Sternguard intermediate shaft bearing, (126–825 mm)
(self-aligning and self-lubrication)

HIGH LOAD

Commercial (0.8–1.5 Mpa)

Wärtsilä High load intermediate shaft bearing
(high load and forced lubrication)



Wärtsilä Thrust bearings

Commercial & Military

Wärtsilä Thrust bearing, (110–560 mm)
(forced lubrication (axial) with optional external lubrication)

Wärtsilä Thrust bearing, (110–560 mm)
(self-lubrication (axial and radial loads) with optional external lubrication)



Wärtsilä generator bearings

Commercial & Military

Wärtsilä Generator Bearing side flanged type, (80–500 mm)

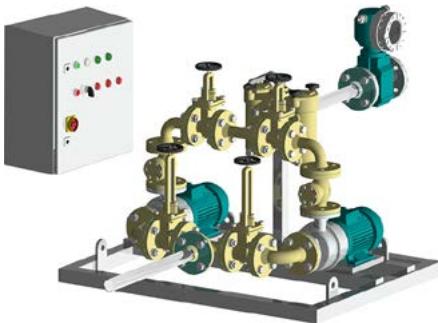
Wärtsilä Generator Bearing central flanged type, (80–500 mm)

Wärtsilä Generator Bearing pedestal type, (80–500 mm)



Wärtsilä Stern Tube Solutions

Our packages are all designed to meet certain standards and can be customised to suit specific applications. Options include oil lubricated sterntubes with white metal or composite bearings or water lubricated sterntubes with composite bearings.



Wärtsilä Other Seals & Bearings Products

Wärtsilä water quality systems

Pumped water flush supply systems with various filtration and temperature control options to improve and increase life of the seal and bearing products installed. Systems are adapted to suit applications either by filtering to required standards in silty/ gritty water environments or controlling closed water temperature in ice-class type applications. Suitable for both open and closed water lubricated sterntubes.

WATER QUALITY SYSTEMS

Flush Supply & Filtration

Wärtsilä Water Quality System: open water (clear)

Wärtsilä Water Quality System: open water (high performance -silty)

Flush Supply, Filtration & Temperature Control

Wärtsilä Water Quality System: closed water system

Seals, Bearings & Sterntubes



Wärtsilä hydraulic equipment

Hydraulic couplings, nuts and bolts designed for easy handling and trouble free operation made from the highest quality steel in accordance with existing classification rules.

HYDRAULIC EQUIPMENT

Hydraulic Couplings
Wärtsilä Hydraulic Couplings: with flange, (100–800 mm)
Wärtsilä Hydraulic Couplings: with flange and longer body, (100–800 mm)
Wärtsilä Hydraulic Couplings: with flange in sleeve, (100–800 mm)
Wärtsilä Hydraulic Couplings: without flange, (100–800 mm) (no reamer bolts required)
Wärtsilä High Friction Hydraulic Couplings, (200–700 mm)
Hydraulic Nuts
Wärtsilä Hydraulic Nut: propeller nut
Hydraulic Bolts
Wärtsilä Hydraulic Bolt: for shaft coupling flanges



Wärtsilä rudders



Wärtsilä nozzle



Wärtsilä tunnel

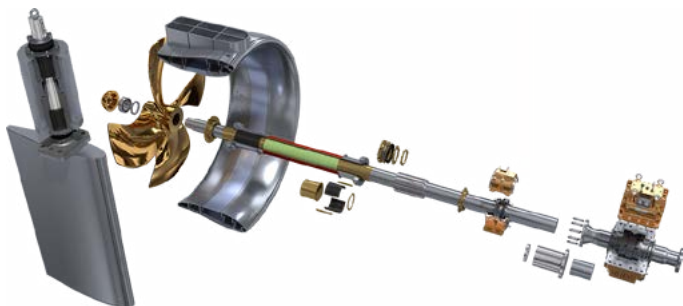
Wärtsilä steel fabrication

Tunnels, rudders & nozzles manufactured to customers' specifications.

Complete stern tube packages

Wärtsilä Seals and Bearings products and services support you by maximising efficiency and minimising operational risks at the lowest lifecycle cost.

Wärtsilä has a long history and wide expertise of supplying complete stern tube packages with off-the shelf or tailored seals and bearings to suit your needs. Whether you have oil or water lubricated shaft lines, we have the products and services to match your requirements.





Ship Design Portfolio & Services

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

Our unique expertise, knowledge, and global footprint allow us to turn our customers' vision into reality and maximize their profits and asset values. With more than 4000 vessels built to our designs, including the



most advanced LNG powered ships, the competitive edge we bring our customers is a well established fact.

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

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

Ship Design

Merchant

Gas carriers



Tankers



Offshore

Platform supply vessels



AHTS vessels



Fishing Vessels

Purse seiners/trawlers



Freezer trawlers



Special Vessels

Ferries



Tugs



Container feeders



Construction vessels



Pipe-layers and cable-layers



Stern trawlers



Wind support



Accommodation/barge



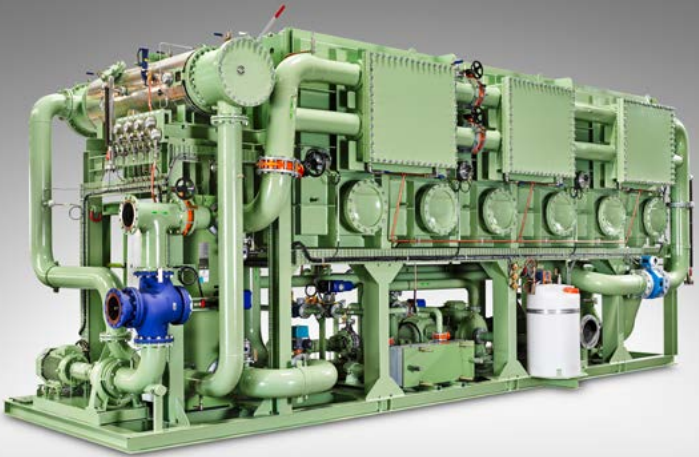


Our people

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.



■ ■ Wärtsilä Serck Como Multi Stage Flash Evaporators

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

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

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

Characteristics

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

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 Serck Como Single Stage Desalination Systems

The Wärtsilä Serck Como 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, drinkable fresh water. Thanks to the low seawater flow the Wärtsilä Serck Como SSD consumes a reduced amount of electricity.

The system uses a vacuum distillation process that enables the use of low temperature heat. The generator utilises 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 energy efficient and cost-effective technology for seawater desalination, with a capacity up to 50 t/d, for marine and offshore applications.

Key benefits

- Low electrical consumption
- High distillate quality
- Easy operation





■ ■ Wärtsilä Oily Water Separators

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

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

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

■ ■ Wärtsilä Bilge Water Guard

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

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

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

■ Wärtsilä Slop Water Treatment System

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

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

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

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



■ ■ Wärtsilä Hamworthy Sewage Treatment Plants

The Wärtsilä Hamworthy 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.

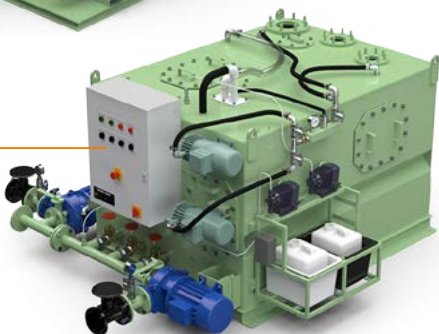
Our sewage treatment plants are certified to meet IMO MEPC 227(64) guidelines, which came into effect 1 January 2016.

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.



Large STC-14 sewage treatment plant



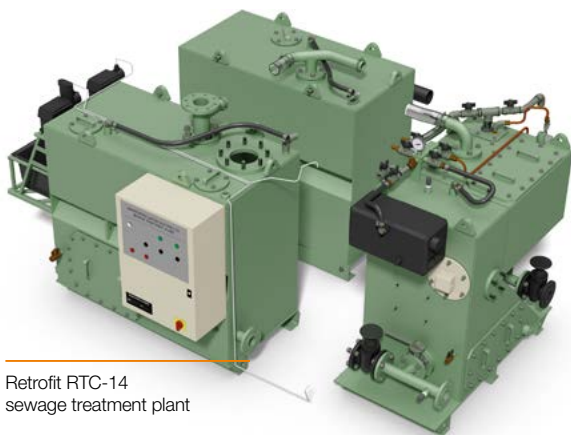
Small STC-13 sewage treatment plant

■ ■ Wärtsilä Hamworthy Retrofit RTC-14 Sewage Treatment Plants

The Wärtsilä Hamworthy 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



Retrofit RTC-14
sewage treatment plant

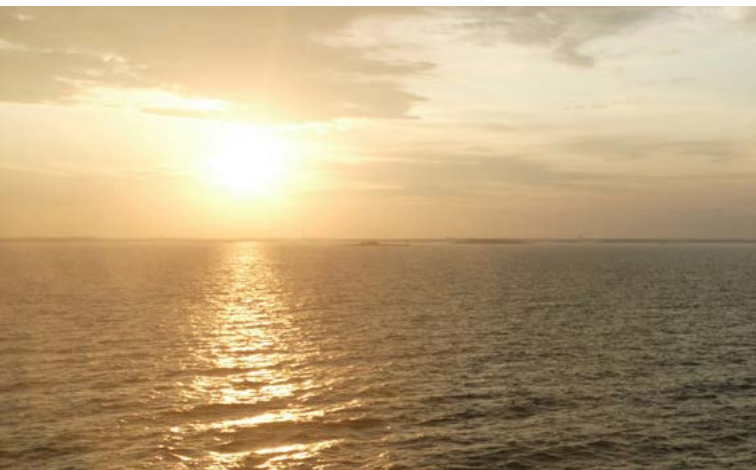
■ ■ Wärtsilä Hamworthy Membrane BioReactor (MBR) Systems

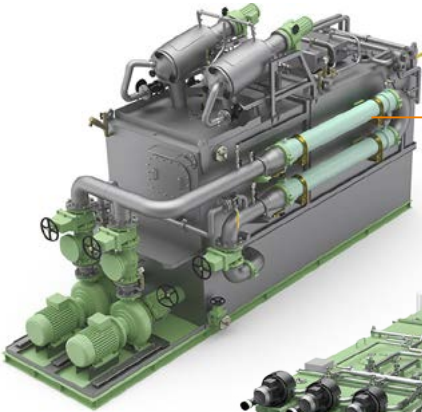
Wärtsilä Hamworthy MBR technology is based on biological degradation and membrane separation and allows for the treatment of grey and black water to satisfy the most stringent standards.

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 Hamworthy 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.

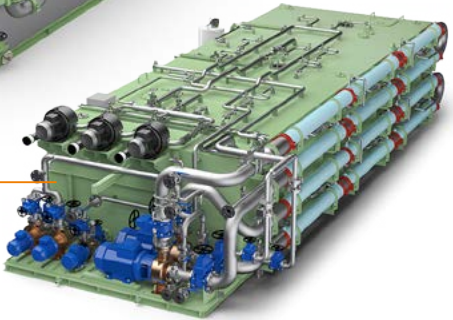
We also supply smaller, more compact versions of our MBR systems. Wärtsilä Hamworthy miniMBR's are ideal for use on smaller cruise and naval vessels, plus ferries with up to a 200 complement, as well as FPSOs and accommodation platforms.





Wärtsilä Hamworthy
MBR system

Membrane module for
larger vessels – each
system is tailored
in-house to bespoke
specifications



■ ■ Wärtsilä Vacuum Collection Systems

The Wärtsilä vacuum collection system uses differential air pressure to transport sewage from the toilet bowls, and other sanitary fittings, to the Sewage Treatment Plant (STP) or independent collection tank.

Ejectors can be mounted direct to the STP for modular construction without the need for a separate collection tank, and only a small amount of flush water is needed compared to conventional gravity systems.

Features

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

Additional optional features

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





■ ■ Wärtsilä Vacuum Toilets

The Wärtsilä vacuum flush toilet has been designed to be mechanically simple, operationally reliable, and stylish in appearance.

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

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

Features

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

Wärtsilä Marine Solutions Worldwide

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