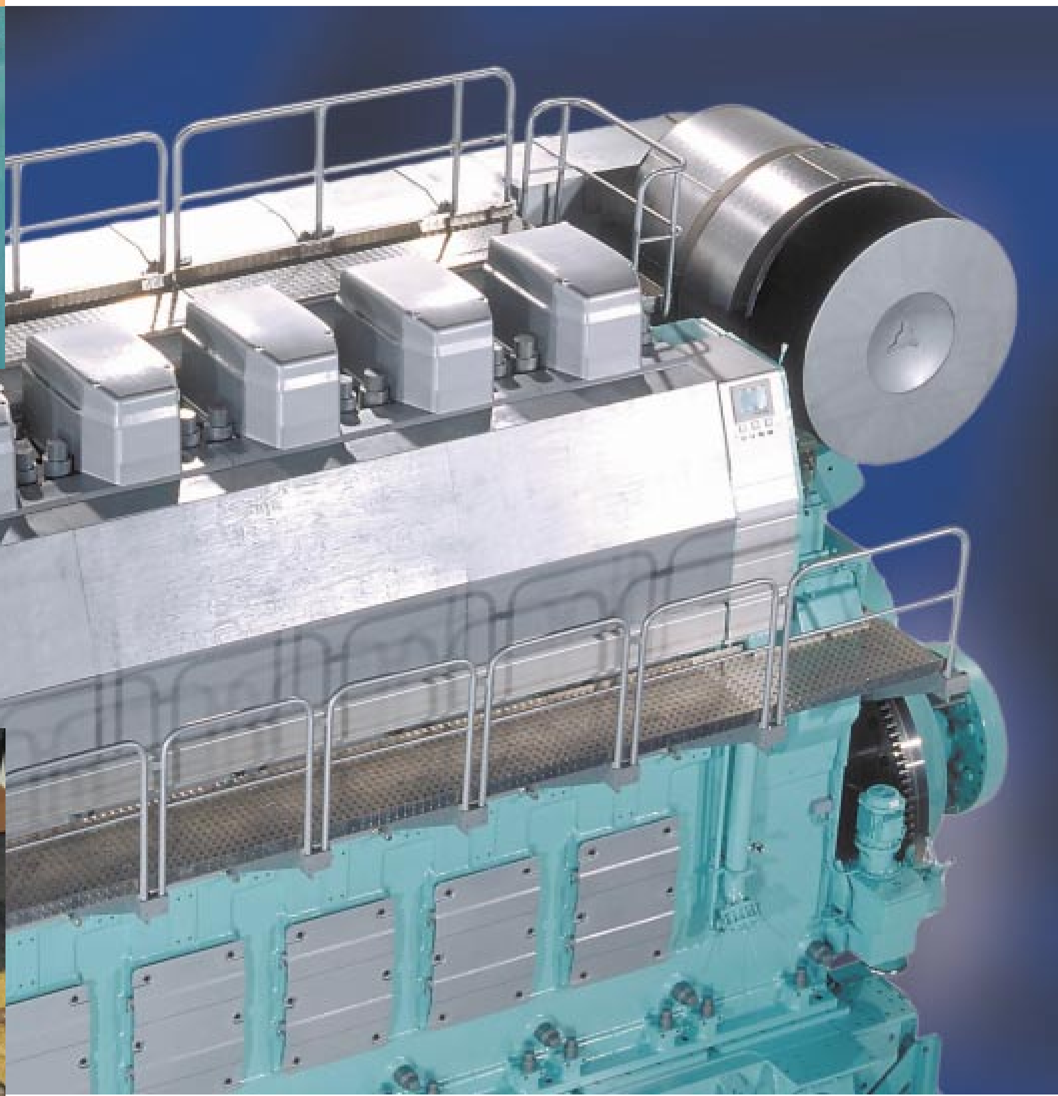
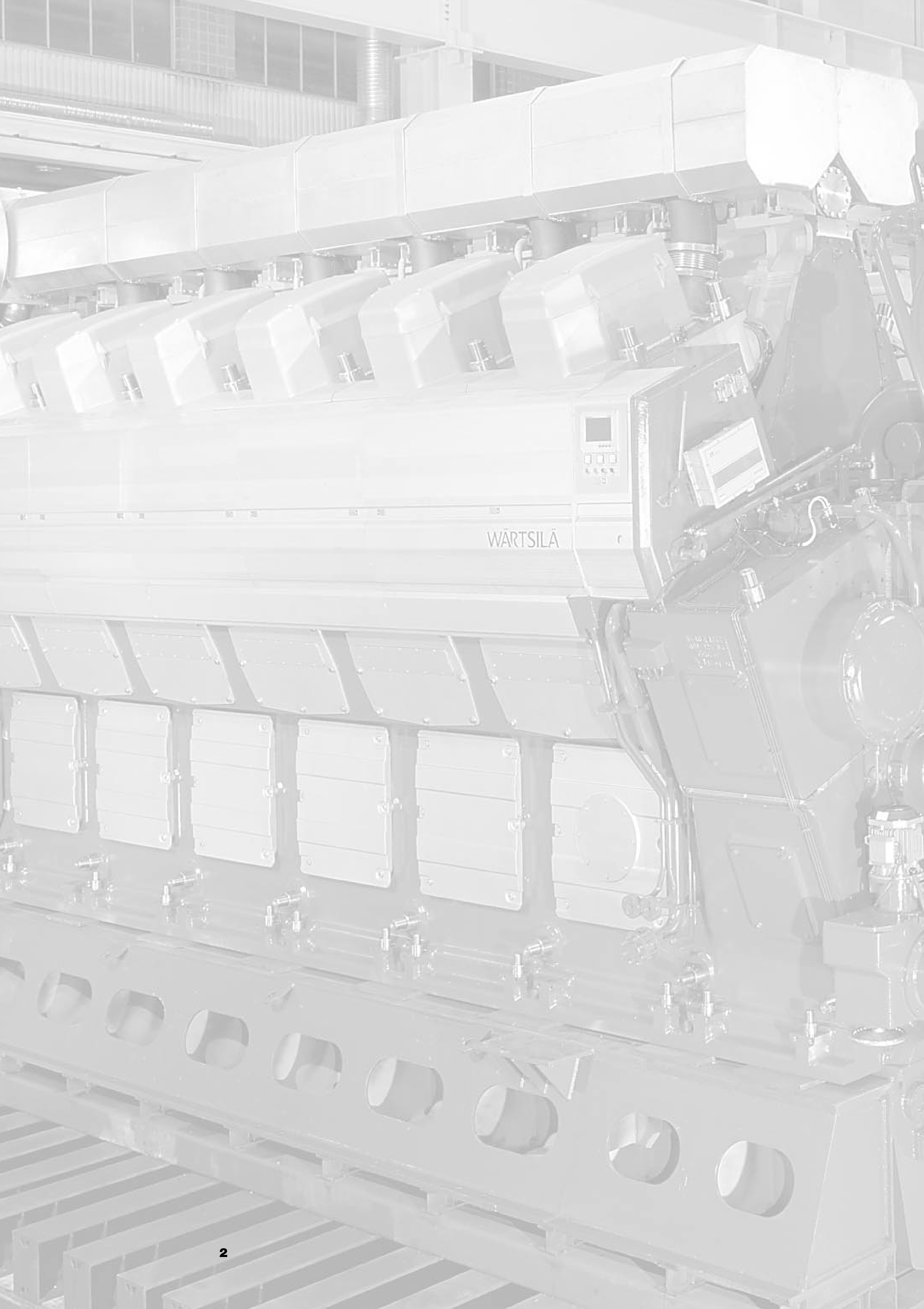
WÄRTSILÄ 64

Technology Review



WÄRTSILÄ


WÄRTSILÄ

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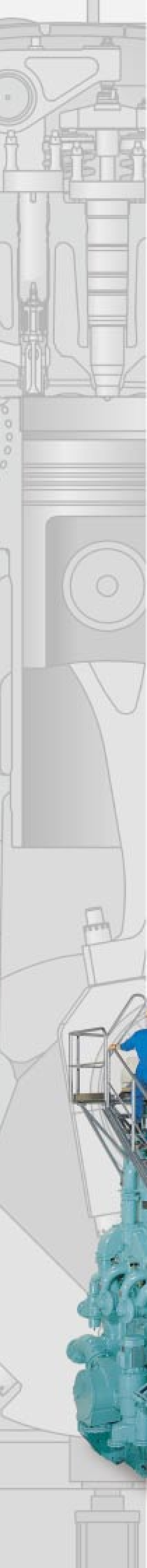
This is a brief guide to the technical features and advantages of the Wärtsilä 64 engine.



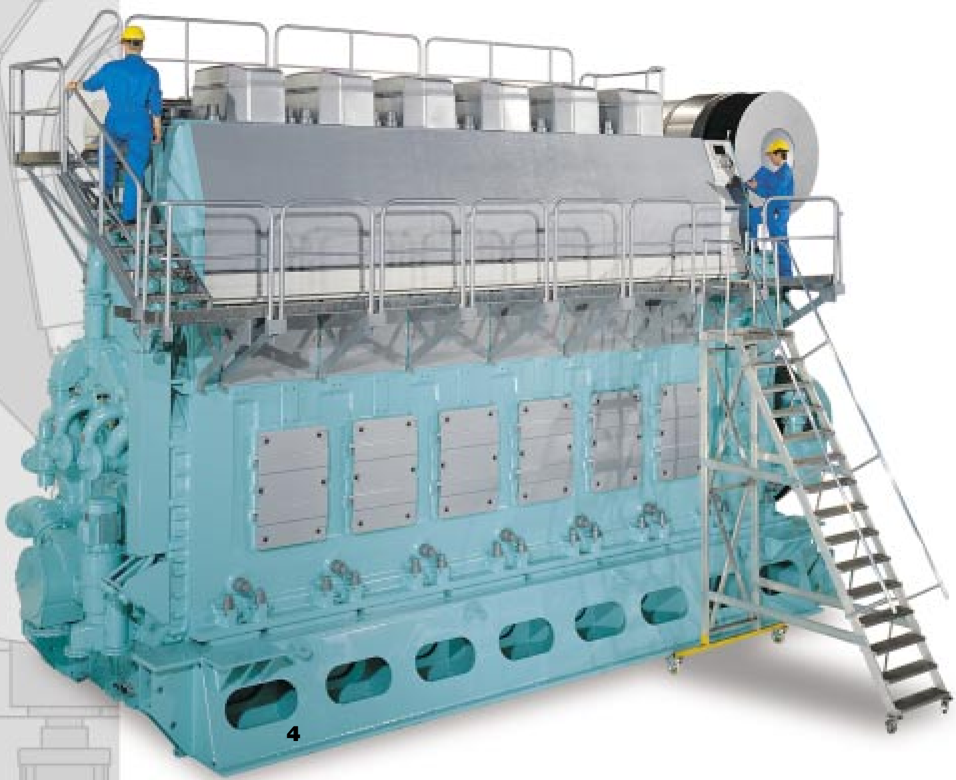
Design Philosophy

The Wärtsilä 64 is based on the latest achievements in combustion technology; it is designed for flexible manufacturing methods and long maintenance-free operating periods. All the essential ancillaries, precisely sized and matched, are built onto the standard engine and the engine has a thoroughly planned interface to external systems. The main qualities of the Wärtsilä 64 are:

- World's most powerful medium-speed engine, 2 MW / cylinder
- High efficiency combustion with low emissions
- High reliability with low maintenance costs, built in experience from Wärtsilä engines
- Compact and integrated design with all ancillaries built on
- Designed for easy maintenance.

With the introduction of the Wärtsilä 64, Wärtsilä offers the world an outstanding range of power options with minimum size and excellent economy for main propulsion machinery and land-based power plants. Medium speed doesn't mean medium power!

This engine, with a cylinder output of 2000 kW, doubles the output range of Wärtsilä medium-speed engines and of any other make of engine for that matter.



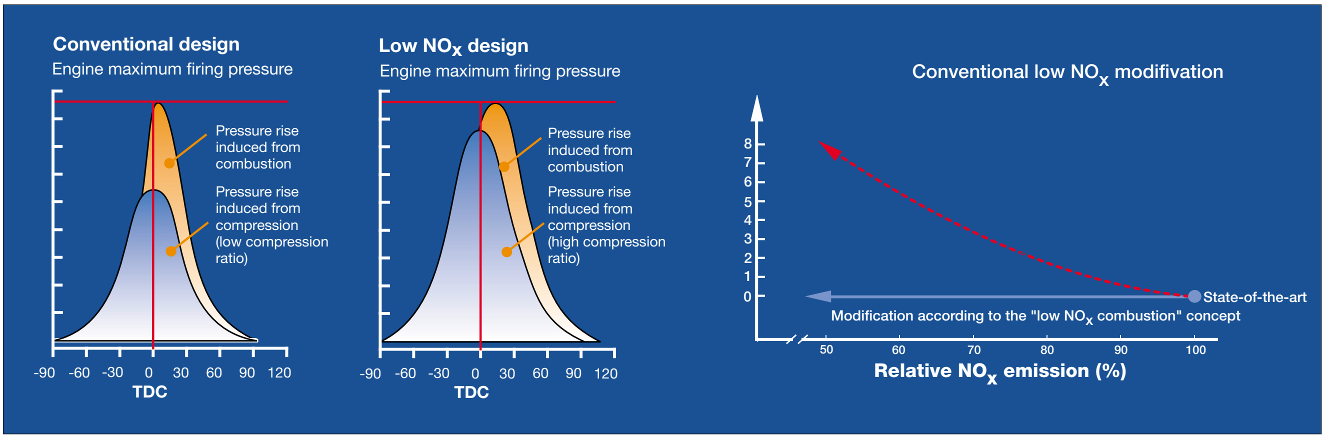
Low Emissions

Hydrocarbons can be burnt under a wide range of conditions. To burn them efficiently with the lowest possible emissions, in particular of NO_x, Wärtsilä developed a Low NO_x combustion process which reduces the NO_x level by up to 25-35 % without compromising on thermal efficiency. Low NO_x combustion is based on:

- An high compression ratio that therefore gives an higher combustion air temperature at the start of injection, which drastically reduces the ignition delay
- A late start of injection and shorter injection duration to place combustion at the optimal point of the cycle with respect to efficiency
- Improved fuel atomization and matching of combustion space with fuel sprays to facilitate air and fuel mixing
- An early inlet valve closing (Miller timing)

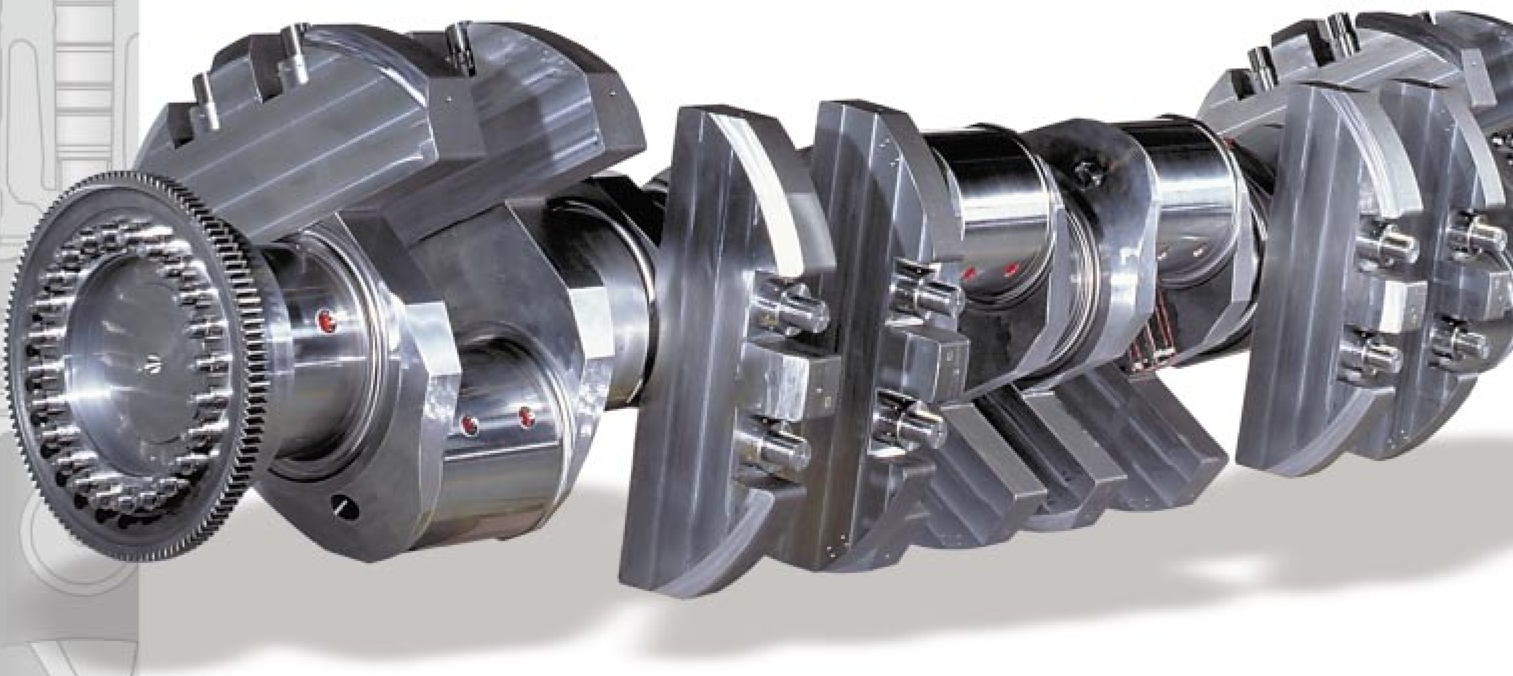
Further reduction of NO_x is achievable by Direct Water Injection. NO_x can be reduced up to 5 g/kWh of NO_x . Direct Water Injection does not adversely affect the power output and it can be switched on and off at any time without affecting the engine operation. A Selective Catalytic Reduction (SCR) system can be installed to further reduce the NO_x level.

For Power Plant installation the Wärtsilä 64 engines fulfill the World Bank NO_x stack limit for 'non degrades area'. In a 'degraded area', which might be the case for a big city with heavy car traffic, etc. the stack limit for NO_x is lower and a SCR catalyst has to be applied.



In the future carbon dioxide (CO_2) emission will be in focus, due to its' expected impact on the global warming. An efficient diesel power plant has low CO_2 emissions. This kind of emissions are an inverse function of efficiency, so the W64 with it's high efficiency is a good alternative.

Crankshaft and Bearings

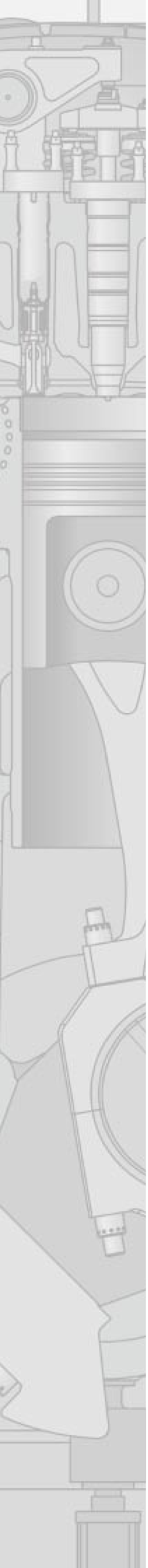


The latest advances in combustion development require a crank gear which can operate reliably at high cylinder pressures. The crankshaft must be robust and the specific bearing loads kept at an acceptable level. This is achieved by careful optimization of crankthrow dimensions and fillets. The specific bearing loads are conservative and the cylinder spacing, which is important for the overall length of the engine, is minimized.

Besides low bearing loads, the other crucial factor for safe bearing operation is oil film thickness. Ample oil film thicknesses in the main bearings are ensured by optimal balancing of rotational masses and in the big end bearing by ungrooved bearing surfaces in the critical areas. All the factors are present to ensure a free choice of the most appropriate bearing material.

Engine Block

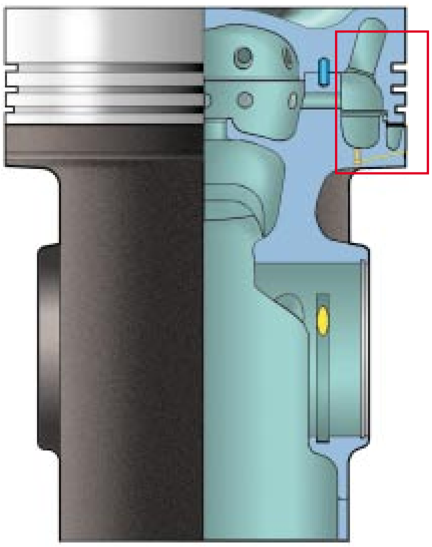
Nodular cast iron is the natural choice for engine blocks today thanks to its strength and stiffness properties and all the freedom that casting offers. The Wärtsilä 64 makes optimum use of modern foundry technology to integrate most oil and water channels. The result is a virtually pipe-free engine with a clean outer exterior. Resilient mounting is state-of-the-art in many applications and requires a stiff engine frame. Integrated channels designed with this in mind thus serve a dual purpose.

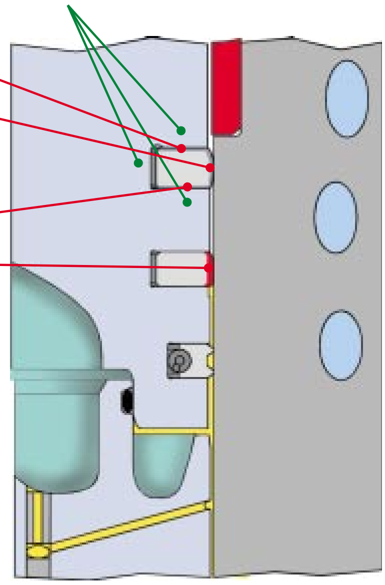


Piston and Piston Rings

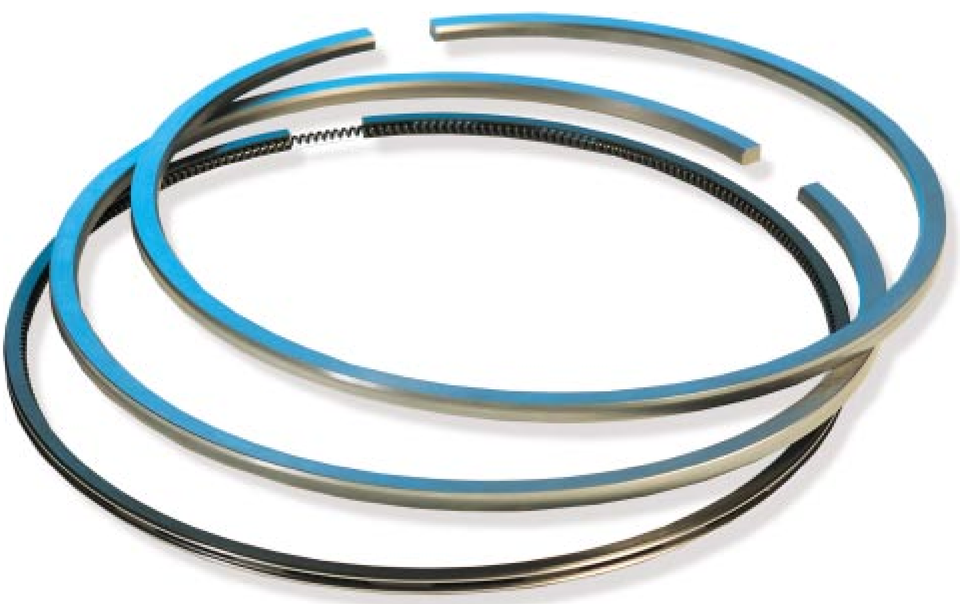
For years, the outstanding piston concept for highly rated heavy fuel engines has been a rigid composite piston with a steel crown and nodular cast-iron skirt. More than twenty years of experience has fine-tuned the concept. When it comes to reliability, there is no real alternative today for modern engines with high cylinder pressures and combustion temperatures. Wärtsilä-patented skirt lubrication is applied to minimize frictional losses and ensure appropriate lubrication of both piston rings and the piston skirt.

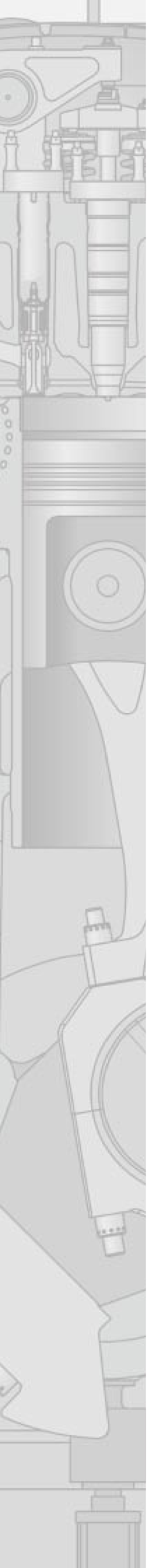
In Wärtsilä's three-ring concept each ring has a specific task. They are dimensioned and profiled for consistent performance throughout their operating lives. To avoid carbon deposits in the ring grooves of a heavy fuel



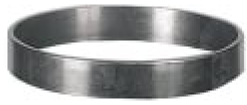


engine, the pressure balance above and below each ring is crucial. Experience has shown that this effect is most likely achieved with a three-ring pack. Finally, it is well known that most frictional losses in a reciprocating combustion engine originate from the rings. Thus a three-ring pack is the obvious choice in this respect, too. The piston ring package and ring grooves are optimized for long lifetime by special wear-resistant coating and groove treatment.



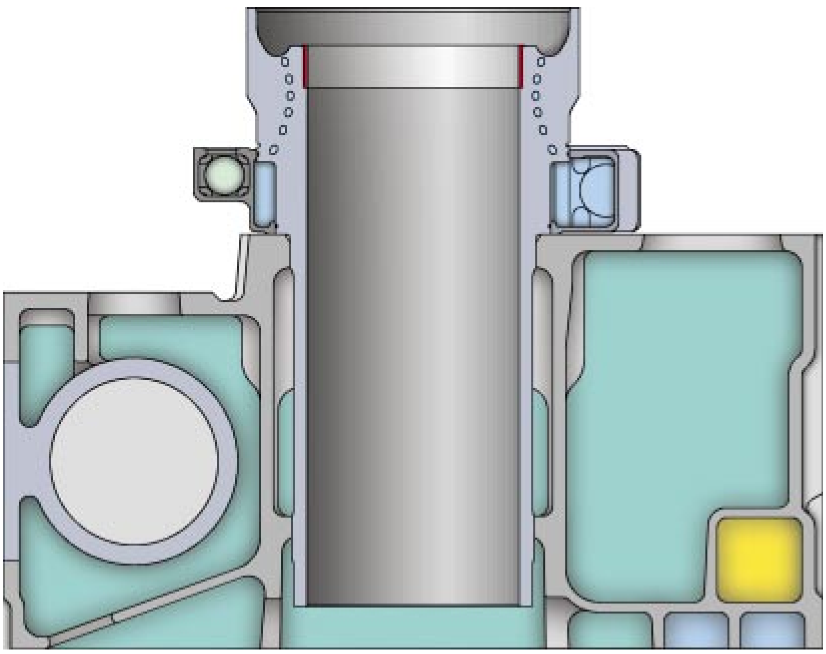


Cylinder Liner and Anti-Polishing Ring



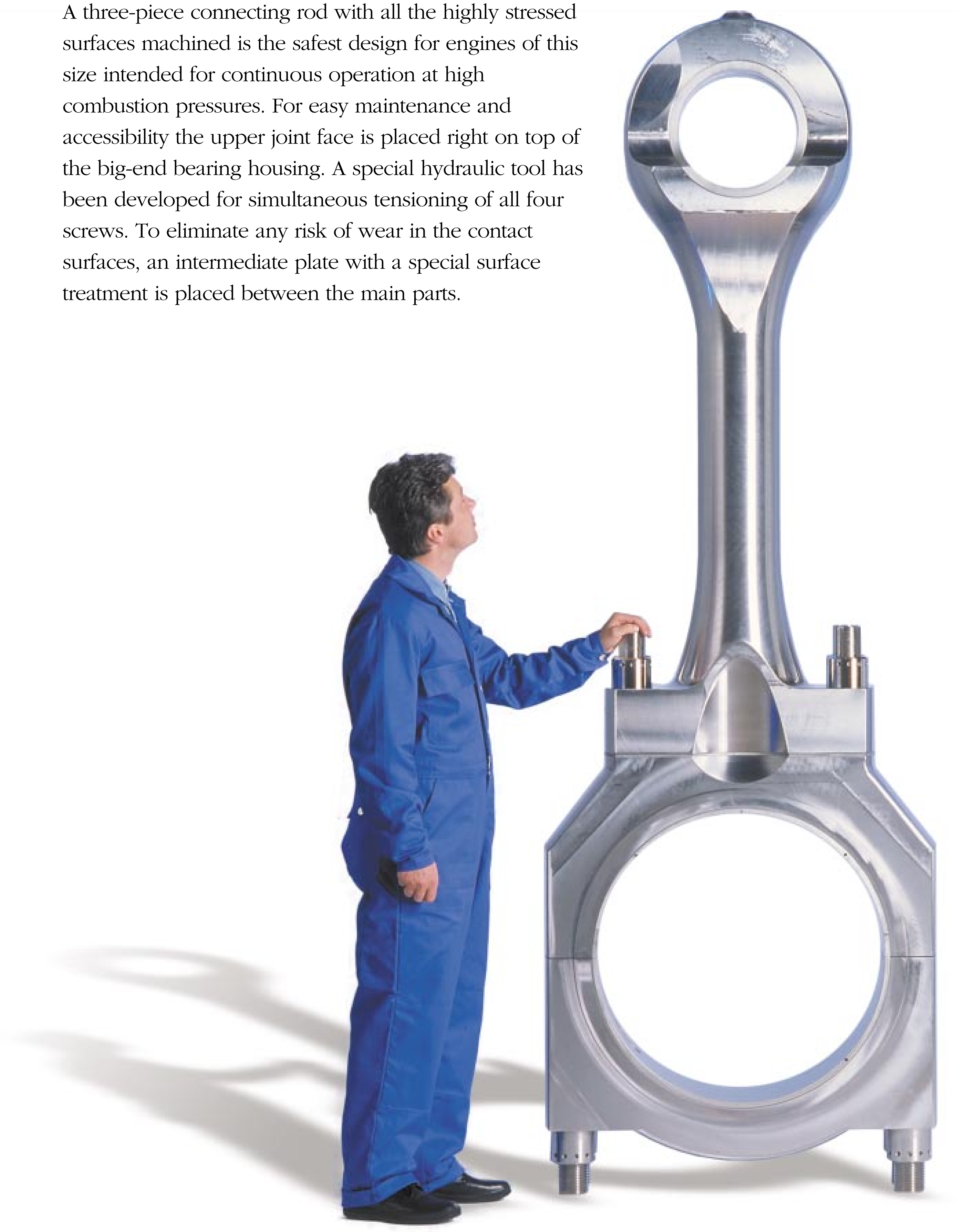
The thick high-collar type cylinder liner is designed to have the stiffness needed to withstand both pre-tension forces and combustion pressures with virtually no deformation. Its temperature is controlled by bore cooling of the upper part of the collar to achieve a low thermal load and to avoid sulphuric acid corrosion. The cooling water is distributed around the liners with simple water distribution rings at the lower end of the collar.

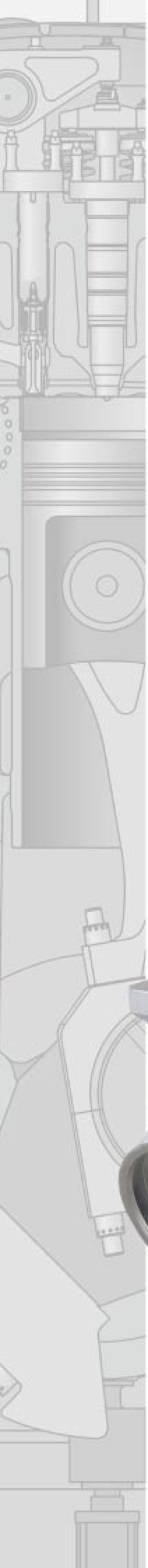
In the upper end the liner is equipped with an anti-polishing ring to eliminate bore polishing and reduce lube oil consumption. The function of this ring is to calibrate the carbon deposits formed on the piston top land to a thickness small enough to prevent any contact between the liner wall and the deposits at any piston position. When there is no contact between the liner and piston top land deposits, no oil can be scraped upwards by the piston. The other positive effect is that the liner wear is significantly reduced at the same time. The strength of the wear-resistant liner materials used for years in Wärtsilä engines has been further increased to cope with the high combustion pressures expected in the future.



Connecting Rod

A three-piece connecting rod with all the highly stressed surfaces machined is the safest design for engines of this size intended for continuous operation at high combustion pressures. For easy maintenance and accessibility the upper joint face is placed right on top of the big-end bearing housing. A special hydraulic tool has been developed for simultaneous tensioning of all four screws. To eliminate any risk of wear in the contact surfaces, an intermediate plate with a special surface treatment is placed between the main parts.



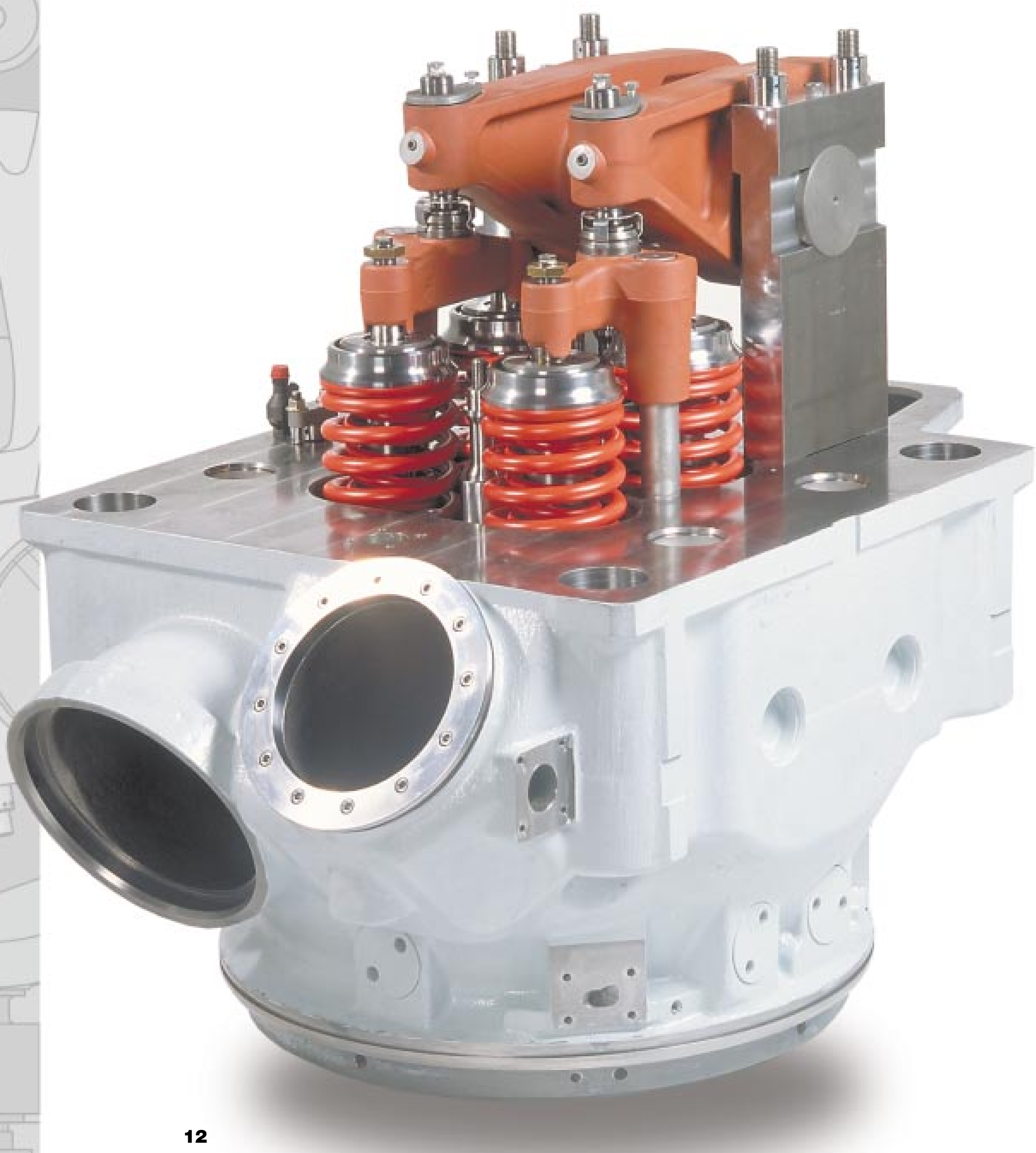


Cylinder Head

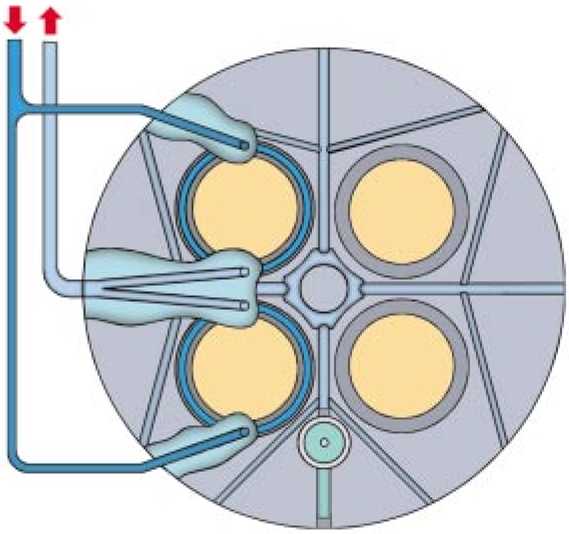
The cylinder head design features high reliability and easy maintenance.

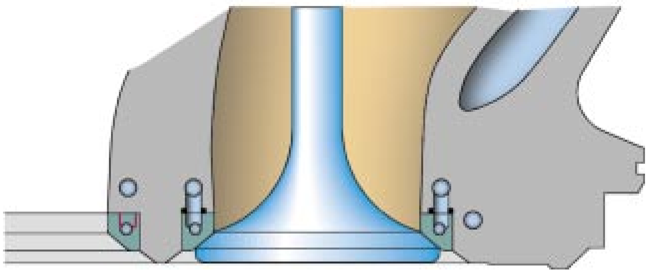
A stiff cone- / box-like design can cope with high combustion pressure, and is essential for obtaining both liner roundness and even contact between the exhaust valves and their seats.

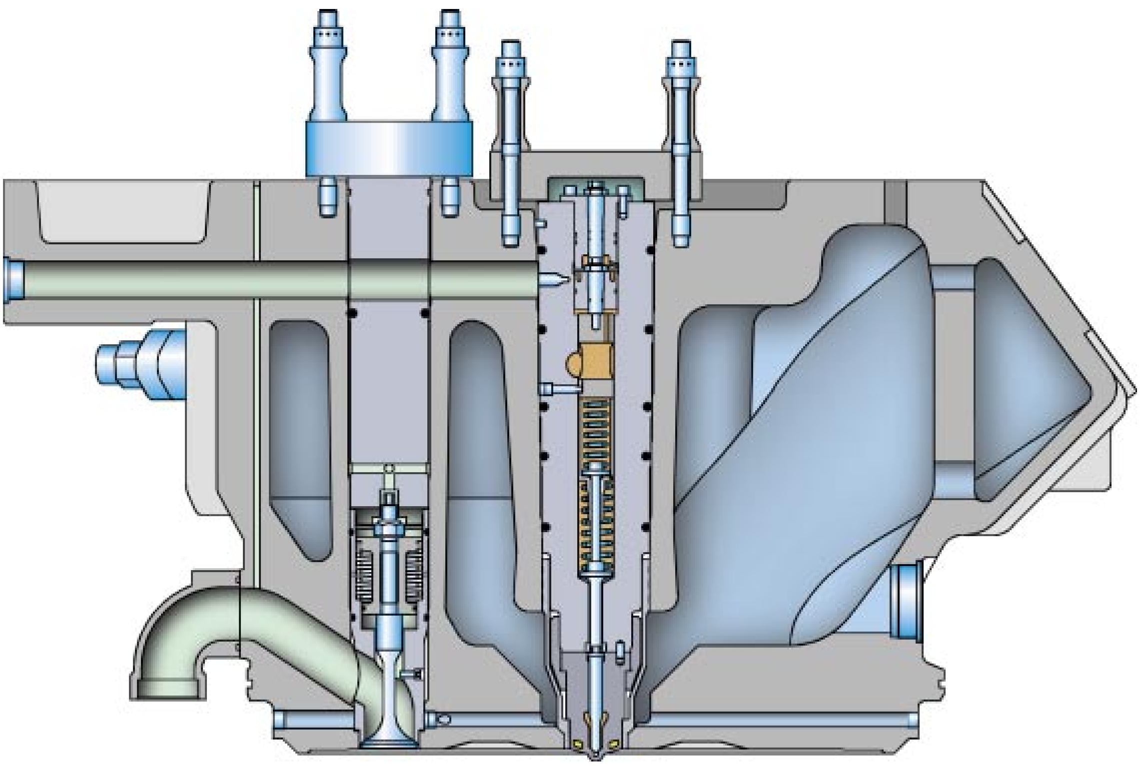
Wärtsilä's vast amount of experience gained from heavy fuel operation all around the world has contributed greatly to exhaust valve design and development. The basic criterion for the exhaust valve design is correct temperature. This is achieved by carefully controlled cooling and a separate seat cooling circuit, which ensures long lifetimes of valves and seats.



The cylinder head design is based on the four-screw concept developed by Wärtsilä and used for almost 20 years. A four-screw cylinder head design also provides all the freedom needed for designing inlet and exhaust ports with a minimum of flow losses. The port design has been optimized using computational fluid dynamics (CFD) analysis in combination with full-scale flow measurements.





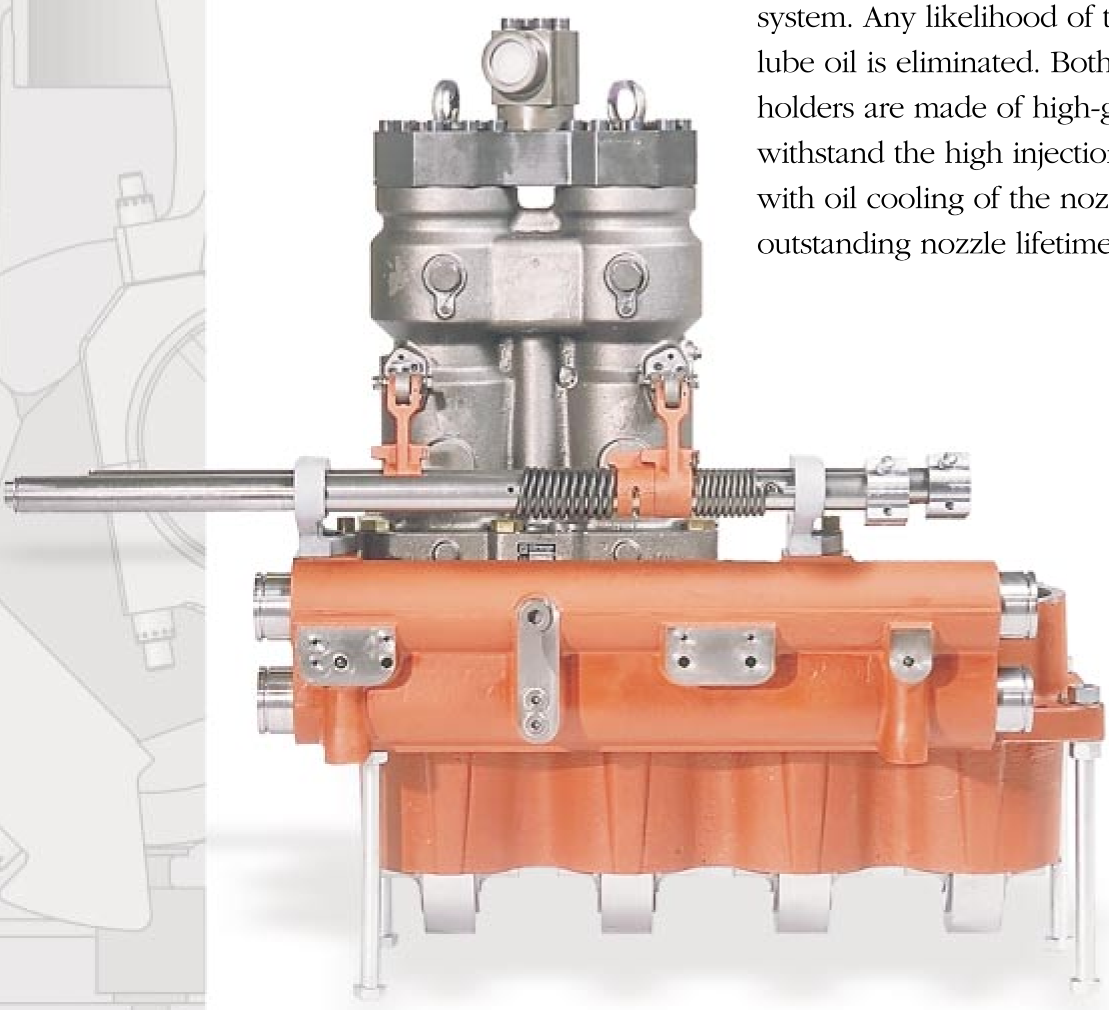


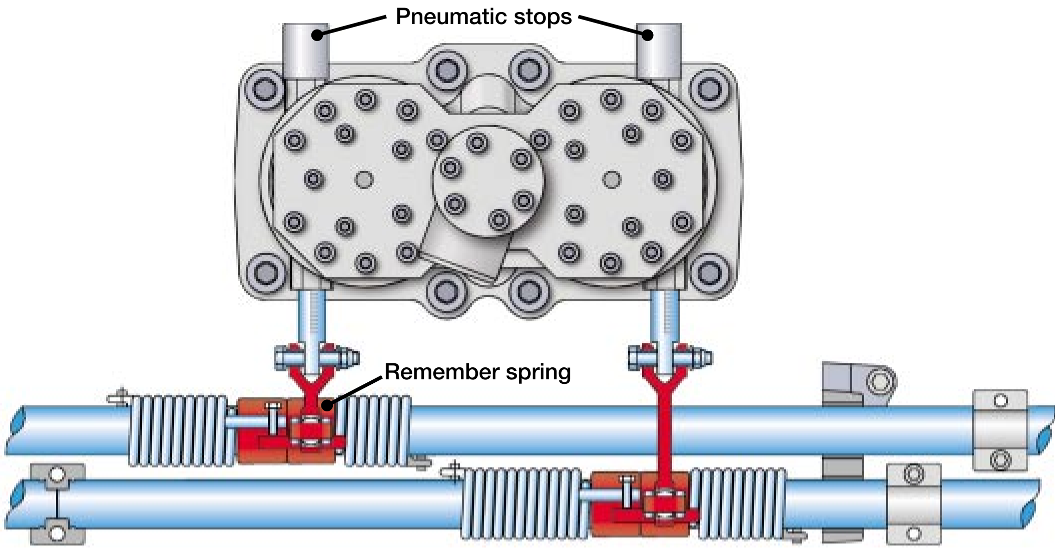
Fuel Injection System

The split pump technology, firstly introduced on the W64, offers unique advantages in terms of operating flexibility, mechanical strength and cost effectiveness.

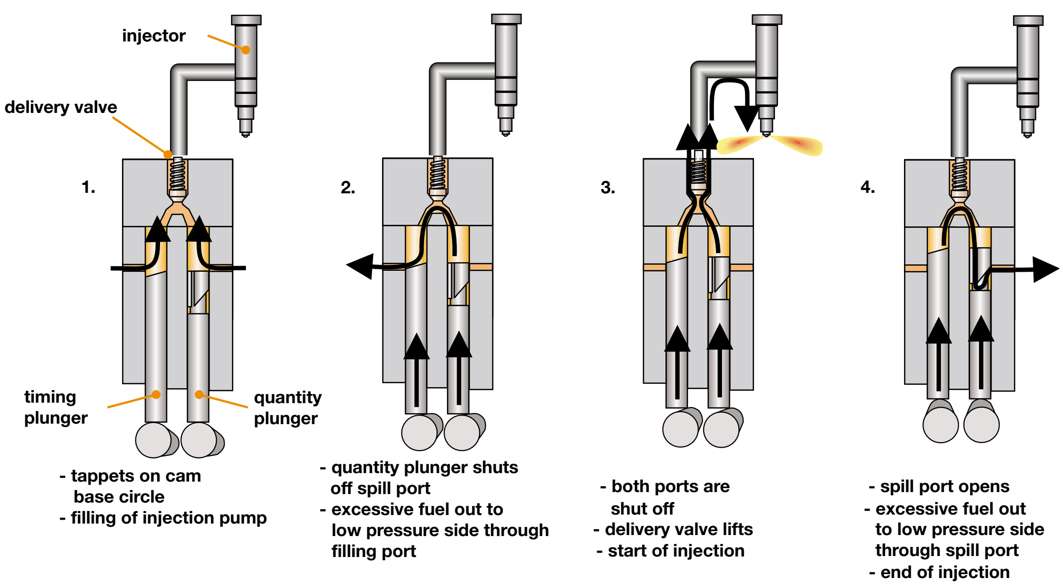
Injection timing can be freely adjusted independently of the injected quantity. Tuning of the injection parameters according to the engine's operational conditions improves engine performance and reduces exhaust emissions. Smaller closed-type pump elements reduce mechanical stresses and increase reliability. Reduced loads on rollers, tappets and cams improve pump driving reliability. The pump elements are adapted from high-volume production of smaller engines.

The high-pressure system has been designed and endurance tested at 2000 bar. The injection pressure is around 1400 bar, which gives an outstanding safety margin. No lubricating oil is required for the pump element since the plunger has a wear-resistant, low-friction coating. Thanks to the profiled plunger geometry the clearance between the plunger and the barrel is kept small, thereby allowing only a minimum of oil to pass down the plunger. This small leakage is collected and returned to the fuel system. Any likelihood of the fuel mixing with the lube oil is eliminated. Both the nozzle and nozzle holders are made of high-grade hardened steel to withstand the high injection pressures. Combined with oil cooling of the nozzles this guarantees outstanding nozzle lifetimes.



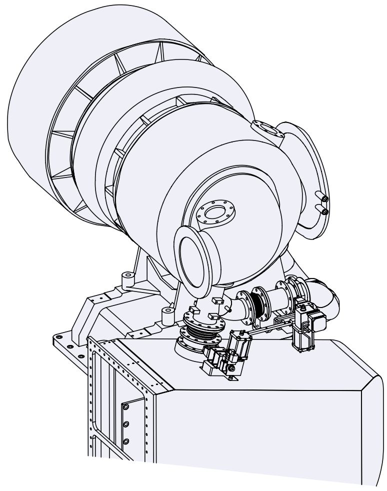


The patented Wärtsilä multihousing principle ensures outstanding safety of the low-pressure fuel system. The fuel line consists of channels drilled in cast parts, which are clamped firmly on the engine block. For easy assembly and disassembly these parts are connected to each other using slide connections. Housing both the entire low-pressure system and the high-pressure system in a fully covered compartment ensures an unbeatable standard of safety.



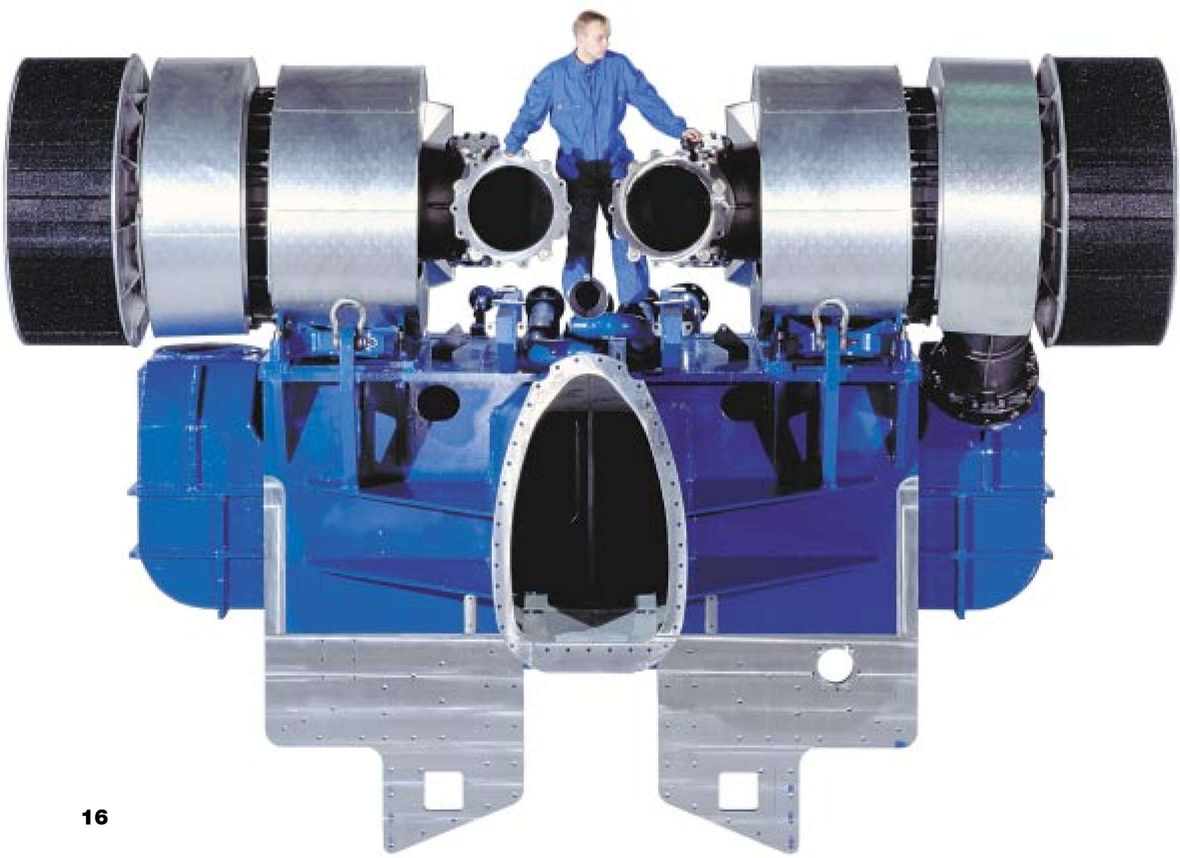
Turbocharging System

Turbocharger technology has undergone a period of intense design and performance development, achieving high performance and high reliability. Only the best available charger technology is used on the Wärtsilä 64.



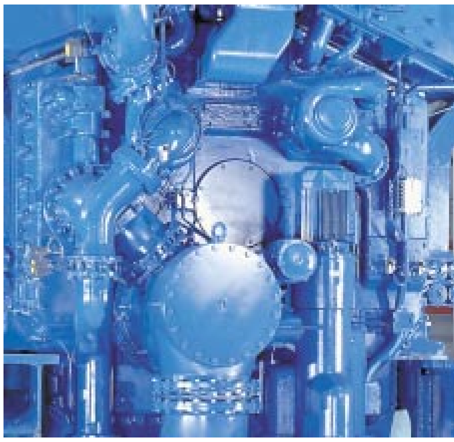
The Wärtsilä 64 is equipped with the turbocharging system that best fulfils the requirements of each application. The standard is a SPEX system, with the option of exhaust waste-gate or air by-pass according to the application.

The SPEX system is designed to apply the benefits of both pulse charging and constant pressure charging. SPEX is able to utilize the pressure pulses without disturbing the cylinder scavenging. The interface between the engine and turbocharger is streamlined, eliminating all the adaptation pieces and piping frequently used in the past. Non-cooled chargers are used with inboard plain bearings lubricated from the engine's lube oil system. All this makes for longer intervals between overhauls and reduced maintenance.



Cooling System

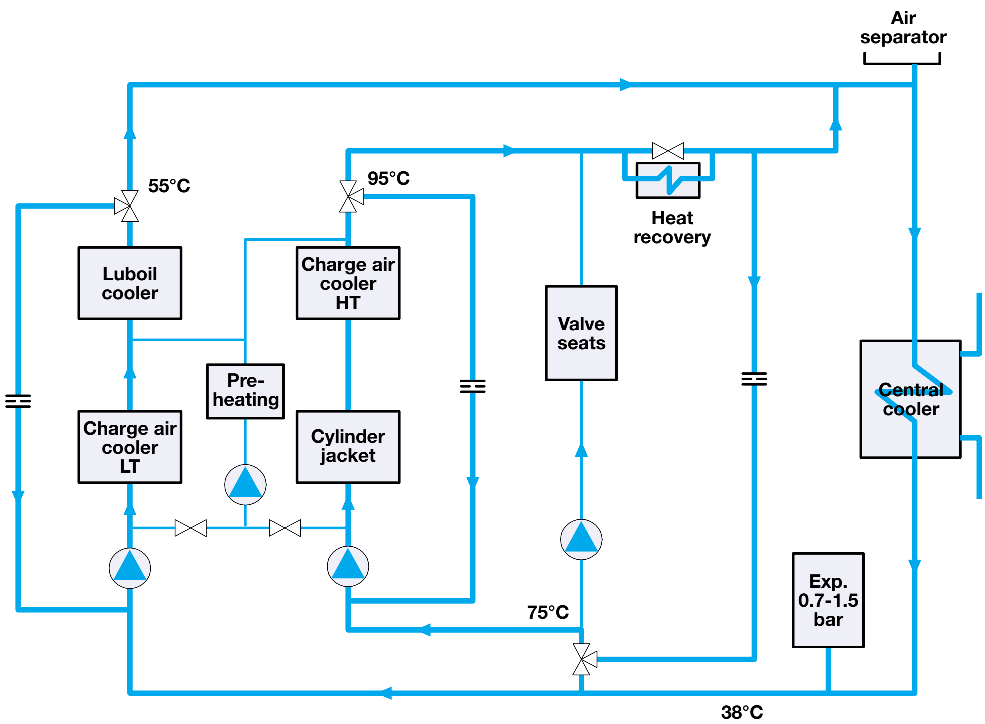
The cooling system is split into two separate circuits: the high temperature (HT) and the low temperature (LT) circuit. The cylinder liner and the cylinder head temperatures are controlled through the HT circuit. The system temperature is kept at a high level, about 95 °C, for safe ignition/combustion of low-quality heavy fuels, also at low loads. An additional advantage is maximum heat recovery and total efficiency in cogeneration plants. To further increase the recoverable heat from this circuit, the circuit is connected to the high-temperature part of the double-stage charge air cooler. The HT water pump is integrated in the pump cover module at the free end of the engine. The complete HT circuit is thus virtually free of pipes.



The LT circuit serves the low-temperature part of the charge air cooler and the built-on lube oil cooler. It is fully integrated with engine parts such as the LT water pump with pump cover module, the LT thermostatic valve with the lube oil module and transfer channels in the engine block.

In addition the LT circuit also provides separate cooling of the exhaust valve seats and a lower seat / valve temperature, thus ensuring long lifetimes.

Directly driven pumps ensure safe operation even during a short power cut.

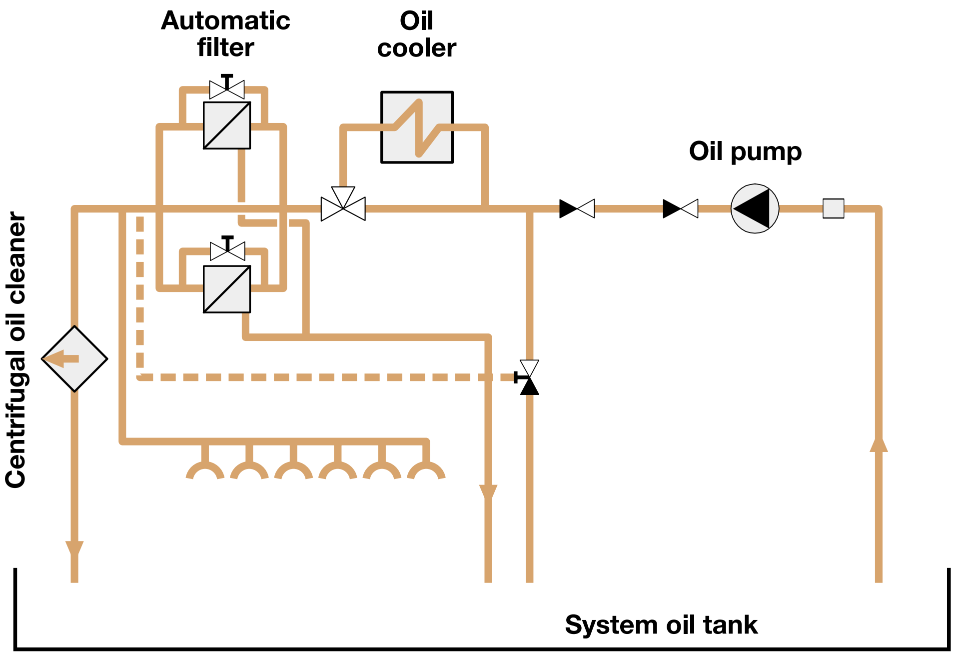


Lubricating Oil System

All Wärtsilä 64 engines are equipped with a complete built-on lube oil system. This comprises:

- Pump cover module
  - Engine-driven main screw pump, with built-in safety valve
  - Prelubricating module
  - Electrically driven prelubricating screw pump
  - Pressure regulating valve
  - Centrifugal filter for lube oil quality indication
- Lubricating oil module
  - Lube oil cooler
  - Oil thermostatic valves
  - Full flow automatic filter
  - Special running-in filters before each main bearing, camshaft line and turbocharger, i.e. before all components.

On in-line engines the lubricating oil module is always located neatly at the back side of the engine whereas on V-engines it can be built on the engine at the flywheel or free end, depending on the turbocharger position. The lube oil filtration is based on an automatic back-flushing filter. This requires a minimum of maintenance and needs no disposable filter cartridges.



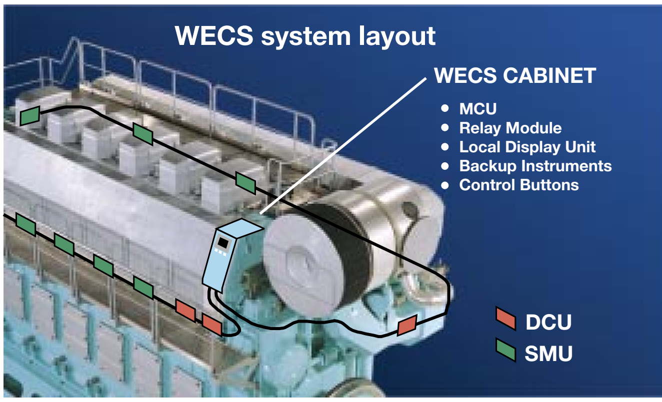
Automation System

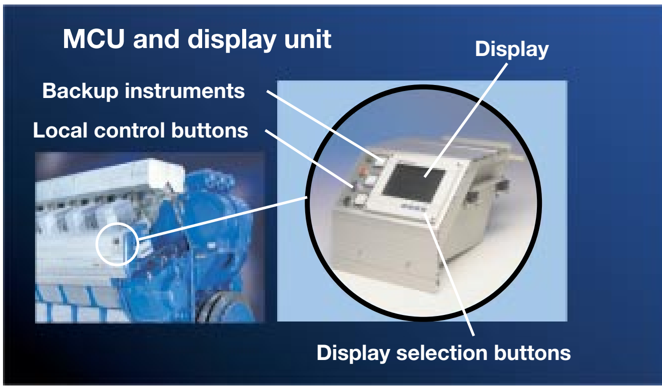
An engine-integrated automation system, WECS, is standard on the Wärtsilä 64. Optimum use of this technology greatly simplifies both the wiring on the engine and the whole installation.

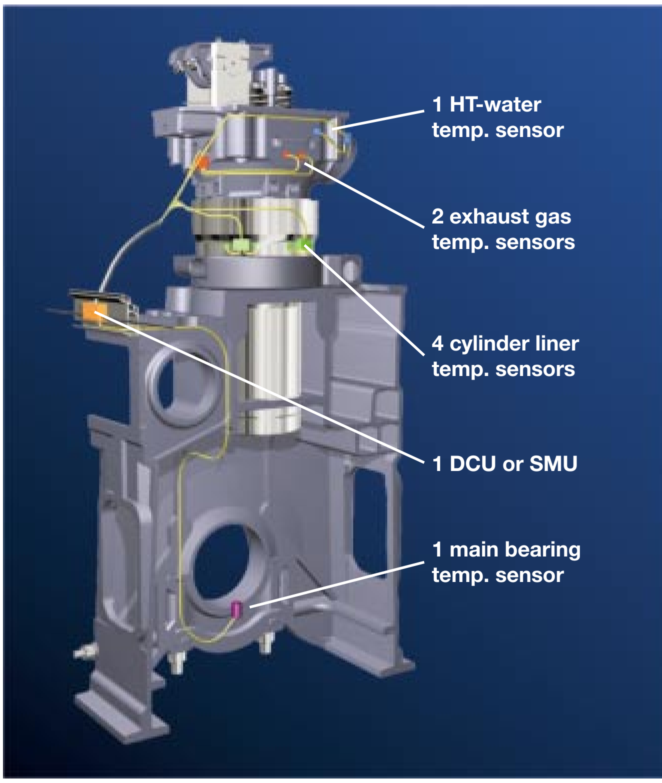
The system has the following main components:

- The Main Control Unit (MCU) Cabinet, which comprises the MCU itself, a relay module with back-up functions, a Local Display Unit (LDU), control buttons and back-up instruments. The MCU handles all communication with the external system
- The Distributed Control Unit (DCU) handling signal transfer over a CAN bus to the MCU
- The Sensor Multiplexing Units (SMU) transferring sensor information to the MCU.

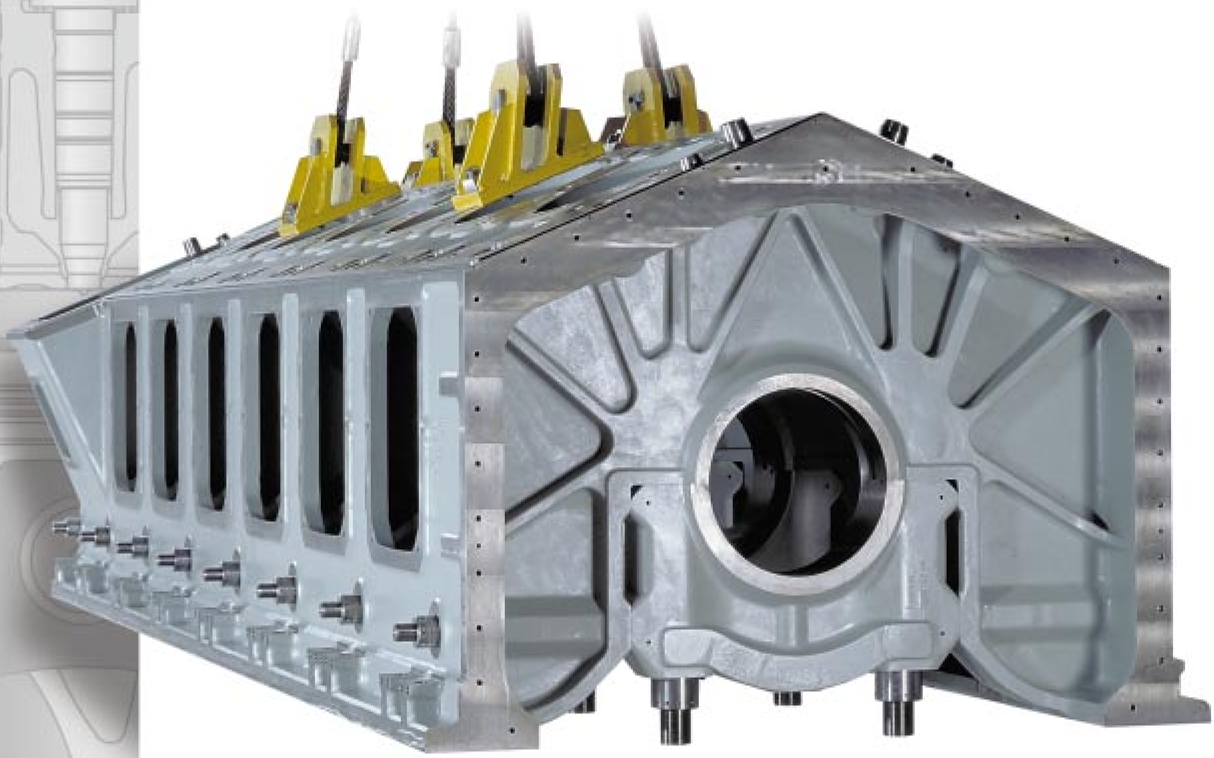
The software loaded into the system is easily configured to match the instrumentation, and the safety and control functions required for each installation. For maximum safety, the durability of all components is ensured by selecting only the best available, verified by stringent testing. Thus temperature resistance, vibration resistance and electromagnetic compatibility are guaranteed. The MCU cabinet is well protected and built into the engine because a diesel engine must sometimes endure rough handling. The same goes for the rest of the hardware, most of which is housed in a special electrical compartment alongside the engine.







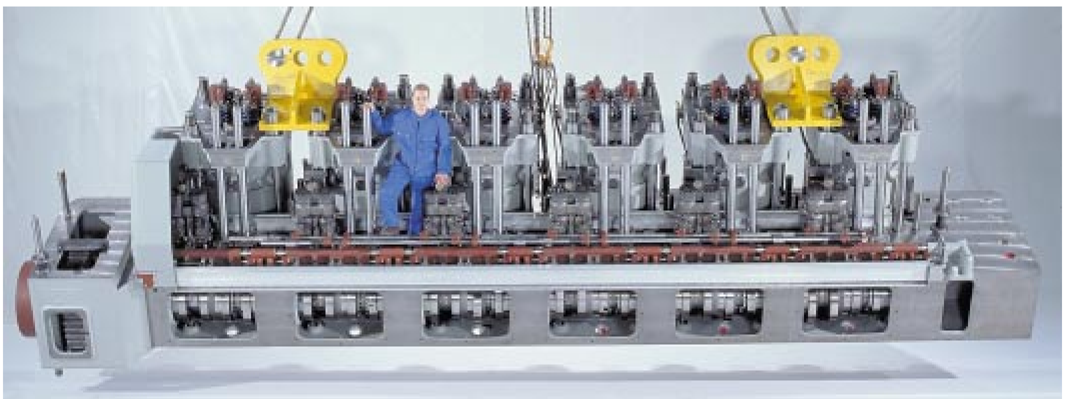
Macro Modules



The Wärtsilä 64 features modularized design for easy maintenance, compactness and manufacturability.

Due to the weight of the V-engines, the engine block [EB] has been split into three parts. The charge air receiver is located between the cylinder banks in a separate casting. This forms a closed structure with high bending and torsional stiffness.

Furthermore the engine delivery time is shorter since main assembly is done in six modules (crankcase [EB] – cylinder banks [EB] – receiver [EB] – turbocharger – lube oil module). The engine can easily be split into parts below the normal maximum transportable weight, 200 tons land based, and again easily re-assembled at site.



At a smaller scale, valid for both the in-line and V-engine, the main parts / functions of the engine are put together in modules such as:

- Guide block module
  - Valve tappets
  - Injection tappets
  - Injection pump
  - Fuel lines in / out
  - Leak fuel channels
- Lubricating oil module
  - Filtration
  - Cooling
  - Temperature regulation for both oil and LT water
- Air inlet pipe
  - Exhaust gas support
  - HT water channel
  - Air into engine
- Free end pump cover module
  - Oil pump
  - Prelube pump
  - Oil pressure regulating valve
  - HT / LT pumps
  - Connections for main / standby HT, LT, oil, fuel, seat cooling circuits
- Cylinder head complete.

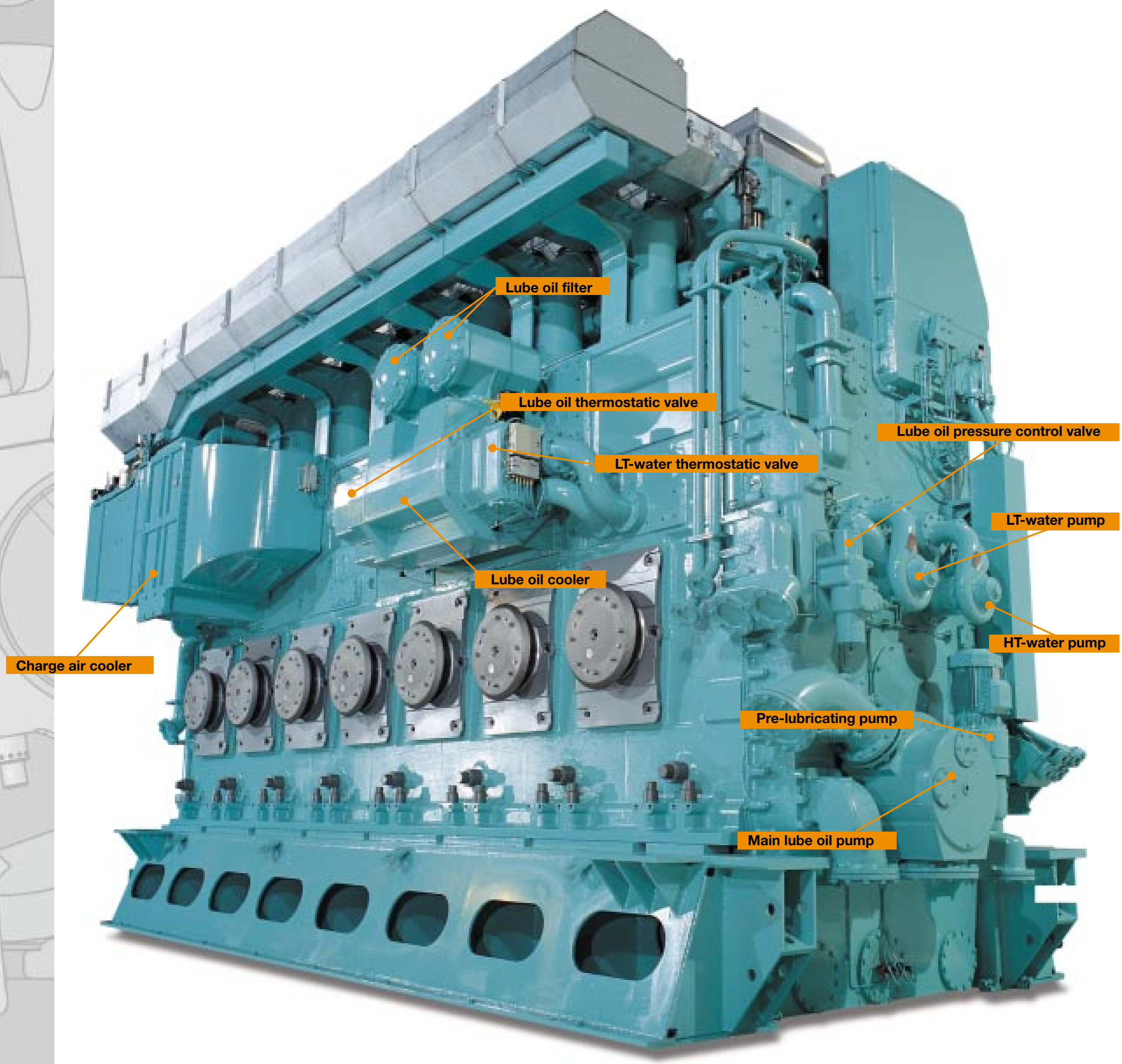
The hot box design encloses the fuel system and is virtually pipe-free, with everything integrated in profiles and castings.

So why to do all this ?

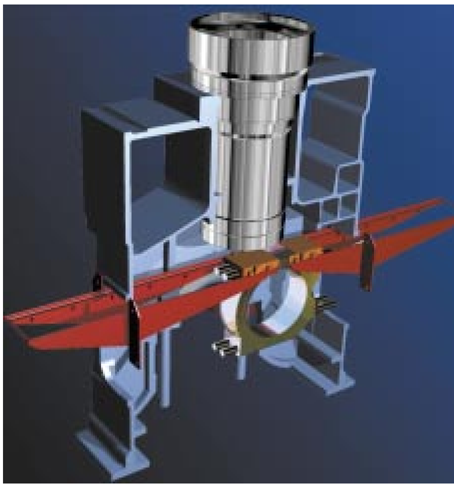
- Yes, it gives You a more precise built engine with a higher quality in a shorter time !
- Design wise is introduced a higher manufacturing precision and quality.
- Maintenance is more simple and faster.
- It can all be made faster.

Easy Application

As already mentioned, the Wärtsilä 64 comes with all main auxiliaries and control system built on the engine. The connections are concentrated at a few points, ensuring fast and easy installation and reducing engine room application work to a minimum. Likewise maintenance and service of the ancillaries is arranged together with the engine. The Wärtsilä 64 comes in a number of standard options, e.g. a turbocharger at either end of the engine and single- or two-stage charge air cooling, without sacrificing the easy interfacing principle. The in-line engines can also be equipped with optional engine-mounted platforms, which further reduces installation work and makes maintenance even easier.



Easy Maintenance

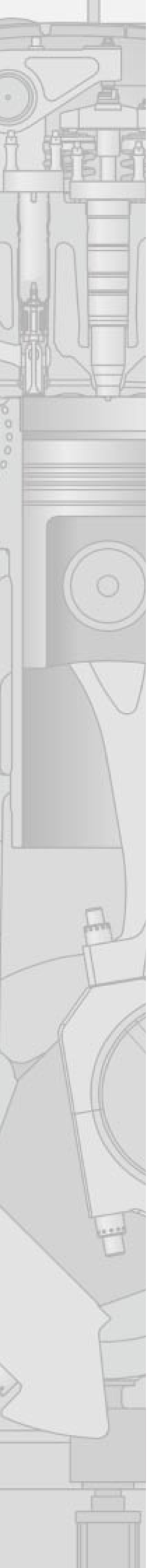


Since the Wärtsilä 64 is a big engine, special priority has been placed on tools and engine design to ensure easy maintenance. For example, it take 3 hours or less to change the cylinder head, piston and connection rod upper part and liner. Given the long intervals between overhauls, this reduces the hours spent on maintenance to a minimum.

Hydraulics are used to pre-tension all the main connections:

- Cylinder head screws
- Connecting rod screws
- Main bearing screws
- Injection valve
- Starting air valve
- Gear wheel connections.

All hydraulic tools are either spring or pneumatic returned and the heaviest weighs less than 25 kg. Naturally the Wärtsilä 64 also incorporates the distinctive Wärtsilä feature of individual fixed hydraulic jacks for each main bearing cap. The unique fuel line design enables the injection pump or complete guide block module to be replaced with a minimum of work and therefore less risk of error. The slide-in connections allow the cylinder head to be lifted without having to remove the water or air pipes. The water pumps are easy to replace thanks to their cassette design and the water channel arrangement in the pump cover at the free end of the engine. The minimum number of pipes and the ergonomic component design ensures greater accessibility to all the above-mentioned components.



The Applications

Marine applications

If you are looking for the lowest possible installed number of cylinders, the Wärtsilä 64 is your choice because, developing 2000 kW/cylinder, it is the most powerful medium-speed engine available.

If you are looking for the optimum propeller speed, the Wärtsilä 64 can offer it. With the nominal engine speed and a gear ratio between 3 and 6 you hit the optimum propeller efficiency for any ship.

If you are looking for diesel-electric/power plant machinery, the Wärtsilä 64 offers you a large number of possibilities: unit output from 12 MW to 35 MW! Synchronous speeds are available for 50 Hz and 60 Hz.

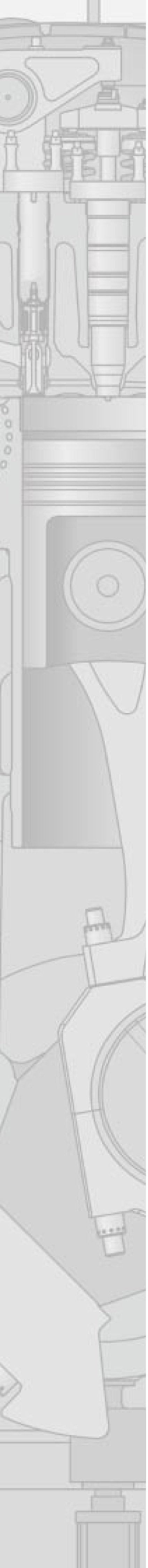
If you are looking for versatility and/or redundancy, the Wärtsilä 64 provides alternatives with minimum engine room length or height as well as minimum machinery weight, giving naval architects a new degree of freedom.

Power plant applications

The Wärtsilä 64 is an ideal prime mover for large Independent Power Projects in the range of > 100 MW. It takes just five 18V64 engines to build a 150 MW size plant.

The Wärtsilä 64 offers true multifuel operation with the capability of burning lowest grade heavy fuel oils and Orimulsion in the same plant. The plant net electrical efficiency is equally high with both fuels.

The reliability and serviceability of the prime movers is crucial when running a base load power plant at full power. As Wärtsilä's most recent engine design, the Wärtsilä 64 combines our collective know-how, and offers all the features and benefits that a modern large medium-speed engine can offer for dependable power generation.



Main Technical Data

	In-line engine	V-engine
Cylinder bore:	640 mm	640 mm
Piston stroke:	900 mm	770 mm
Speed:	327.3 - 333.3 rpm	400 - 428.6 rpm
Mean effective pressure:	25.5 - 25 bar	23.5 - 22 bar
Piston speed:	9.8 - 10 m/s	10.3 - 11 m/s
Output/cylinder:	2 010 kW	1 940 kW
Fuel specification:	Fuel oil, 730 cSt/50°C, ISO 8217, class F, RMH 55 (Orimulsion/Bottom Fuel) (Natural Gas)	

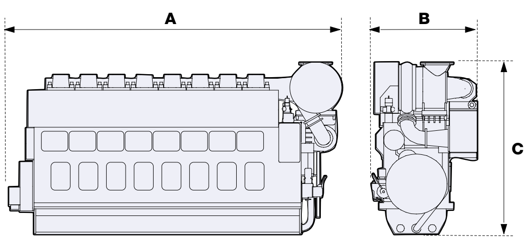
Rated Power: Propulsion engines

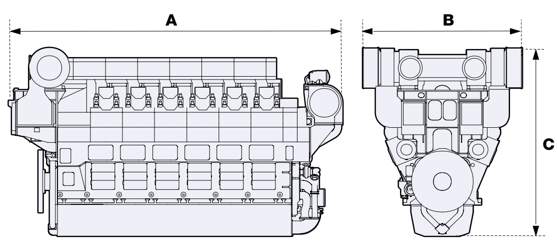
Engine type	Output in kW/bhp at							
	327.3 rpm/60 Hz		333.3 rpm/50 Hz		400 rpm/60 Hz		428.6 rpm/50 Hz	
	kW	BHP	kW	BHP	kW	BHP	kW	BHP
6L64	12 060	16 400	12 060	16 400	–	–	–	–
7L64	14 070	19 140	14 070	19 140	–	–	–	–
8L64	16 080	21 870	16 080	21 870	–	–	–	–
9L64	18 090	24 600	18 090	24 600	–	–	–	–
12V64	–	–	–	–	23 280	31 660	23 280	31 660
16V64	–	–	–	–	31 040	42 210	31 040	42 210
18V64	–	–	–	–	34 920	47 490	34 920	47 490

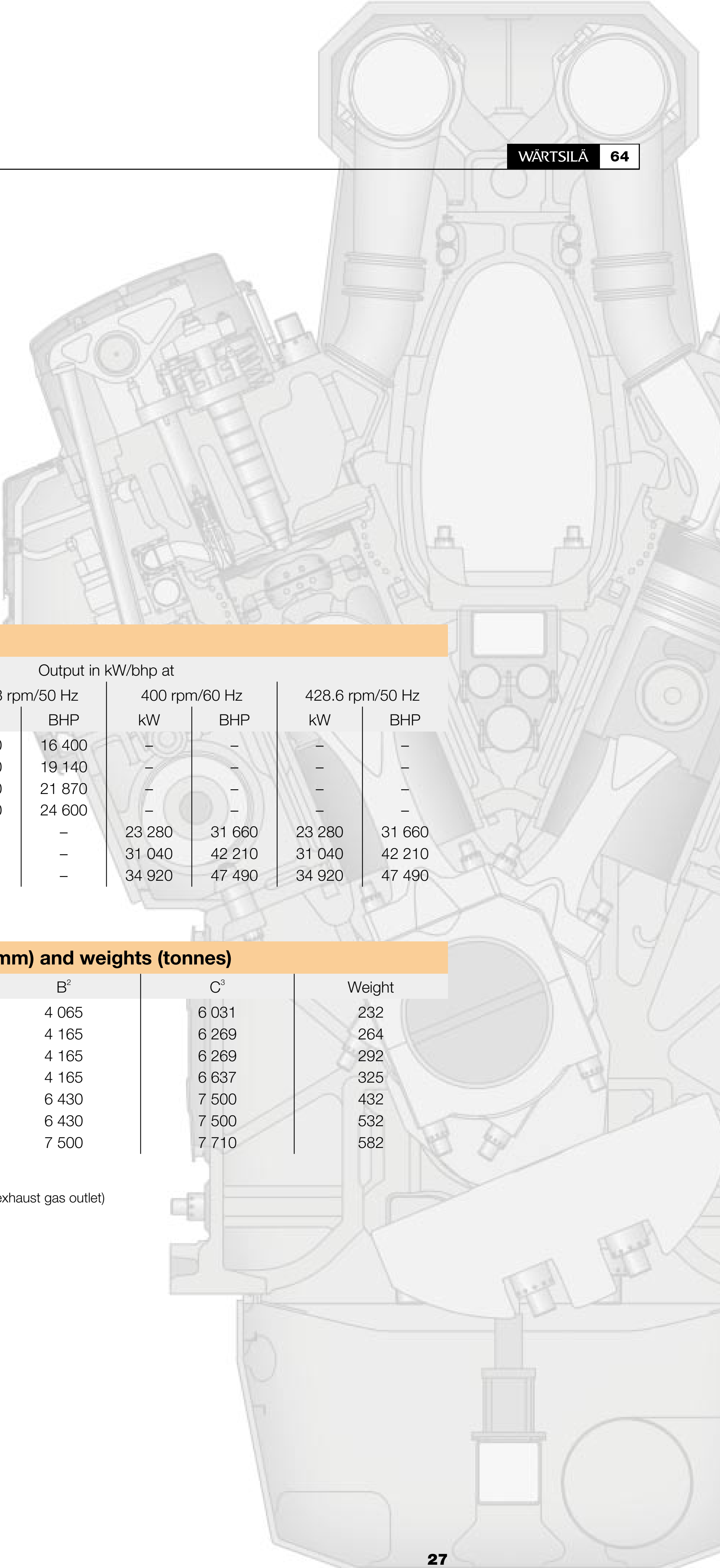
Principal engine dimensions (mm) and weights (tonnes)

Engine type	A[1]	B[2]	C[3]	Weight
6L64	10 250	4 065	6 031	232
7L64	11 300	4 165	6 269	264
8L64	12 350	4 165	6 269	292
9L64	13 670	4 165	6 637	325
12V64	12 765	6 430	7 500	432
16V64	15 365	6 430	7 500	532
18V64	16 975	7 500	7 710	582

1) Total length (turbocharger located at flywheel end)
2) Total breadth
3) Total height (from the bottom of the oil sump to the exhaust gas outlet)







Rated power: Generating sets

Engine type	Output in kW/bhp at							
	327.3 rpm/60 Hz		333.3 rpm/50 Hz		400 rpm/60 Hz		428.6 rpm/50 Hz	
	kW	BHP	kW	BHP	kW	BHP	kW	BHP
6L64	12 060	16 400	12 060	16 400	–	–	–	–
7L64	14 070	19 140	14 070	19 140	–	–	–	–
8L64	16 080	21 870	16 080	21 870	–	–	–	–
9L64	18 090	24 600	18 090	24 600	–	–	–	–
12V64	–	–	–	–	23 280	31 660	23 280	31 660
16V64	–	–	–	–	31 040	42 210	31 040	42 210
18V64	–	–	–	–	34 920	47 490	34 920	47 490

Principal genset dimensions (mm) and weights (tonnes)

Engine type	A[1]	B[2]	C[3]	Weight
6L64	10 250	4 065	6 031	232
7L64	11 300	4 165	6 269	264
8L64	12 350	4 165	6 269	292
9L64	13 670	4 165	6 637	325
12V64	12 765	6 430	7 500	432
16V64	15 365	6 430	7 500	532
18V64	16 975	7 500	7 710	582

1) Total length (turbocharger located at flywheel end)
2) Total breadth
3) Total height (from the bottom of the oil sump to the exhaust gas outlet)

Wärtsilä Corporation is the leading global ship power supplier and a major provider of solutions for decentralized power generation and of supporting services.

In addition Wärtsilä operates a Nordic engineering steel company and manages substantial share holdings to support the development of its core business.

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