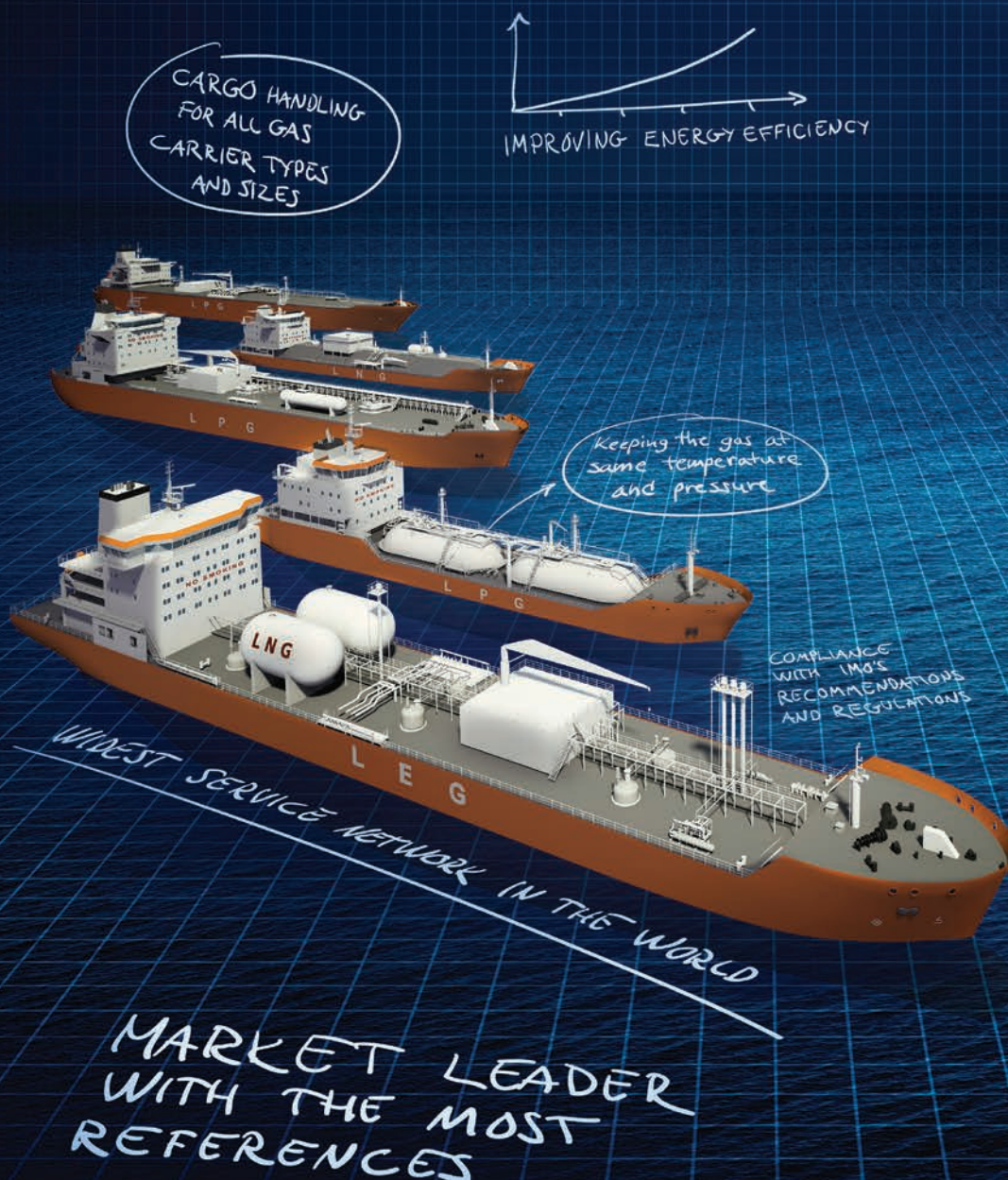


CARGO HANDLING SYSTEMS FOR LPG, LNG, NH₃ & ETHYLENE



At Wärtsilä we strive constantly to do what is best for you. This includes optimising the lifecycle value of your installations by offering precisely what you need; a promise we can deliver on since we provide the oil & gas industry with a broad portfolio of integrated solutions, products and global services.

Whatever the location, no matter how harsh the conditions, we deliver world class efficiency, fuel flexibility, and environmentally sound solutions – everyday.

KEY BENEFITS

- Improving energy efficiency
- Keeping the gas at same temperature and pressure
- Compliance with IMO's recommendations and regulations
- Widest service network in the world

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 based on the extensive experience we have 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, including LNG. Typically these ships are between 4,000 and 40,000 m³.



20,000 m³ LNG shuttle tanker

APPLICATIONS

LNG SHUTTLE TANKERS

Shuttle tankers for LNG are used to transport LNG to remote hubs and small scale import terminals. The typical size of these tankers is up to 40,000 m³.

LNG BUNKERING VESSELS

LNG bunkering vessels are used for ship to ship bunkering operations in line with the increasing use of LNG as a marine fuel. The typical size of these vessels is up to 10,000 m³.

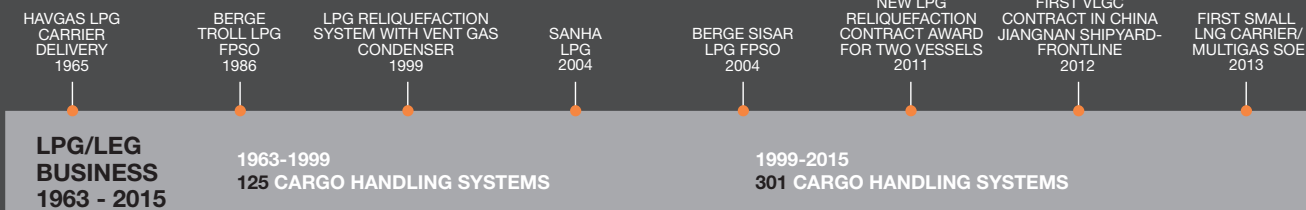
LNG BARGES

Wärtsilä Gas Solutions can provide complete cargo handling systems for LNG barges, as well as the complete ship design package for such LNG barges.

These barges can be built solely for transport/bunkering, or can also be equipped with Wärtsilä LNG Liquefaction, LNG Regasification, or fully integrated LNG power systems.



5,000 m³ LNG bunkering vessel



MARKET LEADER WITH THE MOST REFERENCES

- **SYSTEMS AND PROCESS DESIGN**
- **HARDWARE DESIGN/ MANUFACTURE/ASSEMBLE**
- **NAVAL ARCHITECTURE (SHIPS INTEGRATION)**
- **INSTALLATION, COMMISSIONING AND START-UP**

GAS RECOVERY BUSINESS 1998 - 2015

- 25 HC BLANKET AND FLARE GAS RECOVERY SYSTEMS
- 10 SHIP/FSU BASED VOC RECOVERY SYSTEMS
- 4 SHORE TERMINAL VOC RECOVERY SYSTEMS
- >150 FLARE GAS IGNITION SYSTEMS

LNG BUSINESS 2002 - 2015

- 43 LNG RELIQUEFACTION PLANTS
- 11 REGASIFICATION PLANTS
- 2 TERMINALS
- 4 SMALL SCALE ONSHORE LNG PLANTS

2003
SMALL SCALE
LNG PLANT
DELIVERED

2007
SMALL SCALE
LNG PLANT
DELIVERED

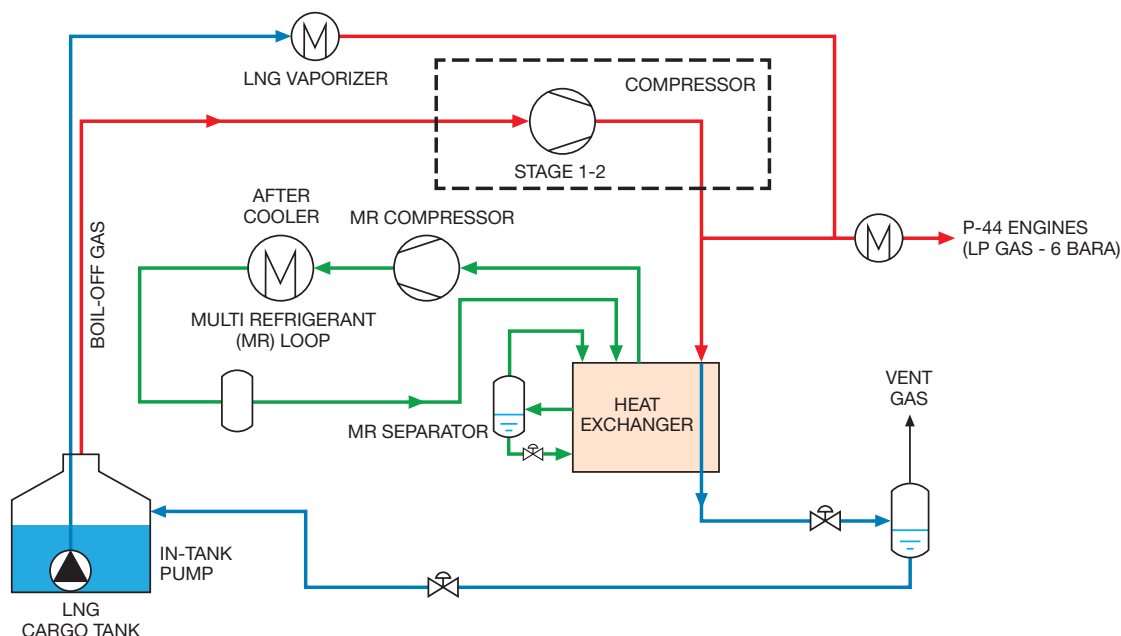
2010
SMALL SCALE
LNG PLANT
DELIVERED

2013
BIOGAS
LIQUEFACTION
PLANT
DELIVERED

SMALL-SCALE RELIQUEFACTION

In addition to the complete cargo handling system design, Wärtsilä also offers a newly developed reliquefaction plant suitable for the small-scale segment.

The system offers cost efficient reliquefaction of LNG boil off from 0.5 tons to 2.5 tons per hour. The system is working with a mixed refrigerant and is ensuring fully refrigerated conditions.



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 Gas Solutions 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 Gas Solutions is also delivering complete cargo handling system to these very large ethane carriers.



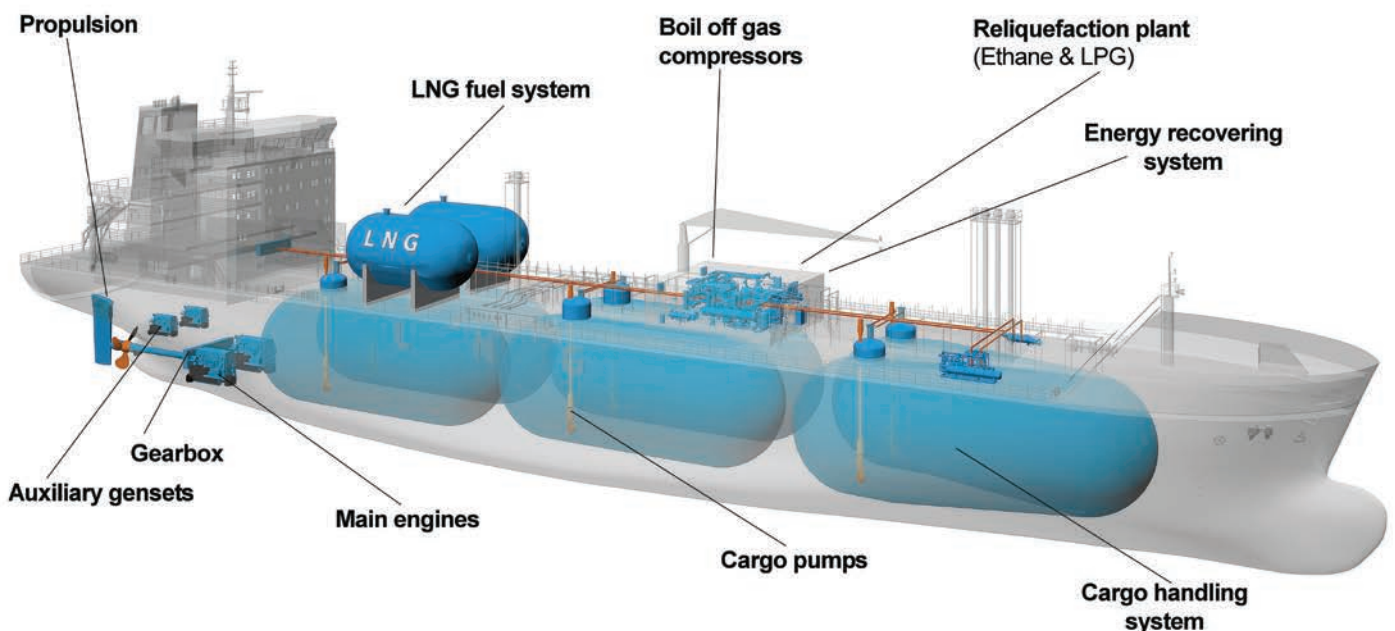
FIRST ETHANE FUELLED ETHANE CARRIER

Wärtsilä has supplied a comprehensive equipment and engineering package to a series of LNG / Ethane Carriers for Danish operator Evergas. These ships are first ever to operate with Ethane as fuel when trading Ethane from US to Europe. Engines and propulsion system, cargo handling plant and fuel supply system are all supplied by Wärtsilä. The vessels were built by Sinopacific Offshore Engineering at their yard in Qidong, China. The scope of work supplied by Wärtsilä enabled these vessels to achieve the operational and fuel efficiency needed to optimize their operating costs, while at the same time complying with the

upcoming Tier III environmental regulations. The Wärtsilä technology provided operational flexibility and redundancy, since it allows the possibility to utilize various conventional fuels in addition to LNG.

"We have enjoyed a lengthy and trusted relationship with Wärtsilä. This, together with Wärtsilä's relentless efforts in understanding and adapting to our demands, has enabled us to successfully achieve a total integrated solution. I am convinced that our DRAGON 27500 series will be a benchmark in the LNG carrier markets."

Martin Ackermann, CEO, Evergas





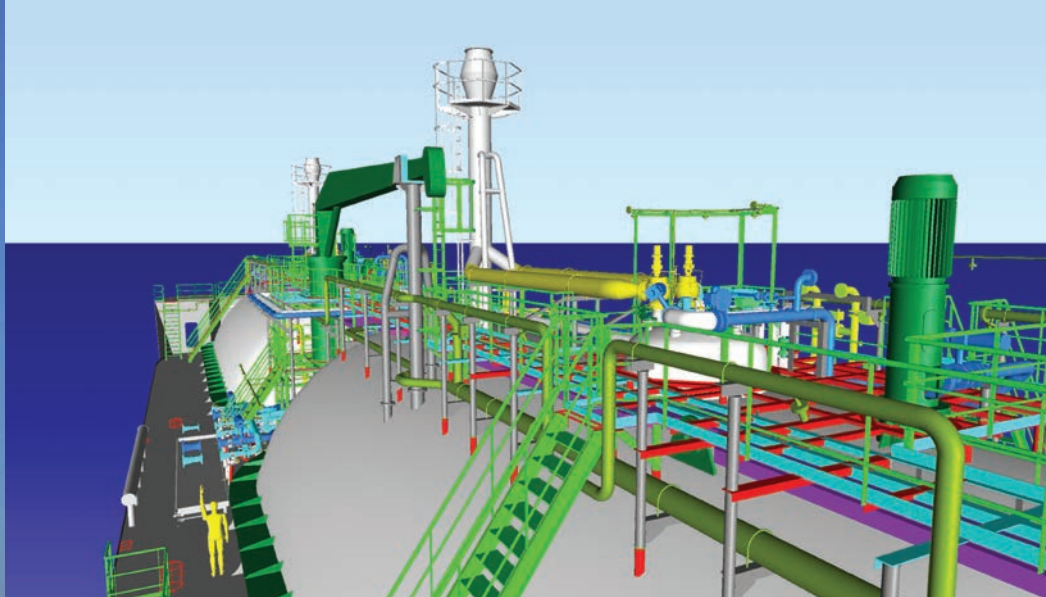
FULLY PRESSURIZED GAS CARRIERS

The largest fleet of gas carriers in the world is in the fully pressurized segment. For fully pressurized vessels the cargo tank volumes are typically in the range 1.000m³ to 11.000m³. Wärtsilä Gas Solutions offer modern solutions and advanced solutions for such vessels.

Fully pressurized vessels carry LPG at ambient temperatures, with the corresponding gas pressure this gives. Cargo tanks are usually able to handle a tank pressure of 18 bar(g).

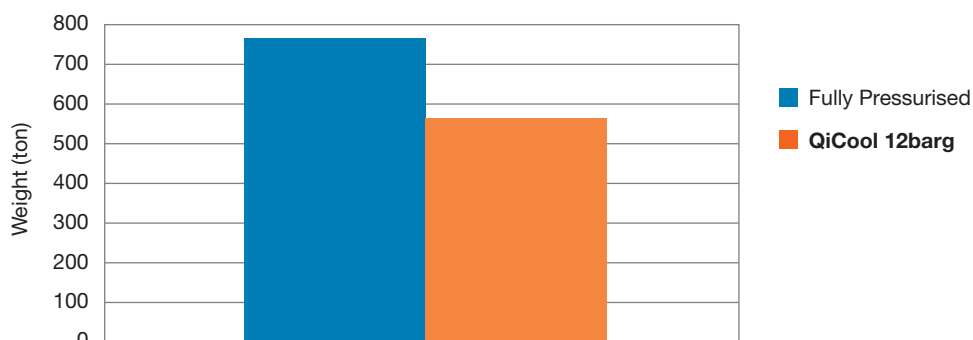
Wärtsilä Gas Solutions has developed the new QiCool Chiller unit suitable for Fully Pressurized LPG ships.

QiCool allows increased loading of the cargo tanks and a possibility to lower the design pressure for the cargo tanks thereby enabling weight and cost savings to be achieved.

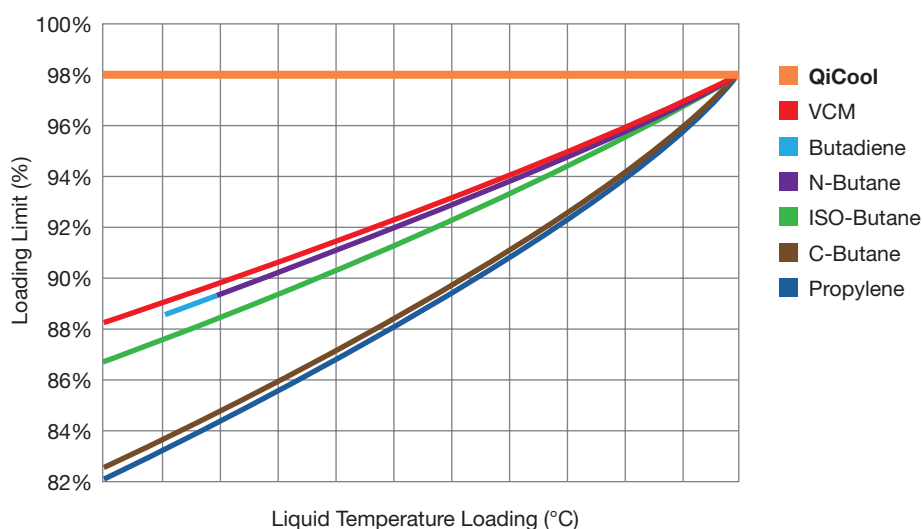


Complete and customizable cargo deck piping designs for fully pressurized LPG carriers.

Weight Saving on Cargo Tanks for 5000m³

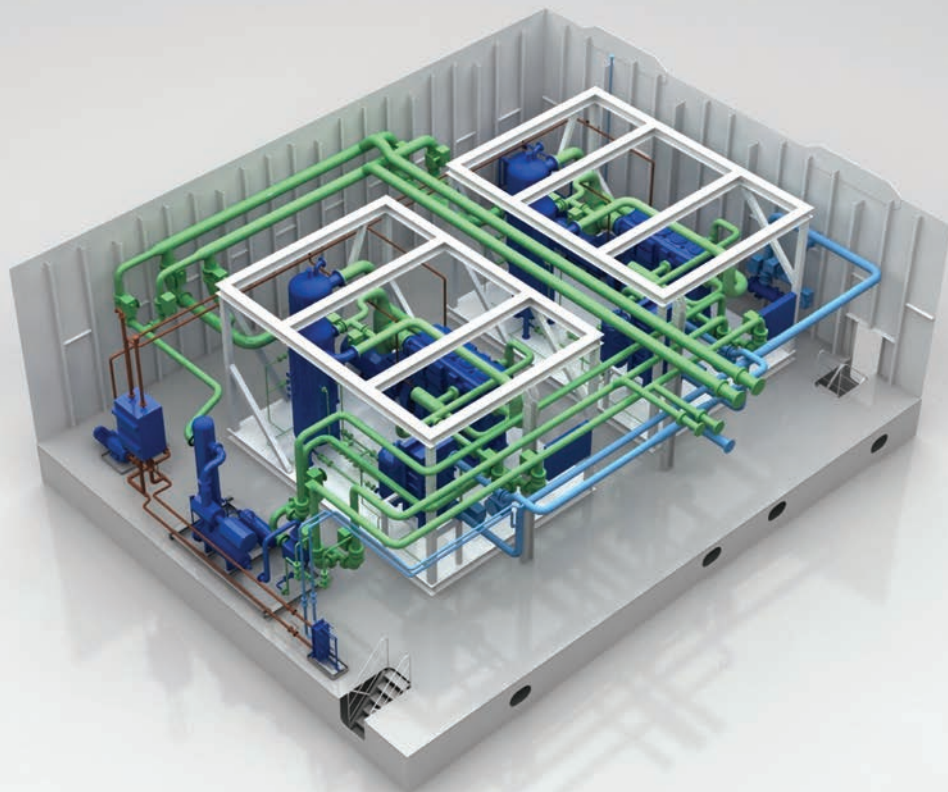


Loading Limits



FULLY REFRIGERATED GAS CARRIERS

In the fully and semi refrigerated vessel segment, Wärtsilä Gas Solutions has for many years been the preferred cargo handling supplier for numerous well-established ship owners. Because LPG is normally transported by these vessels at its coldest temperature (atmospheric pressure), there are high demands for reliable equipment onboard. With innovative, energy efficient solutions, and the broadest portfolio of reliquefaction configurations on the market, we are excellently positioned to meet the needs of our customers. Furthermore, we support this large worldwide segment with the market's best service network.



GAZ PROVIDENCE

The 'Gaz Providence', a 22 500 m³ Fully Refrigerated LPG/Ammonia carrier, is equipped with a Wärtsilä cargo handling system that includes a reliquefaction system with extensive cooling capacity, Wärtsilä Cargo Pumps, and a Wärtsilä Inert Gas System. The Wärtsilä solutions are all integrated for safe and reliable cargo operations.

The vessel is owned by Naftomar Shipping & Trading CO, one of the pioneers

of Greece's LPG trading business, and was built at the Hyundai Heavy Industries yard in 2010. It operates worldwide. Being also a trading company, Naftomar has high operational demands on its fleet. Thus, this ship is designed with large capacity and the flexibility to accommodate various cargo configurations and operations. The Wärtsilä solutions are central to these requirements.

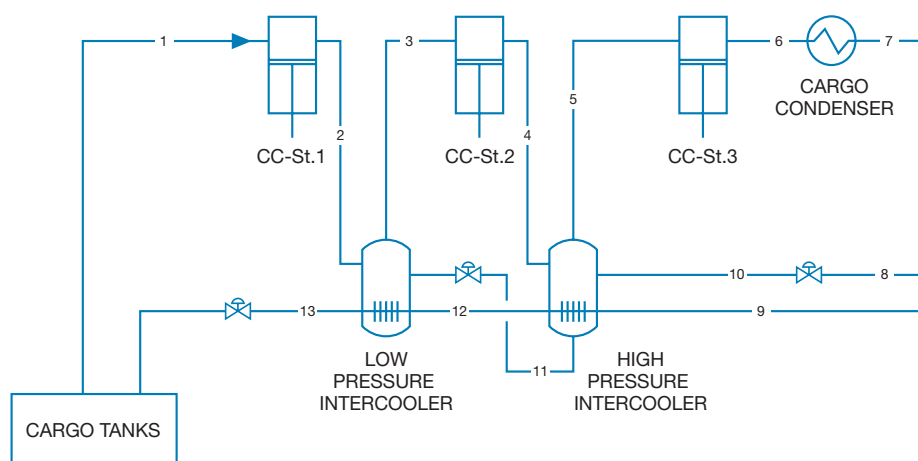


AN IMPROVED PROCESS FOR HIGH ETHANE

- The new Wärtsilä reliquefaction process with an increased pressure design enables the handling of lighter cargoes, such as propane with a high ethane content of up to 8-9%, which is common with shale gas processing plants.
- The new design features two intercoolers with a flash-in-series arrangement to provide ultimate plant performance.
- With full condensing against seawater for even lighter cargoes, there is no need for complicated vent gas cooling systems.
- No vent gas cooling means high performance throughout the entire cargo range.



WGS 3-Compressor Solution Performance Seawater Temperature: 36°C



3K160-3L Base Case

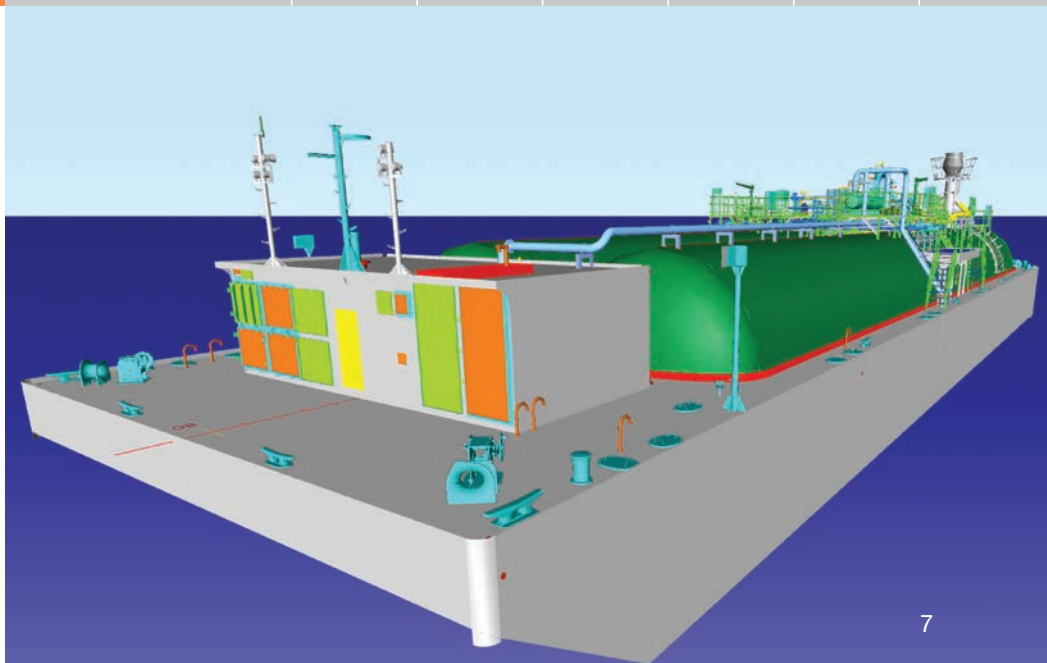
	2.5% Ethane		5.0% Ethane		8.0% Ethane	
Suction pressure (kPa)	100	140	100	140	100	140
Ref. capacity (kW)	312	439	295	417	278	396
Shaft Power (kW)	269	326	288	350	306	372
C.O.P.	1.161	1.346	1.024	1.194	0.910	1.064

LPG BARGES

Wärtsilä Gas Solutions can provide complete cargo handling systems for unmanned LPG barges, as well as the complete ship design package for such vessels.

The key to the system design is its robustness and simplicity, which enhances ease of operation.

The centralized control system comes with the option to monitor cargo system wirelessly from the pusher boat during transport.





Wärtsilä LPG reliquefaction plant onboard
135,000m³ LPG FPSO Sahnä

LPG-FSOS / FPSOS AND OFFSHORE APPLICATIONS

Wärtsilä Gas Solutions has delivered references for purpose built LPG-FSOs and FPSOs where we have designed, manufactured and supplied LPG cooling plants, reliquefaction plants, inert gas generators, nitrogen generators and cargo pumps.

Both LPG-FSO and FPSO new-build barges and conversions of VLGCs have been equipped with cargo handling systems from Wärtsilä. The systems have been designed according to the applicable rules for the actual project, ie from offshore rules to standard ship rules. the required send-out pressure (e.g. up to 130 bar has been studied). LNG at the required discharge pressure is heated in two stages.



SAHNÄ LPG FPSO

Wärtsilä scope of supply includes large propane and butane cooling and reliquefaction plants, comprising skid-mounted units with screw compressors, together with 18 Wärtsilä Svanehoj deepwell LPG cargo pumps and four booster pumps. The supply also consists of a Wärtsilä Moss oil-fired inert gas generator and a Wärtsilä Hamworthy sewage treatment plant designed to treat the sewage of a crew of 60 persons.

A total of five cooling units serve the reliquefaction plant, with two as the second stage in a cascade system. The units are equipped with oil injected screw

compressors, and with commercial propane as a refrigerant. Propane cooling capacity is 197m³/hour from +35°C to -37°C, and butane cooling capacity 106m³/hour from +35°C to -7°C. Overall dimensions are 13.3 x 5.0 x 6.3m, and unit weight is 83 tons.

The reliquefaction plant is designed for operation with LPG with high ethane content in the liquid phase (5 mol%), and will serve the LPG cargo tanks as the first stage in a cascade system. The system comprises of four reliquefaction units with oil-free screw compressors. Overall dimensions are 9.6 x 4.8 x 2.8m, and unit weight 34 tons.

CARGO COOLING PLANTS FOR COOLING OF LPG, HYDROCARBONS OR CHEMICALS

Cooling plants are designed and manufactured by Wärtsilä Gas Solutions to suit individual customer needs. For LPG we have references both for VCM cooling and for LPG FSOs and FPSOs for cooling of gas.

The plants are delivered as skid mounted units either for installation and operation in deck housing or on open deck in EX-zone.

Installing this type of plant on a gas carrier can improve the loading rate when loading "hot" cargoes. On FSOs and FPSOs the plant is cooling hot gas from the upstream process plant before it is expanded into the cargo tanks.

Propane and propylene are the preferred refrigerant for the cooling plants. Compressors will typically be of the screw type.



Wärtsilä LPG cooling plant onboard
135,000m³ LPG FPSO Sahná



HEAT EXCHANGERS

Wärtsilä heat exchangers are manufactured in accordance with Wärtsilä Gas Solutions design and are applied to various duties including condensers, heaters, vaporisers and intermediate coolers.

Shell and tube type heat exchangers for heating of LPG cargo are delivered with high nickel alloy stainless steel and titanium tubestacks.

For cargo heating applications seawater is typically circulated on the shell side to prevent freezing and tube cracking, avoiding cargo leakage.



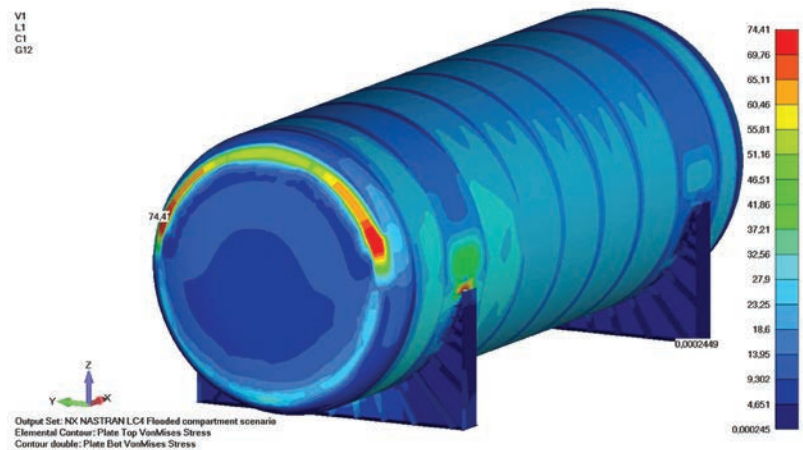
SHIP DESIGN AND CARGO TANK DESIGN

As a member of the Wärtsilä Group, we 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.

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).



3,500m³ LPG carrier of new QICool type



Cargo tank design utilizing the most modern tools for strength calculation, temperature distribution calculation and FEM analysis

WÄRTSILÄ SERVICES: LIFECYCLE EFFICIENCY SOLUTIONS

Wärtsilä Services supports its customers by offering the most comprehensive portfolio of services in the industry, thereby optimising their operations and the lifecycle performance of their installations.

Our service network is the broadest in the industry, consisting of more than 11,000 service professionals in over 60 locations in more than 70 countries. We offer expertise, local availability, responsiveness and environmentally sound actions for all customers, regardless of the make of their equipment.

Our services cover everything from basic support, with parts, field service and technical support to service agreements and condition



based maintenance; from installation and commissioning, performance optimisation, including upgrades and conversions, to environmental solutions, technical information and online support.

The choice available to you extends from parts and maintenance services

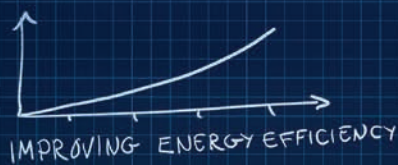
to a variety of comprehensive, customised long-term service agreements, including performance and operations & management agreements. Optimising your operations and preventing the unexpected is our shared passion.

"We serve you whenever, wherever".

Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

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CARGO HANDLING
FOR ALL GAS
CARRIER TYPES
AND SIZES

Keeping the gas at
same temperature
and pressure

COMPLIANCE
WITH IMO'S
RECOMMENDATIONS
AND REGULATIONS

WIDEST SERVICE NETWORK IN THE WORLD

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