



Equipment and Solutions

**MARINE LNG FUELLING AND BUNKERING**





## THE CRYOSTAR GROUP

CRYOSTAR is a cryogenic equipment manufacturer with more than 600 employees including 150 engineers. With its Headquarters located in France, the company operates five production sites and is present worldwide through seven business centers and sixteen business partners.

Founded in 1966, the company has over 40 years' experience with LNG and has become the world leader for boil-off gas compressors and on-board liquefaction units for LNG carriers. The company has delivered thousands of cryogenic pumps for liquid hydrocarbon applications (including methane, ethylene, ethane, etc.)

CRYOSTAR engineers continuously innovate with patented solutions for various applications throughout the LNG supply chain, such as small scale liquefaction, LNG transportation, LCNG/LNG vehicle refueling stations and LNG bunkering.



## SAFETY AND STANDARDS

Safety is an integral part of CRYOSTAR's management and manufacturing commitments. For each new development or project, the company performs a risk analysis using approved techniques such as HAZOP (Hazard and Operability) and FMEA (Failure Mode and Effects Analysis). CRYOSTAR's equipment and solutions comply with most stringent machine and safety regulations such as the Pressure Equipment Directive 97/23/CE (Module H and H1) and ATEX.



## FACTORY AND ON-SITE ACCEPTANCE TESTS

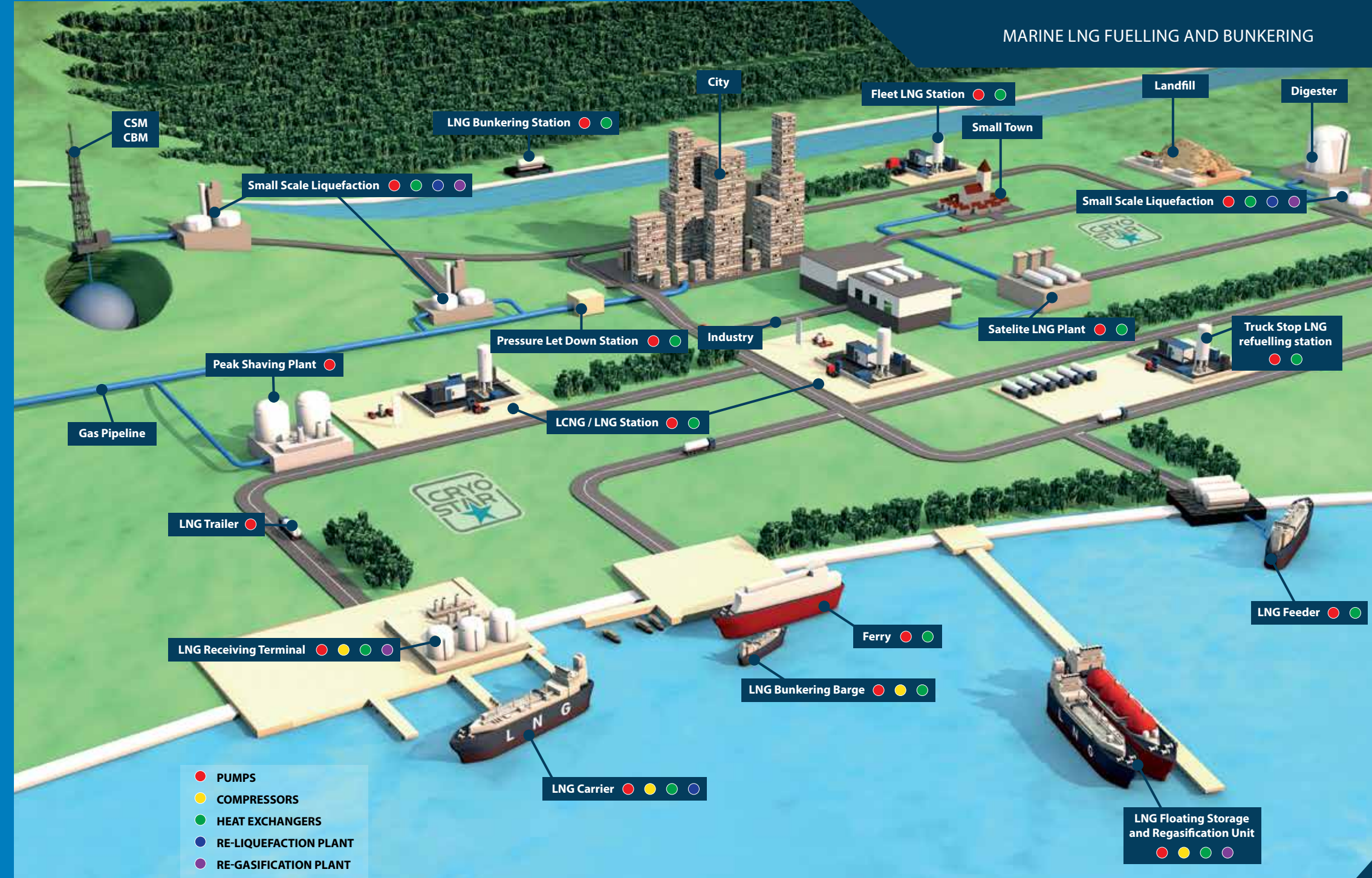
CRYOSTAR's Headquarters boast the world's largest and most sophisticated liquid nitrogen test facility for cryogenic pumps as well as three test facilities dedicated to turbines. CRYOSTAR engineers subject each pump and turbine to a performance test prior to shipment, offering customers guaranteed performance. CRYOSTAR provides commissioning, start-up and support for onboard performance testing for LNG carrier regasification units.

## QUALITY AND ENVIRONMENT

CRYOSTAR is ISO 9001-2008 certified. To structure its environmental approach, CRYOSTAR has used the ISO 14001 standard to set up all the organizational and operational processes necessary for an aspiring Environmentally Responsible company. In parallel, CRYOSTAR has applied this approach to Health and Safety through the OHSAS 18001 standard ISO 9001-2008/ ISO 14001-2004 / OHSAS 18001-2007 quality assurance system.



## MARINE LNG FUELLING AND BUNKERING







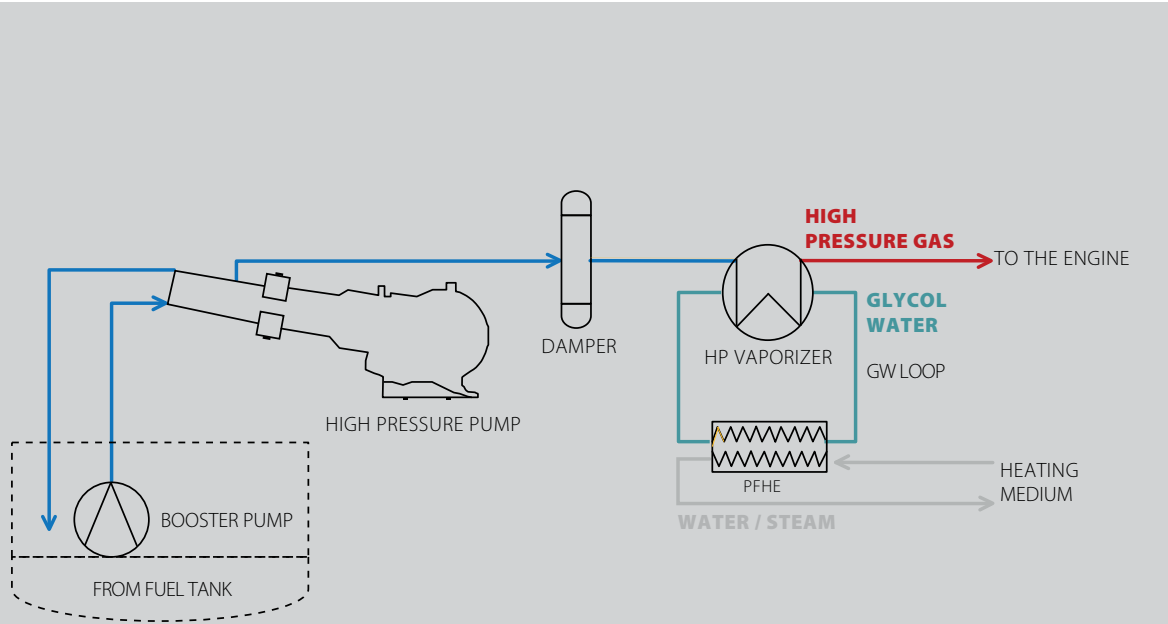
FUELLING THE FUTURE

In recent years, vessel emission regulations have progressively tightened. This means that alternative methods are necessary to achieve compliance. Fuelling with LNG is one of the simplest and cleanest ways.

CRYOSTAR, A UNIQUE EXPERIENCE IN THE FIELD

CRYOSTAR has always been a key supplier of cryogenic pumps and pump systems globally. This experience, often in conditions more extreme than LNG, places CRYOSTAR in the unique position of having a strong combination of vast marine and pumping experience, unlike any competitor.

This experience base, allows well designed pumping systems for LNG powered vessels, be it for lower pressure 4-stroke dual/tri fuel diesel, high pressure 2-stroke dual fuel engines or medium pressure gas fuelled turbines.



Typical HP FGSS, equipment supplied by CRYOSTAR

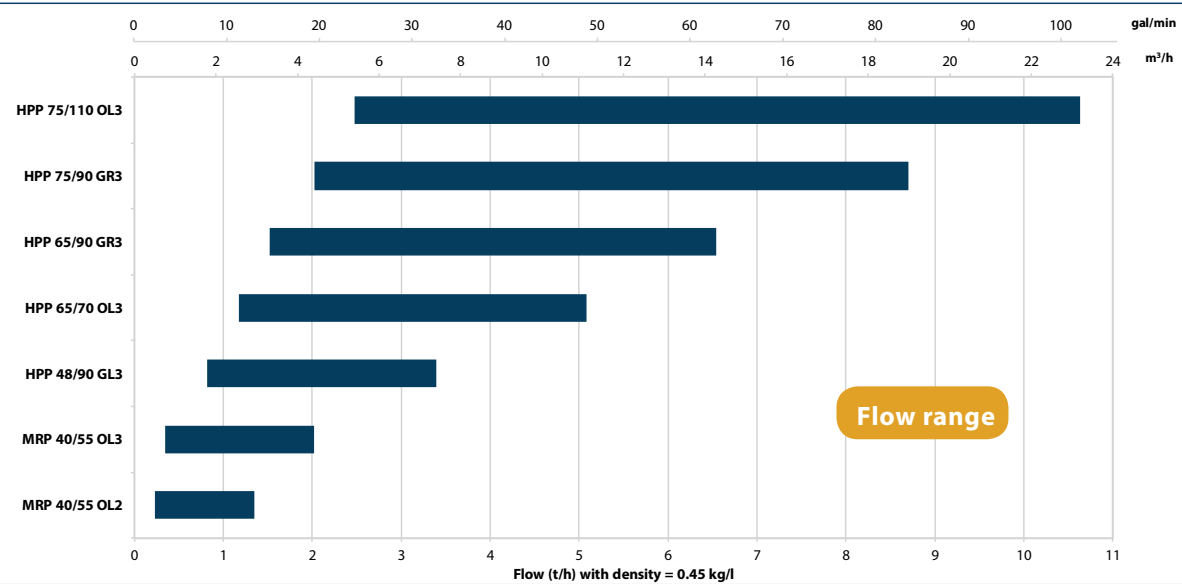
DUAL FUEL 2-STROKE MARINE ENGINES

The high pressures required to fuel a 2-stroke diesel cycle engine on gas are well within the range of these exceptional pumps. Developed over a period of 40 years, they represent the very highest quality available.

Extremely low NPSH levels coupled with high reliability and efficiency make CRYOSTAR the natural choice. Simple maintenance and option of belt, gear or hydraulic drives complete the package. The pumps are delivered on completed skids fully tested in our world-leading facility in France. Pumps for ethane fuelling complete our portfolio.



Main Engine Technology	Operating Pressure
2-stroke, HP tri-fuel diesel / ethane / NG	400
2-stroke, HP dual fuel diesel / NG	300







FROM FUEL TANK TO ENGINE

Small in-tank pumps are perfectly suited for fueling application. They are fitted with ceramic bearings for extended lifetime and can be mounted either in an external sump, or within the tank.

Our SUBTRAN range represents hundreds of references, including LNG fuelling applications. Small SUBTRANS supply the liquid to the high pressure pumps located deck-side, or can also be used to directly feed the low pressure Fuel Gas Supply Systems (FGSS).

Main Engine Technology

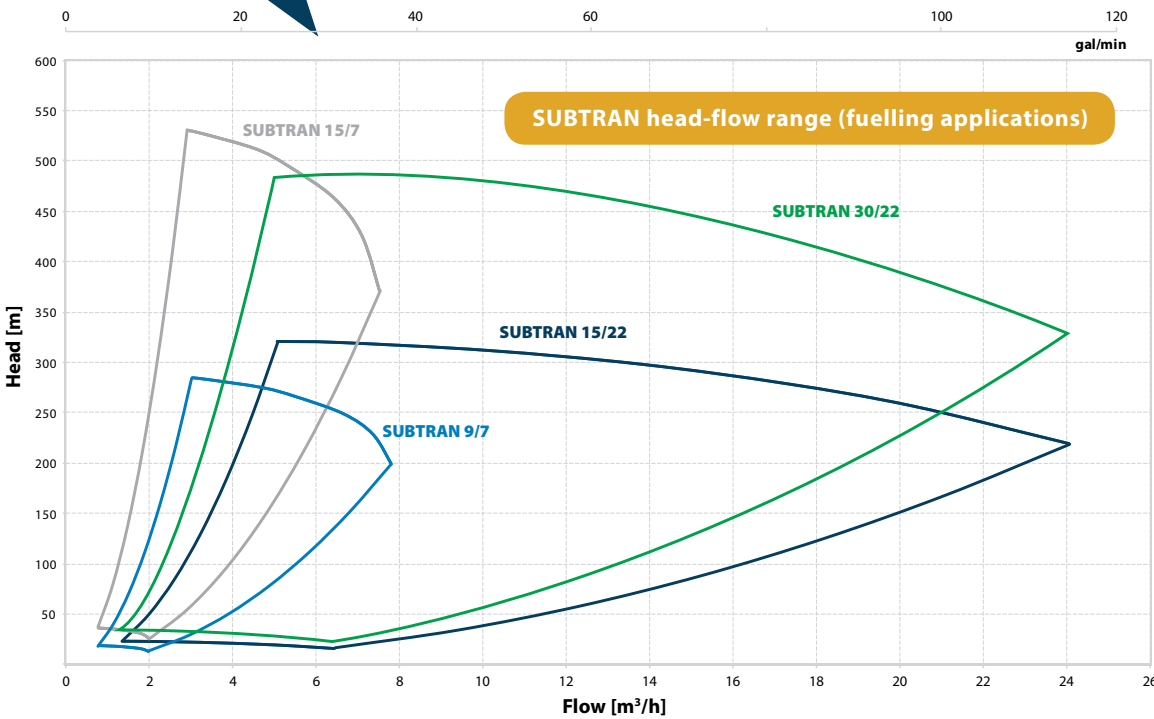
Medium pressure 2-stroke dual fuel diesel / NG

Low pressure 4-stroke dual fuel diesel / NG

Operating Pressure

17 bar

6.5 bar



SUBTRAN submerged pump

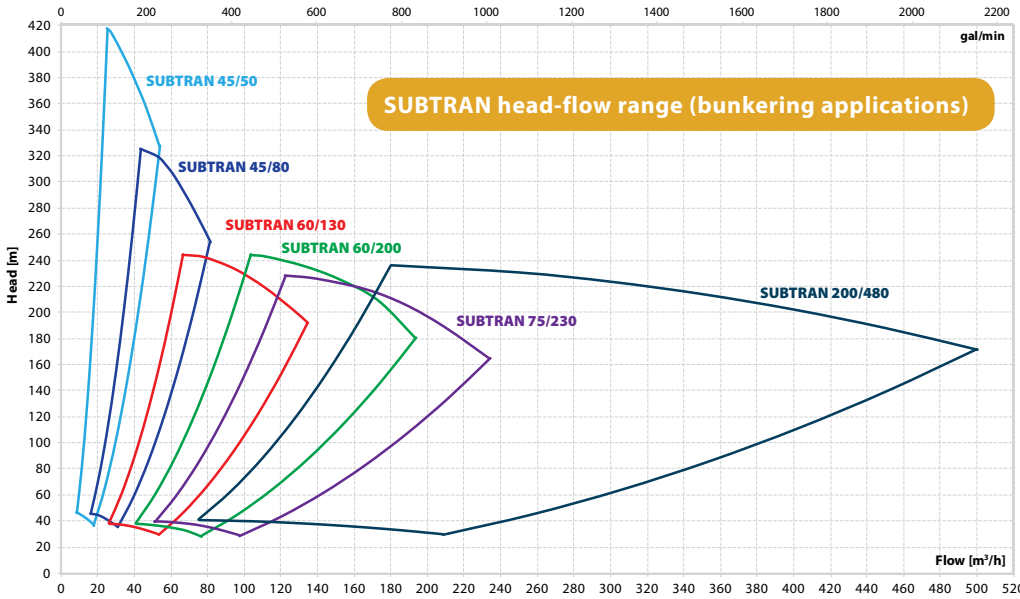
LNG/LEG/LPG BUNKERING AND TRANSFER

Bunkering consists of transferring the LNG from distribution source, to fuel tanks embarked onboard. As the number of LNG fuelled ships is exponentially growing, LNG bunkering solutions will continue to develop, under aspects already known, but all require safe, economical and reliable operation.

CRYOSTAR's renowned SUBTRAN (submerged transfer) pumps are used throughout the LNG supply chain from liquefaction plant, through ethane carriers, to LNG transfer and bunkering stations. The seal-less design offers higher safety with no risk of leakage and reduces maintenance costs to a minimum.



The SUBTRAN is a fully submerged pump transferring LNG from storage to fuel tank. Alongside with in-tank installation, complete skid mounted package is also possible.



Mounting options for SUBTRAN pumps

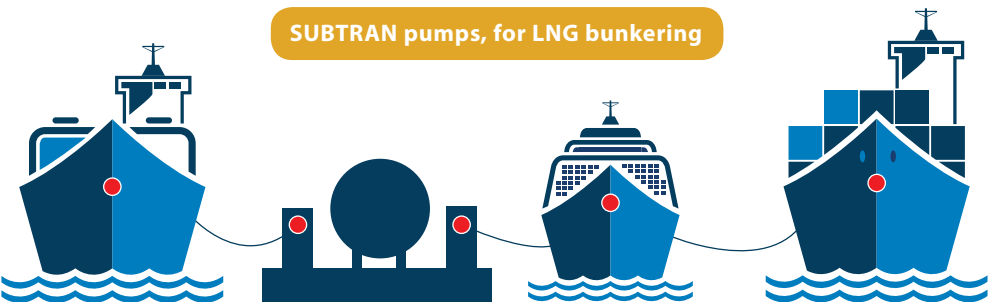


Flanged Version  
In line vertical or horizontal

Low pressure Barrel  
In sump vertical

Removable Pump  
In tank vertical or horizontal

SUBTRAN pumps, for LNG bunkering





MULTISTAGE VERTICAL PUMPS (VP)



Designed for cryogenic extreme conditions, CRYOSTAR VP pumps are recognized for their reliability and can run 24 hours a day without any maintenance for up to two years depending on site conditions. Generally used for LNG processing, this model is also suitable for LNG fuelling systems feeding gas turbines at medium pressure.

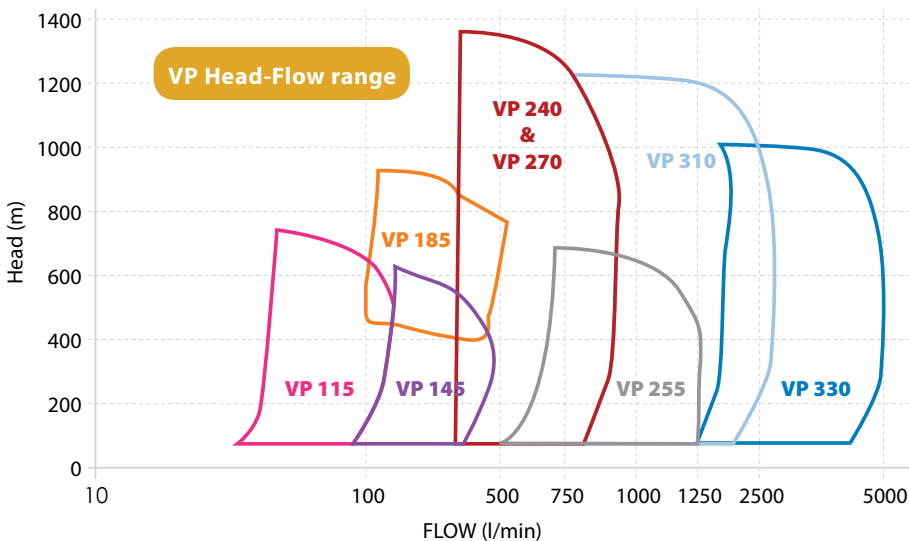
The multi-stage modular design extends the range of operating flow rates and allows delivery head, up to 1800 m (5905 ft).



1st high-speed DF turbine fast ferry, featuring VP pumps

Main Engine Technology	Operating Pressure
Gas turbine	50 bar

VP multistage pump



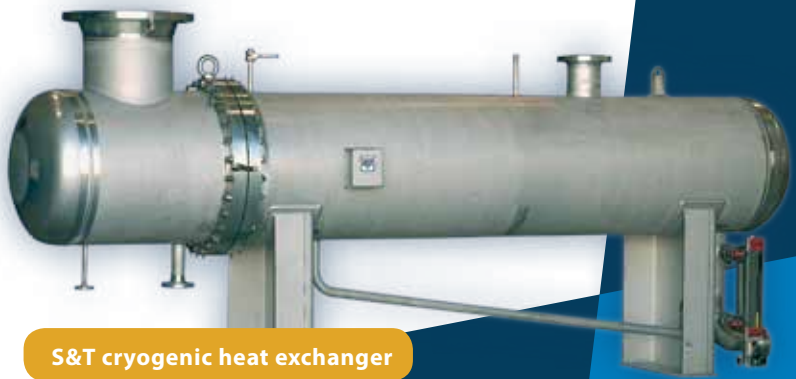
HEATERS AND VAPORIZERS

Natural gas heaters and LNG vaporizers are an essential part of the equipment installed on LNG fueled vessels. CRYOSTAR has more than 30 years of experience in designing and supplying stainless steel heat exchangers to the marine industry.

Shell and tube type: typically used for low pressure systems, consisting of a single pass shell with stationary head, fully welded to the U-tube bundle. A proven split-range control philosophy allows accurate flow and temperature settings to be achieved, while minimizing system pressure losses. Reliable control systems also provide protection to prevent icing in case of heating medium flow disruptions.

Coil wound type: typically used for HP systems, can be mounted as stand-alone equipment, directly on the high pressure pump's skid or packaged separately with complete glycol water (GW) system.

Main Engine Technology	Operating Pressure
Medium pressure 2-stroke dual fuel diesel / NG	17 bar
Low pressure 4-stroke dual fuel diesel / NG	6.5 bar



S&T cryogenic heat exchanger

Main Engine Technology	Operating Pressure
2-Stroke, HP tri-fuel diesel / ethane / NG	400
2-Stroke, HP fuel diesel / NG	300



HP vaporizer skid with a complete GW system





## PREMIUM TECHNOLOGY IS OUR STANDARD

When designing our machines, we source the best possible materials and components. Sophisticated tools are used to analyze and prepare the best possible solution for each design aspect. Finally the machines are proven by testing in rigorous conditions in one of our 5 test facilities.



### Vacuum insulated cylinders

Vacuum insulated cold end to greatly reduce heat in-leak. Combined with an optimal suction chamber design, it allows much lower NPSH requirements.

### Self-lubricating geared drives

Low operating speeds mean that our pumps can do without an external forced lube oil system. Our proven splash oil lubrication system reduces the footprint while improving reliability and reducing maintenance costs.



### Ceramic bearings

To allow service intervals with the best possible performance, ceramic bearings are utilized in our submerged pumps.

**CRYOSTAR's philosophy is to propose machines designed for the application rather than "push" an existing low cost model into a specialized role.**



Reciprocating pump cryogenic Factory Acceptance Test

## CARING FOR YOUR EQUIPMENT FOR 40 YEARS

Since the production of equipment began in 1967, CRYOSTAR has always emphasised the need to support the end-user for the life of the equipment.

In the world of marine applications, the reliability and efficient operation of the equipment is mission-critical. This is why CRYOSTAR allocates each vessel to a single point of contact for most efficient servicing, parts supply and technical back-up.

Many end-users benefit from our maintenance agreements when it comes to dry-dock servicing. Dedicated spare part kits ensure that no critical parts are missing during this time-pressured period off-hire. Our large team of technical experts can handle routine and major servicing anywhere in the world.

Unplanned maintenance interventions are always a challenge, with the vessel presenting a moving target. It requires skill, patience and immense co-operation to achieve seamless service under these circumstances. CRYOSTAR's service team is geographically distributed, affording quick reaction

times wherever you may be, and the 24h service line means that you are guaranteed a response.

Most equipment only needs major servicing at 5 and 10 year intervals, so it is key that the organisation is well planned and our team is always ready to work with you to define a course of action.





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**INDIA**

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**RUSSIA**

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**SINGAPORE**

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locations worldwide, please go to  
**[www.cryostar.com/locations](http://www.cryostar.com/locations)**

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