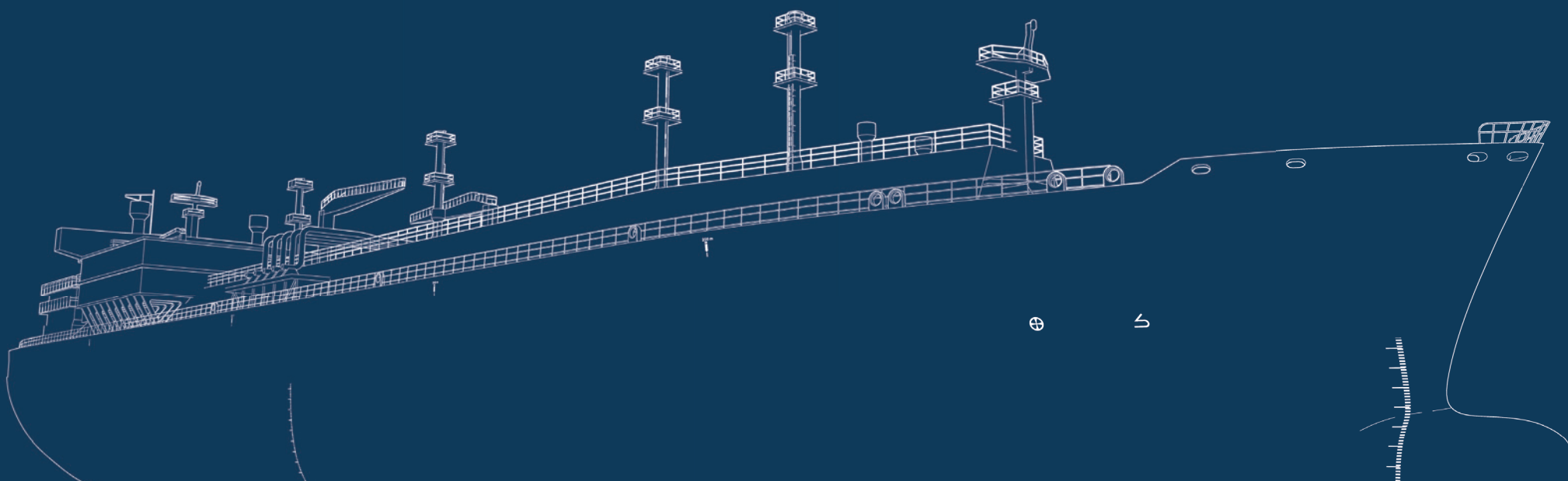




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Equipment and Solutions

LNG TRANSPORTATION, CARGO HANDLING AND FUELLING APPLICATIONS



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WORLDWIDE PRESENCE

Since the production of equipment began in 1967, CRYOSTAR has always emphasized the need to support the end-user for the life of equipment. Our machines are built to last; it is our priority to maintain high quality throughout the lifetime of our products.

For each new project, a Service Key Account Manager will be assigned to help you plan commissioning activities. CRYOSTAR is also capable of offering customized service contracts to help you run our equipment at maximum efficiency.

In case of unplanned maintenance, CRYOSTAR's service team is geographically distributed, offering quick reaction times wherever you may be, and the 24h service line guarantees that you will get a response.

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



CRYOSTAR Headquarters CRYOSTAR France CRYOSTAR Business Centers

INNOVATION

At CRYOSTAR, innovation is at the heart of everything we do, not just for teams dedicated to Research & Development, but also for teams who work every day to design the equipment we sell.

A community of Experts, Specialists and Referents also capitalise on their own experience and the feedback received from customers to continue to innovate.

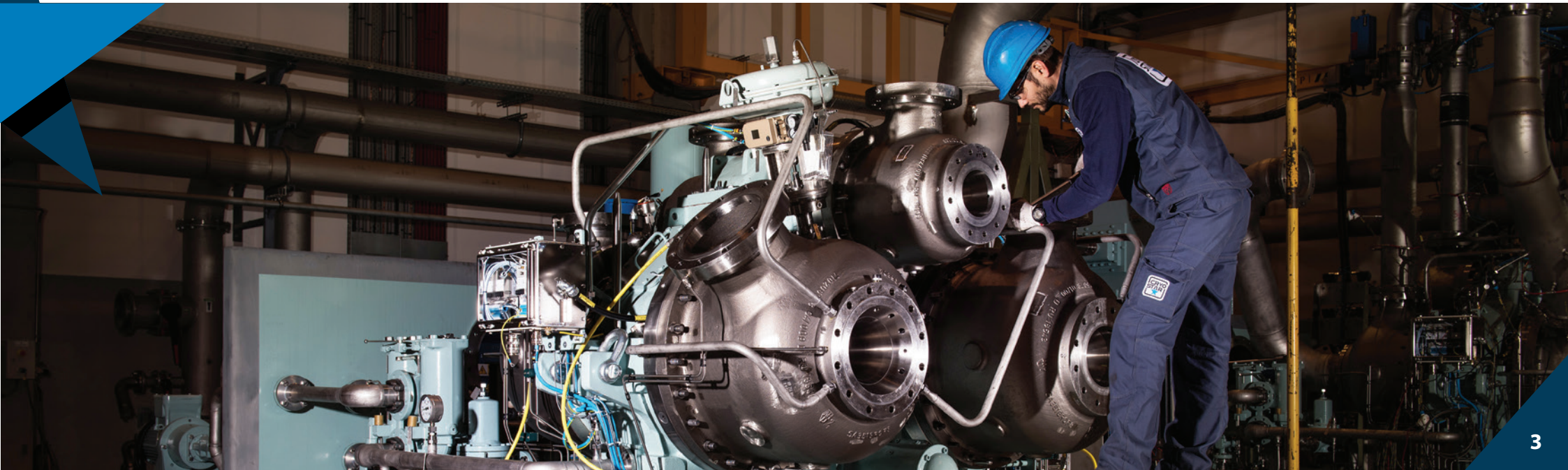
PRODUCTION AND TESTING

Our compressors are manufactured and tested at our Headquarters in France.

Critical parts are sourced as locally as possible in order to maintain tight quality controls. Our warehouse contains thousands of components and is equipped with an Automated Storage & Retrieval System.

Our assembly and testing teams operate from 3 assembly halls and 5 test facilities. In some cases, packaging may be performed at subcontractor sites.

Testing is performed to international standards on our site with specialised rigs and data acquisition units to record precise results.





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HEALTH, SAFETY, ENVIRONMENT

CRYOSTAR's HSE policy is based on the following certifications : **ISO 9001** (V2015), **ISO 14001** (V2015) et **ISO 45001** (V2018).

This structuring approach made it possible to anchor continuous improvement in the company's culture.

CRYOSTAR guarantees its machines' compliance with customer specifications and the regulations in the country where they are installed to enable customers to operate

equipment with complete confidence. **Safety of both property and people is our priority.**

CRYOSTAR is committed to the social and societal area for its employees' well-being. Therefore, diversity, balance and well-being at work, are notions which CRYOSTAR views as being of vital importance through targeted actions at the heart of its human resources policy.



TRAINING

CRYOSTAR Training Center offers training sessions adapted to all the equipment and solutions.



Theoretical courses can be combined with practical sessions, depending on the availability of the equipment on the customer's site or in CRYOSTAR's factory.

- ★ Get the best out of your equipment
- ★ Maintain the equipment safely & efficiently
- ★ Improve your awareness to increase the MTBF

QUALITY

All marine equipment is built and monitored by one of the major Classification Societies.

CRYOSTAR has experience with ABS, BV, DNV, Lloyds, NK, CCS, KR among others.





LNG carrier
50 - 270,000 m³



LNG Bunker vessel
50 - 20,000 m³



Merchant vessel
Fuel gas tanks

Cargo management

BOG Cargo Compressors

Cargo Handling Heat Exchangers

Cargo/Transfer Pumps

BOG control LNG Subcoolers

Fuel supply

Fuel Gas Compressors

Fuel Gas Vaporizers and Heaters

Fuel Gas Pumps

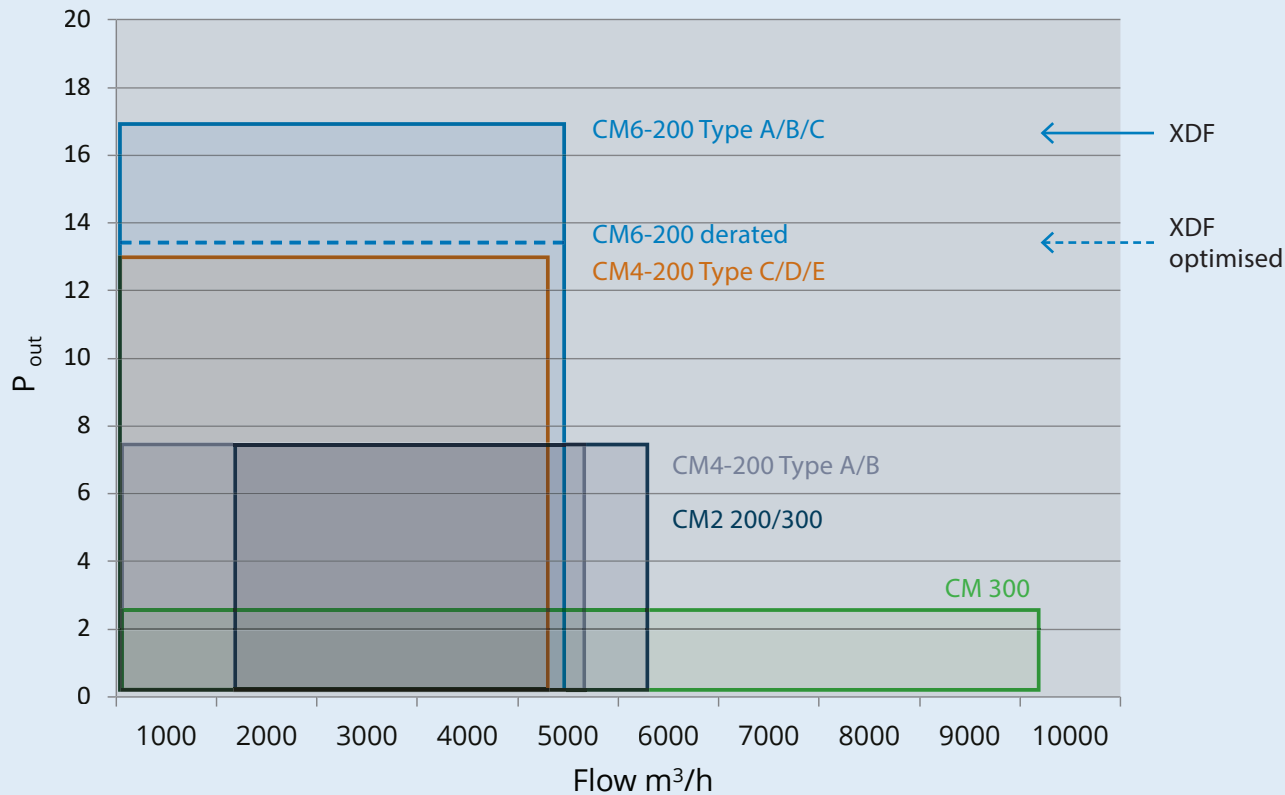
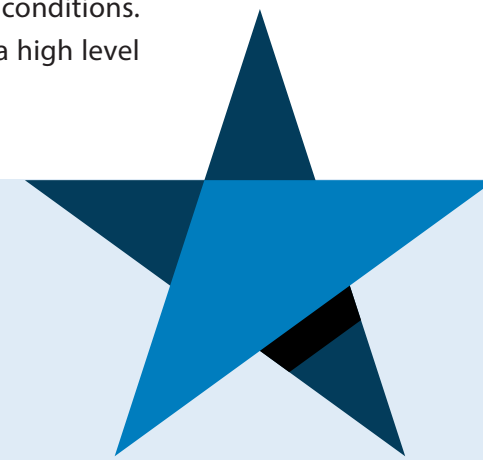


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FUEL GAS COMPRESSORS TAILORED TO YOUR NEEDS

CRYOSTAR offers wide range of models, encompassing medium pressure 2-stroke, low pressure 4-stroke and steam turbine driven vessels.

Emphasis is on efficiency coupled with flexibility of operation under a wide range of operating conditions. Precision engineered compressor wheels provide optimum performance while maintaining a high level of reliability.



Based on current models

Over
4,000 years*
of running
experience !

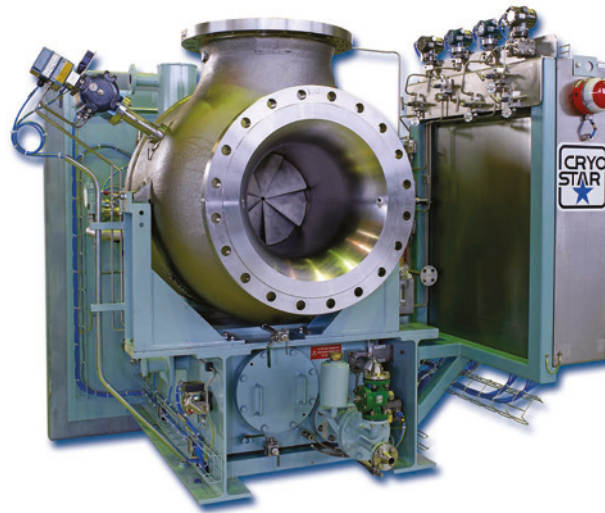
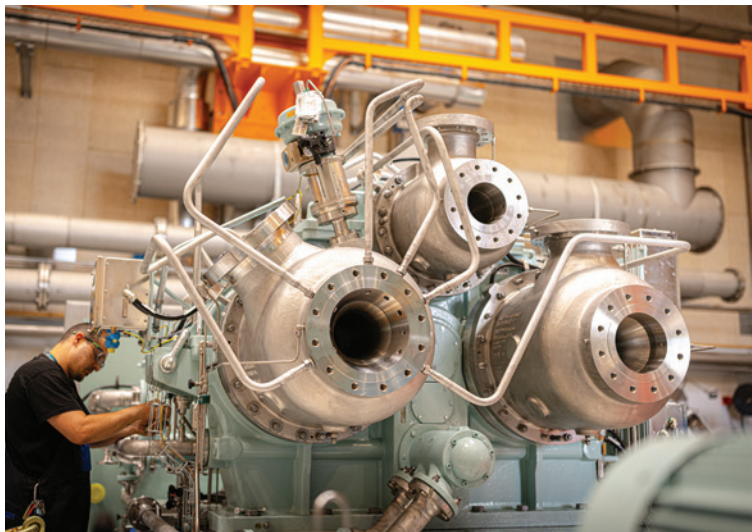
*Based on one of each pair of CRYOSTAR Low Duty compressors operating 80% of the time since delivery

CARGO HANDLING FOR LNG CARRIERS AND LNG BUNKER VESSELS

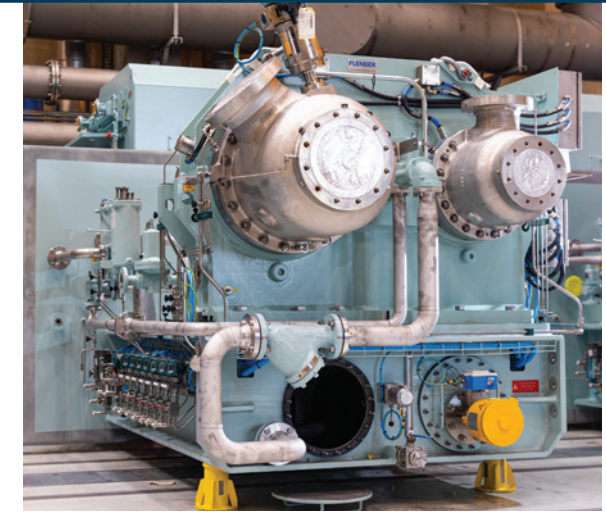
CRYOSTAR has been facilitating safe and reliable cargo handling on LNG carriers and bunker vessels since the 90's. Tank pressure control during loading and unloading is a critical aspect of vessel operation. During loading vapour return compressors move the necessary volume of gas ashore to maintain safe tank pressure levels.

FROM STEAM TURBINES TO MEDIUM PRESSURE 2-STROKE ENGINES

CRYOSTAR began producing compressors to supply boilers fitted to steam turbine propelled vessels. As new propulsion technologies were proposed, close co-operation with engine makers, shipyards and ship-owners led to the most versatile designs allowing flexibility for operational needs.



The world's most popular compressors on LNG carriers



FUEL GAS COMPRESSORS FOR MEDIUM PRESSURE DUAL FUEL ENGINES

Developments in current generation 2-stroke DF engines have resulted in a reduction in fuel gas pressure requirements from 17 to around 13 bar, allowing the introduction of a newer generation of the highly successful CM4-200 series compressors for these newer applications.

Operation of this fixed-speed design allows for simple control for the required flows. A wide inlet temperature range is accommodated allowing for a very flexible solution.

CRYOSTAR compressors are suitable for LNG carriers of all popular capacities and can be used to feed engines from the major makers.

The vast experience built up with multi-stage compressors on 4-stroke DF engines has been carefully reviewed and the key aspects incorporated in these newer applications.



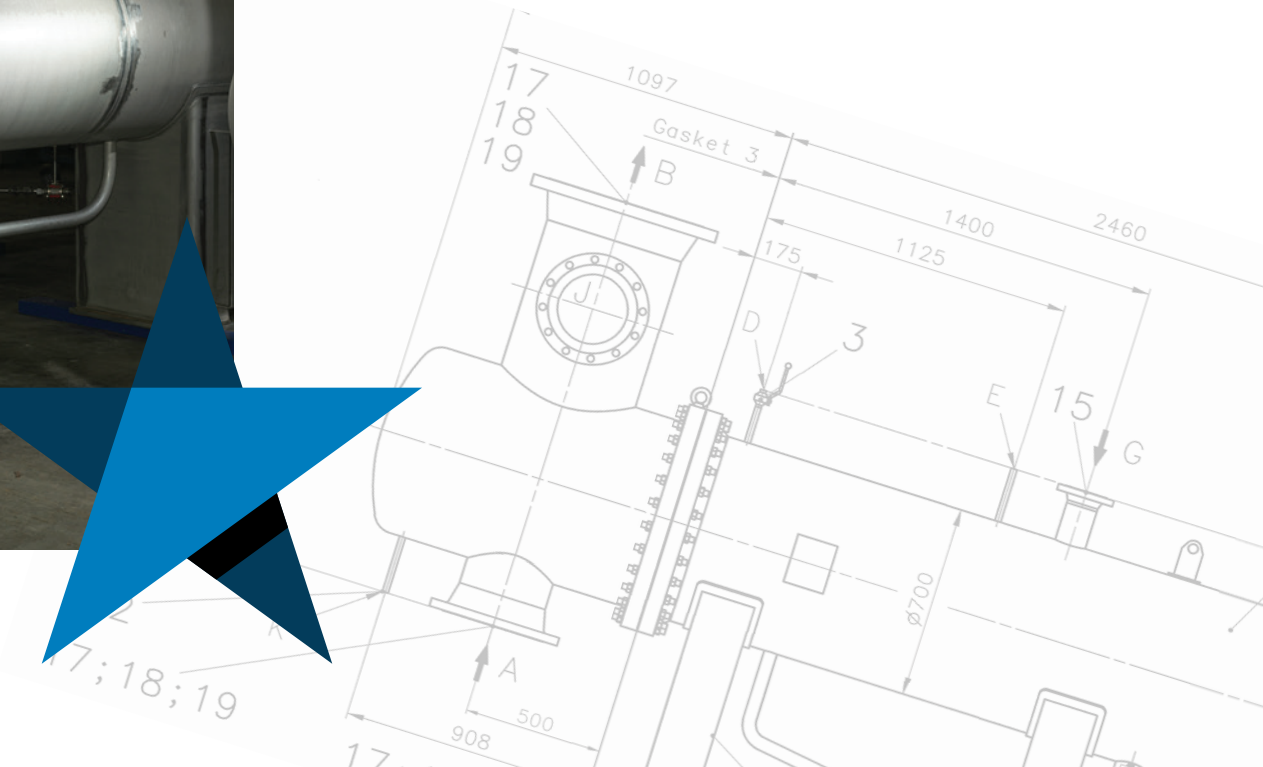
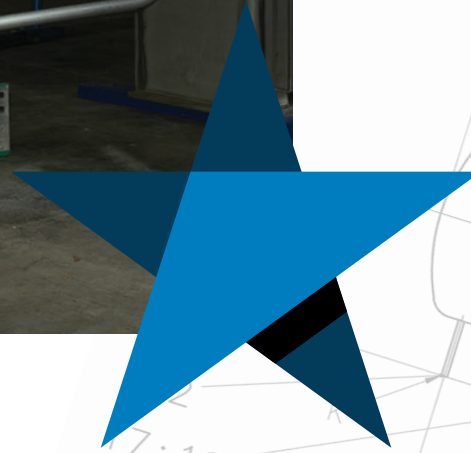
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INDUSTRY – STANDARD CRYOGENIC HEAT EXCHANGERS

Matching performance of heat exchangers to the upstream compressors or pumps is a key factor in system optimisation. We have been advancing the design and performance of our equipment continuously as vessel technology has advanced. Accurate temperature control and reliable operation are assured through our proven control philosophies.

Rugged design and worry-free operation is delivered with every set of heat exchangers.



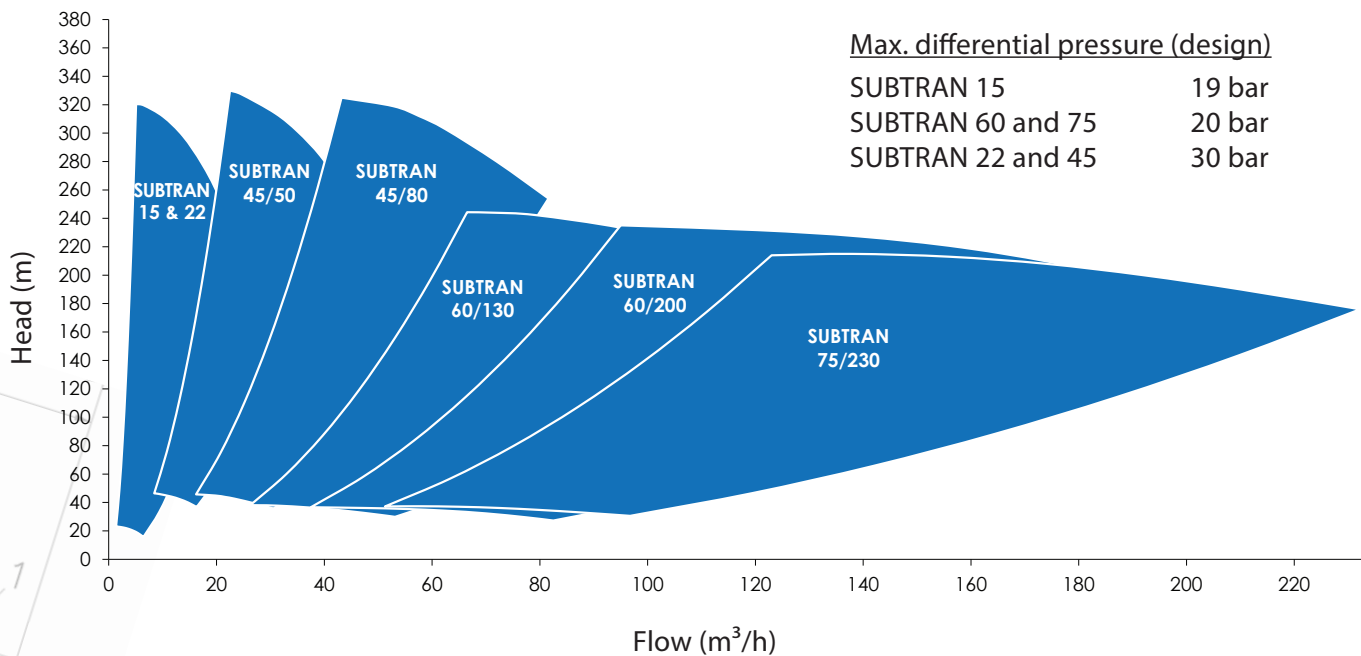
FUELLING FOR THE FUTURE...

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 to achieve compliance.

FROM FUEL TANK TO ENGINE

Small in-tank pumps supply the liquid to the high pressure pumps located deck-side.

Perfectly suited for this application, they are fitted with ceramic bearings for extended lifetime. Mounting can be either in an external sump, or internally in the tank.



SUBTRAN Head-Flow ranges



Subtran submersed pump



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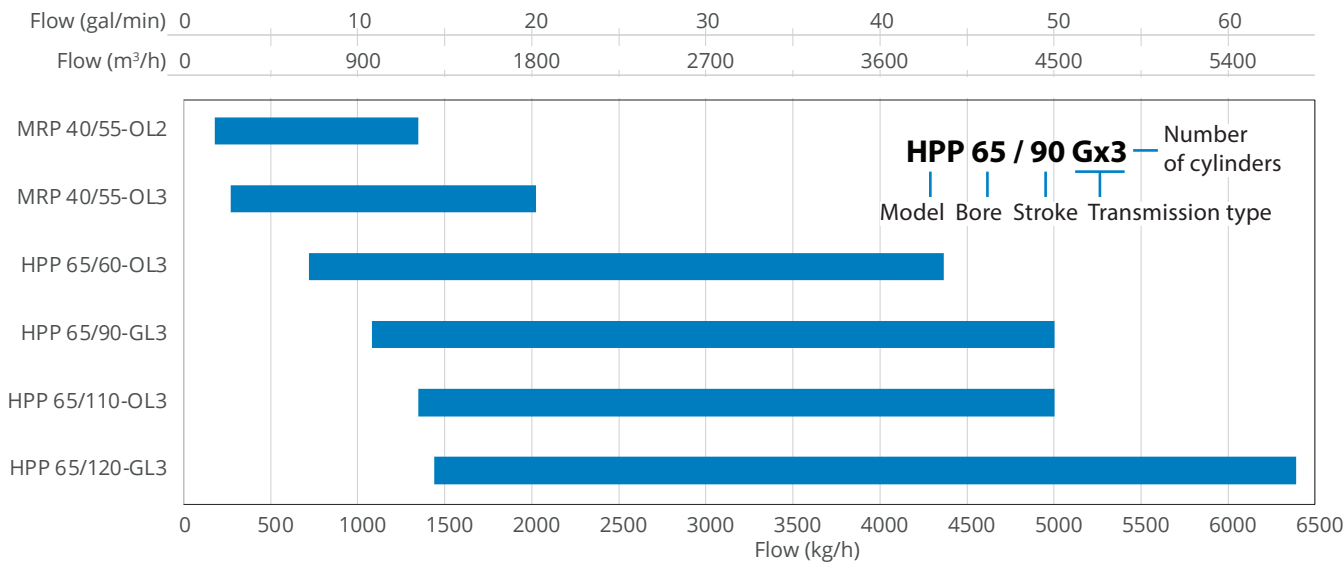
40 years of experience
in every pump...

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.



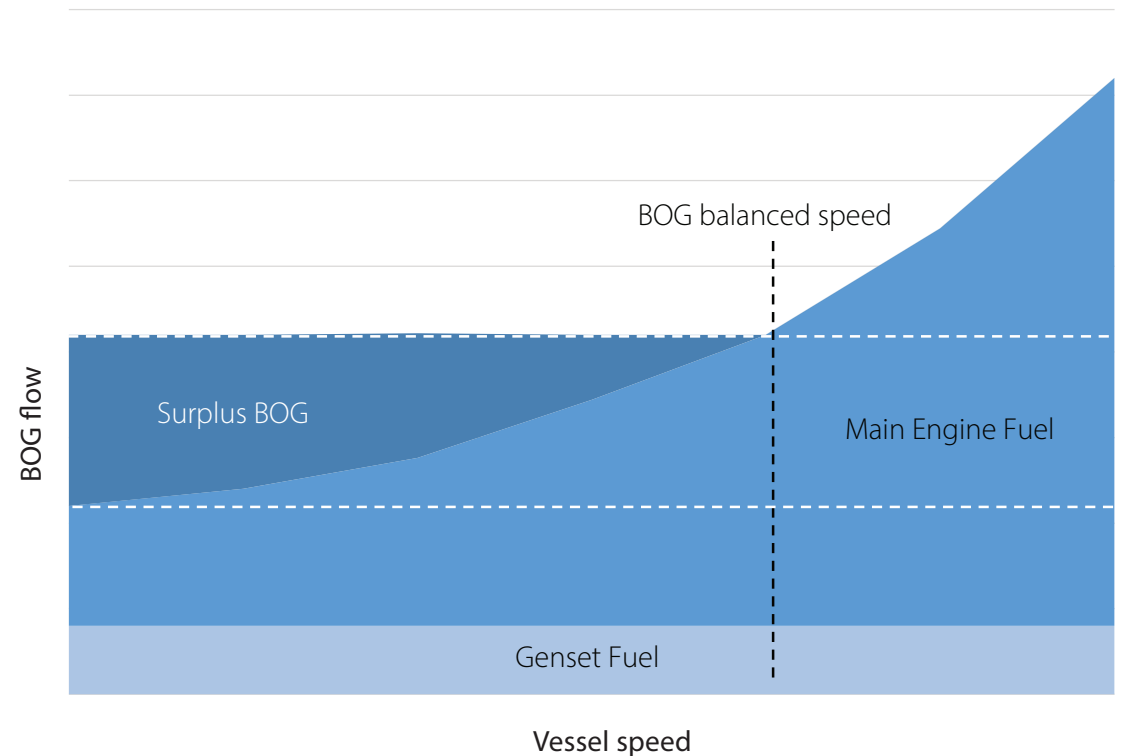
Triplex
reciprocating pump

BOIL-OFF GAS MANAGEMENT

Managing the boil-off gas on any liquefied gas carrier is fundamental to achieve both commercial and environmental goals.

Much of the vessel's life will be spent navigating at slower than the BOG balanced speed, resulting in surplus BOG, which if disposed of in a GCU, represent a both a financial loss and an unnecessary impact on the environment.

Choosing Reliquefaction requires **higher power consumption** due to the required BOG compression and gas phase change, while **Subcooling** of the LNG avoids this and **does not impact the design** of fuel gas machinery





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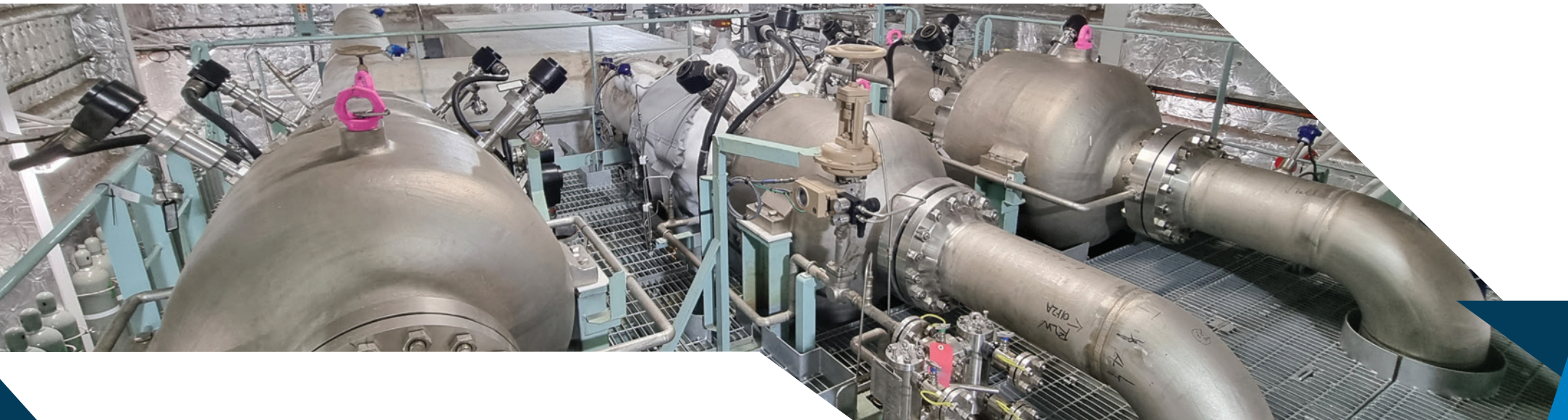
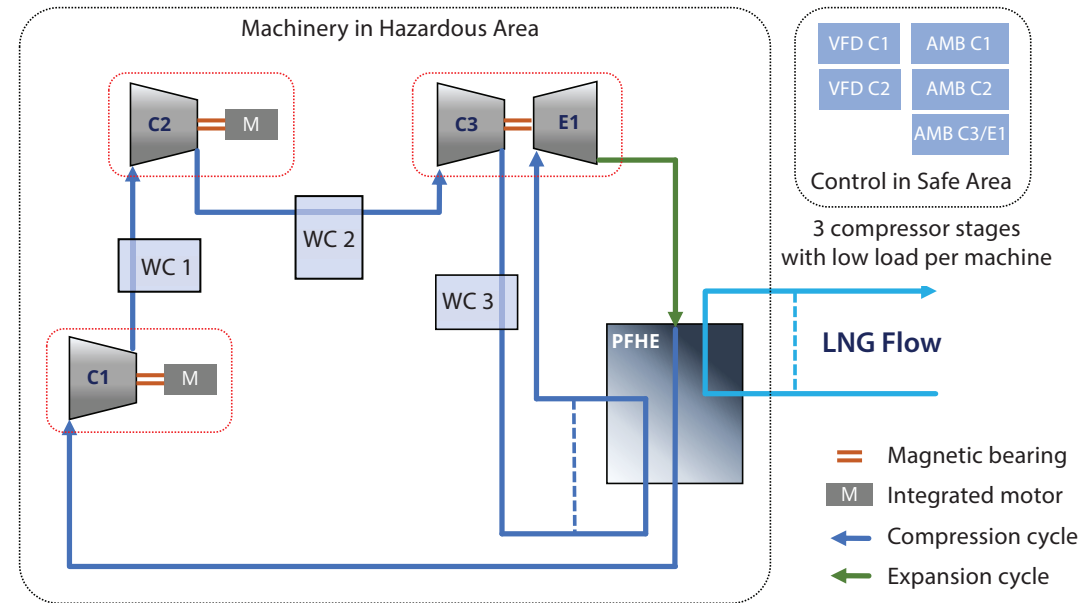
EcoChill

EcoChill provides a perfect opportunity to benefit from dealing with BOG by introducing subcooled LNG to the tank via spray headers or lower return lines. The cold power produced in the plant is transferred to a stream of LNG circulated from the tank. This cold in turn offsets some of the tank's natural heat in-leak.

A simple arrangement of machinery achieves this task within a very compact skid. A range of models are available suitable from LNG Bunker vessels to full-sized LNG carriers.

Turbomachinery installed uses Active Magnetic Bearing technology, making the system totally oilfree, hermetic and virtually maintenance-free.

Water intercoolers maximise efficiency, while an APFHE (aluminium plate fin heat exchanger) provides the means to transfer the cold directly to the LNG.



CARING FOR YOUR EQUIPMENT FOR 50 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 parts kits ensure that no critical parts are missing during this time-pressured period off-hire. Routine and major servicing can be handled by our large team of technical experts 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 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.

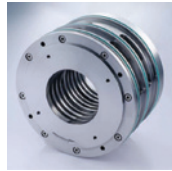




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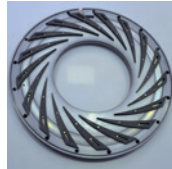
PREMIUM TECHNOLOGY IS OUR STANDARD

When designing our machines, the best possible materials and components are sourced. Sophisticated tools are used to analyse 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.



GAS SEALS

Especially developed, together with a major sealing supplier, CRYOSTAR uses the latest technology to minimise sealgas consumption while maintaining the safety of a gas tight seal.



FLOW CONTROL

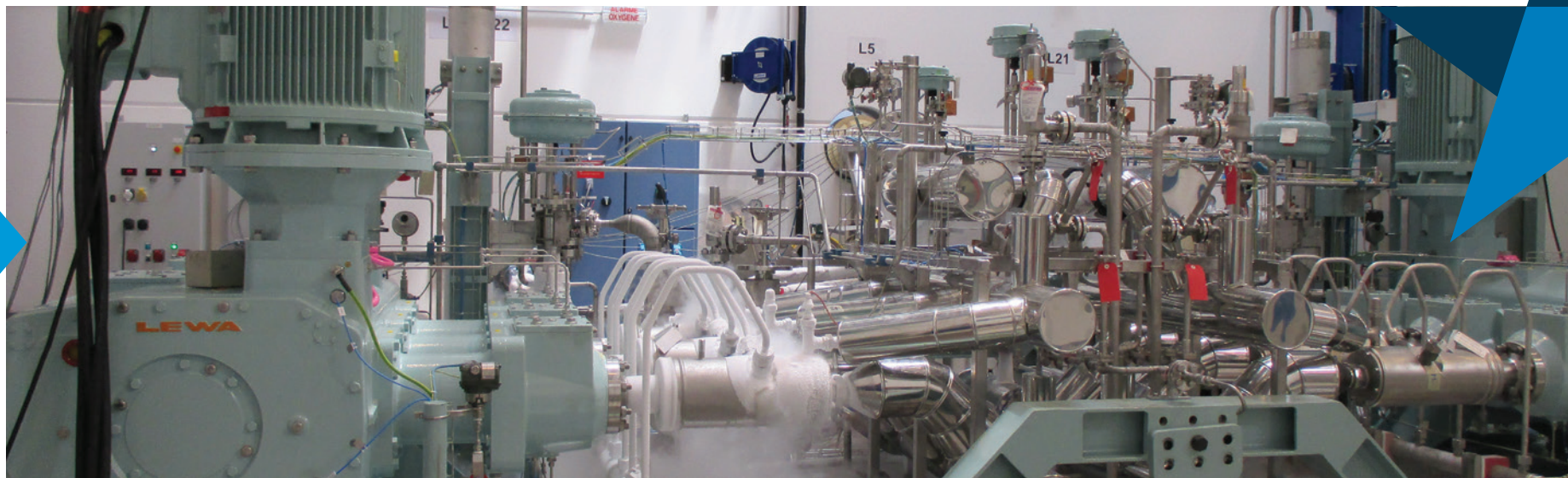
To provide the smoothest stepless flow control, Variable Diffuser Vanes are used. These systems are applied to thousands of our machines.



HIGH-SPEED BEARINGS

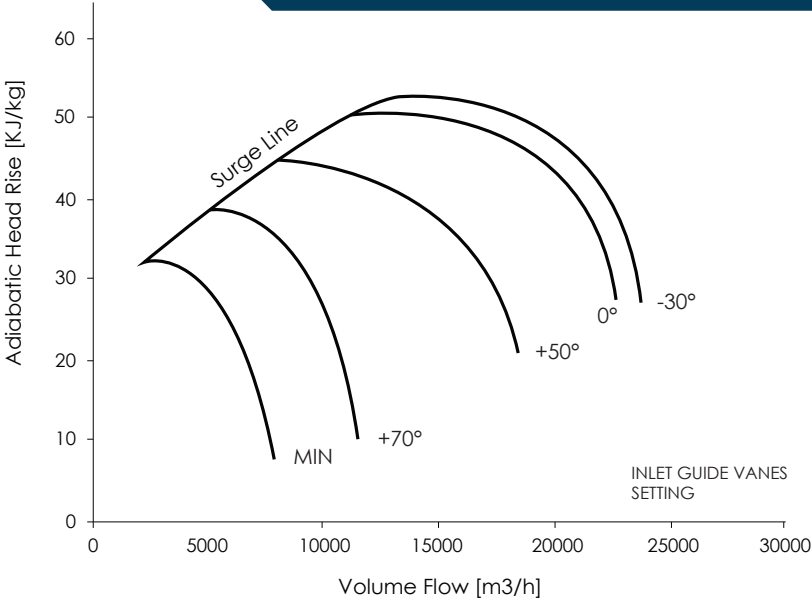
To allow long service intervals with the best possible performance, tilting pad bearings are utilised in all our high speed turbomachinery gearboxes.

*Reciprocating
pump Factory
Acceptance Test*

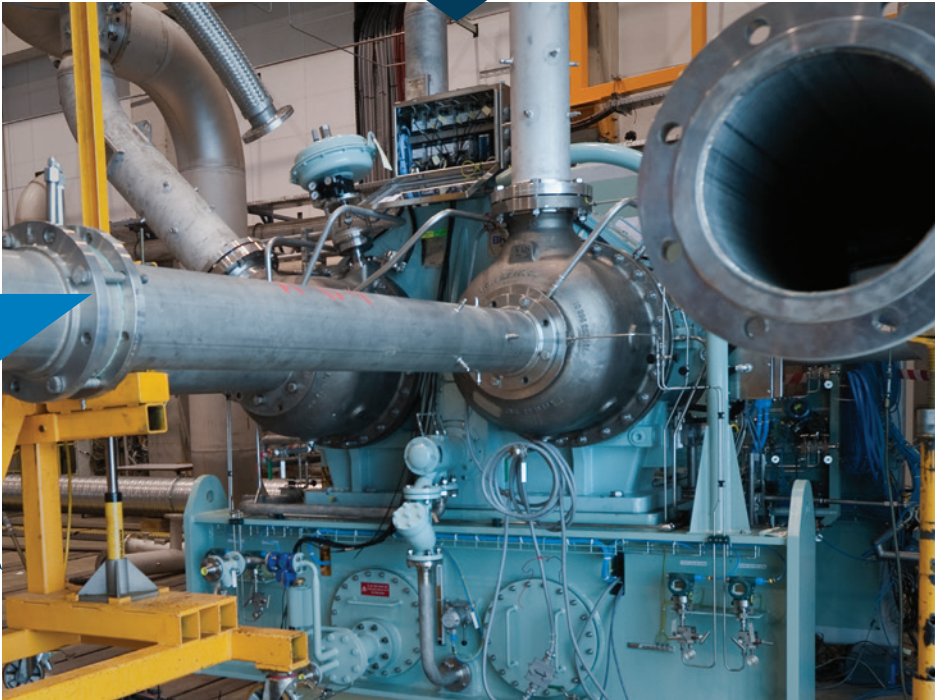


LANDBASED BOG COMPRESSORS AND BLOWERS

LNG Receiving Terminals are equipped with blowers to balance the gas volumes when LNG carriers unload. These machines are derivatives of the similar machines installed on the carriers themselves. Built to different regulations, they benefit from the rugged reliability provided by the on-board machines.



Multi-stage BOG compressor



Single stage return gas blower



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BRAZIL

CHINA

FRANCE

INDIA

SINGAPORE

UK

USA

For contact and address of the CRYOSTAR
locations worldwide, please go to
www.cryostar.com/locations

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