

FRAMO SUBMERGED LIQUEFIED GAS PUMP

Together for sustainable shipping



50 years of pump expertise now available to LNG applications

For over half a century, Framo has partnered with the marine industry, delivering reliable and environmentally sustainable pumping solutions. Based in Bergen, Norway, our world-leading pump technology has revolutionised marine cargo pumping.

Framo hydraulically driven submerged cargo pumps provide safe, efficient and flexible cargo handling of any type of liquid cargo. Improved cargo handling performance gives quicker turnaround time, more ton-miles, and fewer voyages in ballast.

Our pumps have earned a reputation as the most reliable and efficient solution available, ensuring safe and uninterrupted vessel operation while at the same time supporting sustainable shipping.

Framo SLG pump sets a new standard

As pioneers and leaders in marine pumping systems, Framo continues to set the benchmark for performance and reliability. Leveraging five decades of invaluable expertise, the Framo Submerged Liquefied Gas pump is a fully submerged centrifugal pump meticulously designed for LNG applications.

With a fail-safe design ensuring reliable fuel supply and cargo discharge, the Framo SLG pump sets a new standard in marine pumping technology, reinforcing our commitment to driving efficiency and sustainability in the maritime industry.

Navigating challenges of handling liquefied gases

Operating temperatures as low as -195°C place special design demands on a submerged pump. For example, the poor lubricating properties of liquefied gases expose the motor shaft bearings to premature failure, necessitating specialised design considerations.

Another challenge is heat. Liquid gas fuel is typically stored right below the liquid's vapor temperature, making it highly volatile to excess heat. Therefore, it's crucial to design the pump's cooling system to minimise heat transfer to its surroundings. The Framo SLG pump directly tackles this issue. By ingeniously using process flow for cooling, the SLG pump effectively prevents heat transfer to the stored fuel, ensuring safe and efficient operations.

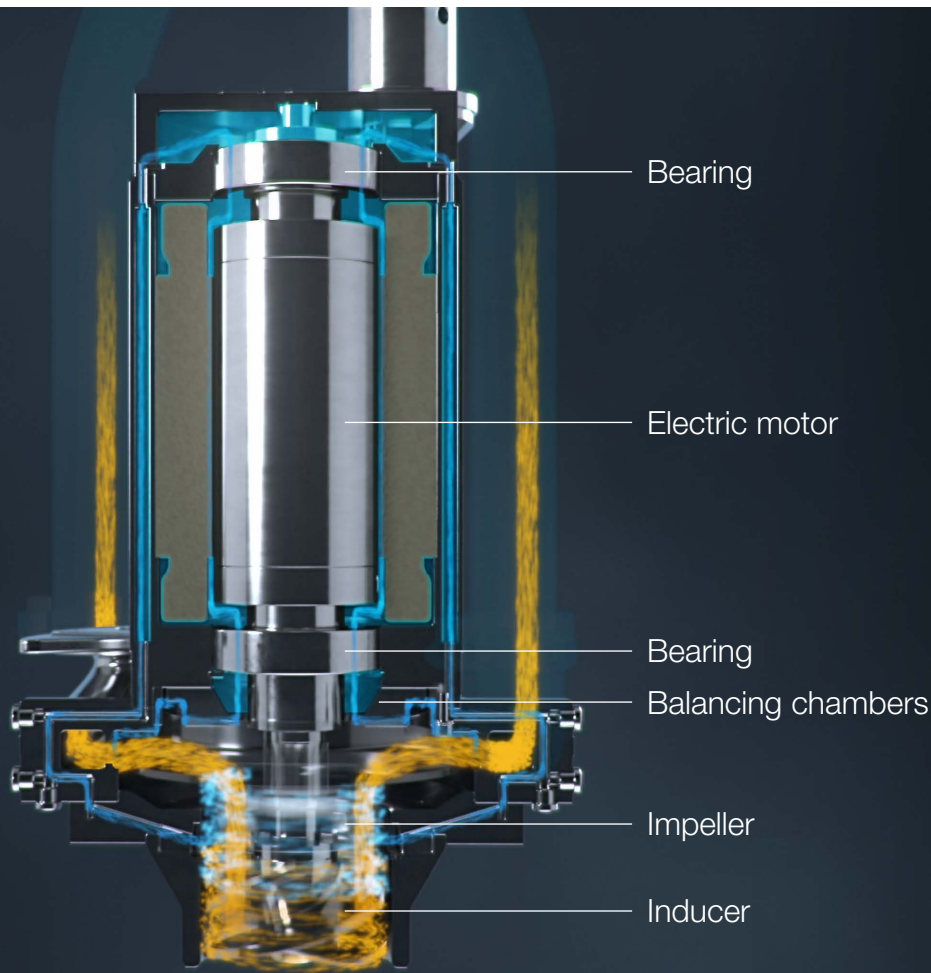


Supporting the alternative fuel transition

As the maritime industry shifts towards sustainable practices, Framo is at the forefront, championing the transition to alternative fuels. With a strong focus on carbon neutrality and emission control, we're leading the way in embracing sustainable solutions.

Since 2022, Framo has been a significant player in the methanol dual fuel segment, with plans to cover all future fuels. Leveraging nearly a century of experience and over 80,000 pumps, we've developed innovative solutions like the SLG pump for LNG fuel applications and are pioneering electric pumps for ammonia.

Recognising the need for net-zero fuels, we're committed to advancing technologies that reduce greenhouse gas and carbon dioxide emissions. From onboard CO₂ capture to liquid CO₂ pumping systems, Framo is dedicated to driving sustainability in the maritime industry.



FRAMO SUBMERGED LIQUEFIED GAS PUMP

Framo SLG pump design philosophy

Framo's new submerged electric liquid gas fuel pump combines our expertise in hydraulic submerged cargo pumps and electric seawater lift pumps into a single, efficient design.

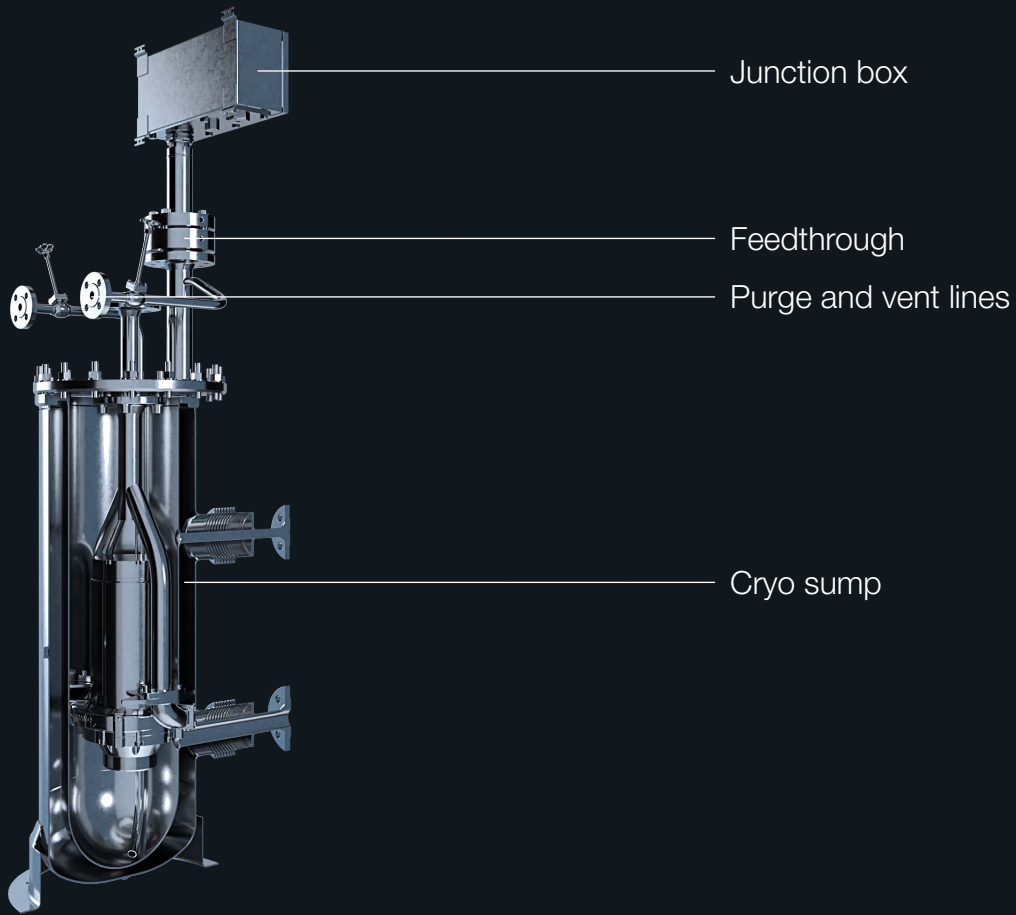
All external connections are located on the top plate of the pump, from which the pump is suspended during operation. The pipe stack integrates the fuel discharge pipe and power transmission into one component, eliminating the need for hanging electric cables and providing mechanical protection for the integral power transmission. Additionally, the pump and pipe stack are enclosed by a caisson pipe, which further reduces mechanical strain on the pump components caused by sloshing. The caisson pipe also significantly reduces the need for radial fixed supports in the tank walls.

With no seals, the entire pump operates fully immersed. The rotating assembly is thrust-

balanced by continuously adjusting the allowed wear ring leak flow and pressure loss. The same flow is used to cool the electric motor before returning to the suction side of the pump. The generation of boil-off gas is further reduced by fitting a highly efficient, custom-built electric induction motor. The Framo SLG pump is versatile, fitting seamlessly into any tank configuration.

Pump head

The SLG features an optimised flow path, striking the ideal balance between stage count and overall system efficiency. Leveraging our renowned double volute configuration



enhances efficiency during off-design operation. The optimised inducer significantly reduces suction cavitation and the NPSH requirement. The compact design reduces cryo sump height requirements, thus minimising head space.

Motor

Framo SLG pump is powered by a custom-built 400V electric induction motor, utilising a VFD/VSD (Variable Frequency/Speed Drive) to reach its peak rated speed of 7000 rpm. Tested and validated for cryogenic temperatures at the Framo factory, the motor operates with an impressive efficiency of 96% at peak continuous power.

Cooling

In the volatile environment of liquid gas fuel storage, minimising heat transfer is crucial. The Framo SLG pump uses process flow to cool the motor unit, eliminating the need for an external cooling mechanism. Pressurised flow over the wear rings is directed into the motor, dissipating heat in the air gap between the stator and rotor. This cooled flow is then returned to impeller suction side via a conduit, maximising heat transfer out of the tank through the discharge flow. At peak power, only a fraction of generated heat is transferred into the tank.



TEM (Thrust Equalising Mechanism)

Operating at a minimum temperature of -196°C , traditional lubricants are inadequate for the Framo SLG's needs. Given the poor lubricating properties of liquid gases and the fully submerged rotating assembly, motor shaft bearings face the risk of premature failure. Our dynamic TEM maintains the equilibrium of thrust forces by manipulating pressure loss over wear rings and a balancing orifice. This ensures longevity and reliability throughout the SLG's lifetime.

Particle straining

The Framo SLG pump features a robust particle straining system to guard against pollution. Starting with a first barrier strainer at the suction or suction line, followed by a second barrier centrifugal separation, and finally, a third barrier wear ring gap. This layered approach ensures protection from clogging or erosion, maintaining smooth operation.

Pipe stack and power transmission

Our versatile pipe stack assembly, with sections spanning 1 m to 6 m, features three conductor rods spaced at 120-degree intervals. The conductors and their protective pipe are allowed to move axially independently of the fuel discharge pipe, countering differing temperature gradients. The fuel discharge pipes are flanged, while the conductor pipe has a male/female sliding connection. The three conductors have spring-loaded male/female stab-in connectors on each end, ensuring a stable and reliable phase connection. Similar connections are used to terminate the conductors to the motor and feedthrough.

Top plate connections

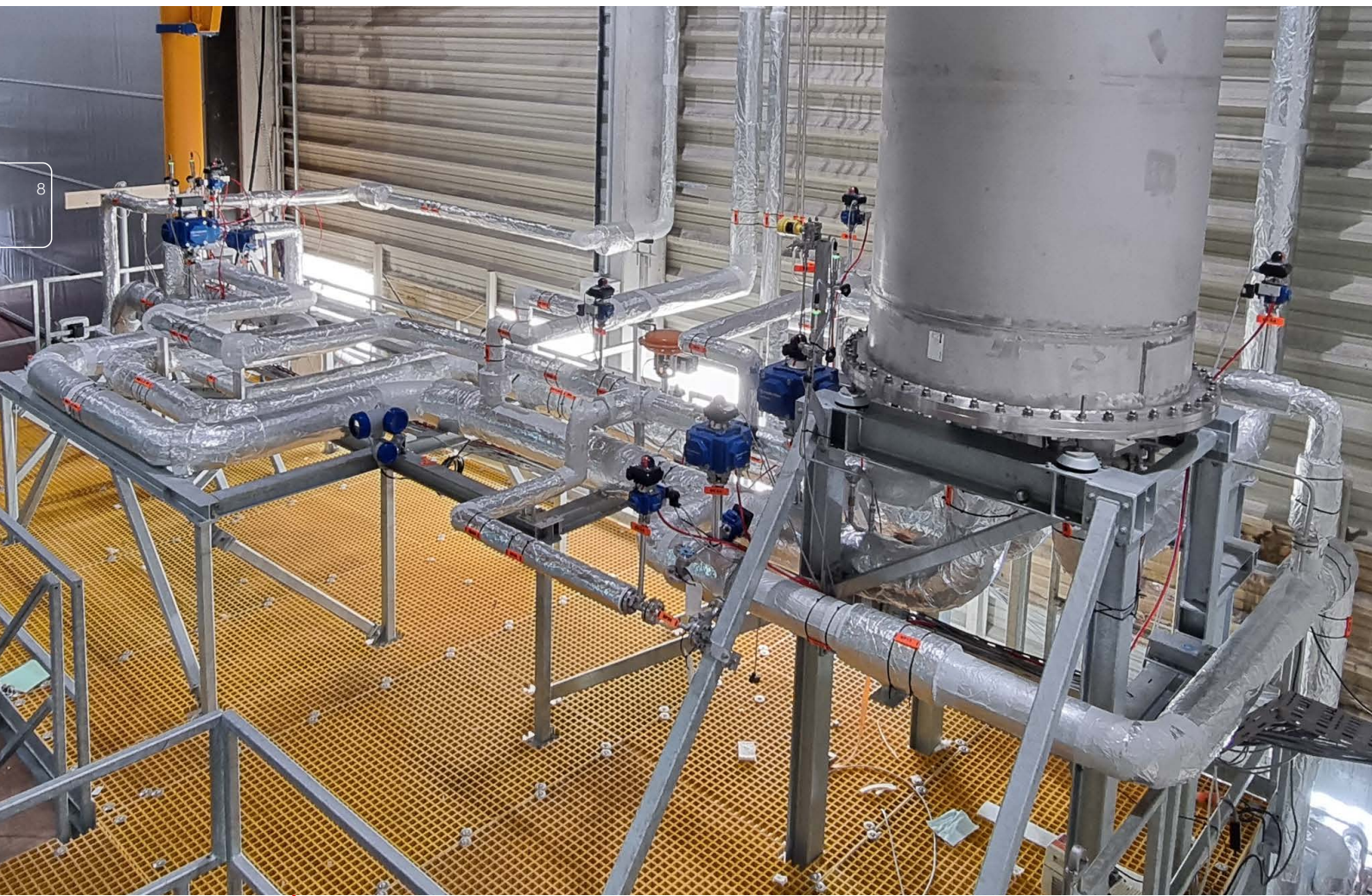
All pump operation connections, including discharge flange, power transmission feedthrough, and junction box, are located on



the top plate. Additional connections, like purge/vent lines and instrumentation, can be added upon request, reducing tank penetrations. Junction box and feedthrough meet IP, IEC, Atex, Ex, and class requirements.

Cryo sump

For in-line or tank connection space (TCS) mounting, Framo supplies a vacuum-insulated cryo sump with foil insulation to significantly reduce thermal losses. Its top cover consolidates all connections for easy access. all connections for easy access.



FRAMO SUBMERGED LIQUEFIED GAS PUMP

Development, production, and testing

Materials

All pump, pipe stack and top plate materials are selected for their superior characteristics at extreme low temperatures. Components are predominantly crafted from 316 stainless steel, with wear rings made of aluminium bronze CC333G, and power transmission conducted via aluminium rods. Insulation and spacer pieces, designed for insulation, primarily consist of PTFE and PEEK materials.

Maintenance

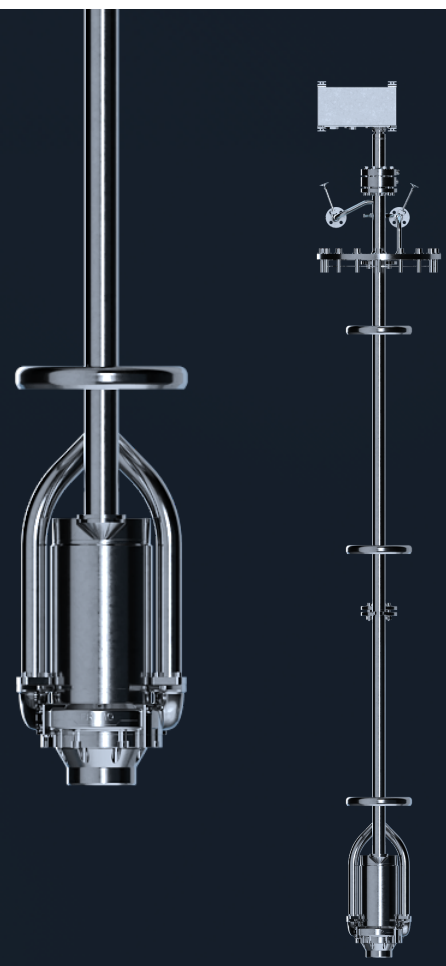
Under normal operating conditions, the Framo SLG Pump requires servicing every 25,000 operating hours or every 5 years, aligning with vessel dry dock schedules. During maintenance, the pump undergoes disassembly and inspection, with minimal parts requiring replacement. Bearings are replaced every 5 years, while wear rings are replaced every 5–10 years based on their condition. Framo SLG pumps are seamlessly integrated into our existing service programme, which boasts service offices and technicians located worldwide.

SLG 25-2/4S

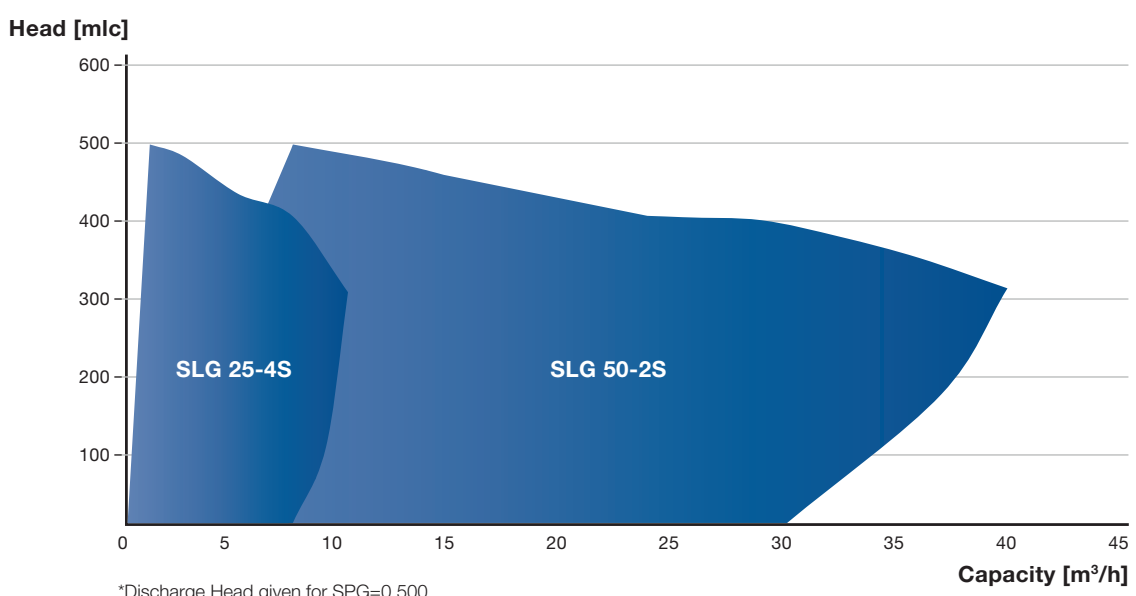
Capacity: 1–10 m³/h
Discharge pressure: 10–20 Bar
Rated continuous peak power: 15 kW
Number of stages: 2–4

SLG 50-1/2S

Capacity: 7.5–40 m³/h
Discharge pressure: 10–20 Bar
Rated continuous peak power: 50 kW
Number of stages: 1 or 2



Pump performance curve



*Discharge Head given for SPG=0.500



OUR COMPANY

A partner to rely on

Since 1938, Framo has upheld a tradition of in-house development, production, and testing for all our products. Our factories stand as symbols of excellence, meticulously designed to ensure efficient and high-performing production processes.

We're dedicated to seamlessly integrating our new liquid gas pumps into our existing facilities and production lines. To support this, we've constructed a cutting-edge liquid gas test loop, capable of conducting both prototype and production testing. Scalable and adaptable, this test loop is poised to accommodate future pump designs as we continue to innovate.



24/7 support

With over half a century of experience Framo AS service organisation provides technical support during the installation phase of a project, as well as professional service throughout the lifetime of the vessels. Condition-based maintenance and correct operation are the best ways of ensuring optimal equipment performance. The Framo service organisation is here to support you 24/7.

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