MAN Cryo
LNG onshore and offshore bunker systems

Engineering the Future – since 1758.
MAN Diesel & Turbo
From February 2016, MAN Cryo – formerly known as Cryo AB – became a product brand of MAN Diesel & Turbo. With MAN Cryo, MAN Diesel & Turbo situated in Gothenburg, Sweden, is one of the world’s leading manufacturers of cryogenic equipment for the storage, distribution and handling of Liquefied Natural Gases (LNG).

For more than 50 years Cryo AB has put skills and advanced technology at the service of the gas industry. As such, MAN Cryo products are available for demanding marine and industrial gas companies when it comes to selecting the most efficient and economical cryogenic equipment for marine gas fuel systems as well as for offshore and onshore bunkering systems.

MAN Diesel & Turbo is the world’s leading provider of large-bore diesel engines and turbomachinery. Our product portfolio includes two-stroke and four-stroke engines for marine and stationary applications, turbochargers and propellers, as well as gas and steam turbines, compressors and chemical reactors.

MAN solutions can be found in ship propulsion, engine-based power plants and turbomachinery trains for the oil & gas and process industries. We support our global customers with a comprehensive range of after-sales services under the MAN PrimeServ brand.
Introduction to LNG as a Marine Fuel
Fuelling for tomorrow – MAN Cryo

Over decades, marine fuels suppliers have developed an excellent global infrastructure for ship bunkering of traditional marine fuels such as Heavy Fuel Oil (HFO) in addition to Marine Gas Oil (MGO) and Marine Diesel Oil (MDO). It has practically become a tradition to use heavy fossil fuel for the marine industry. Nowadays, new international regulations are forcing ship owners to move away from this tradition.

Due to the new IMO Annex VI legislation effective from 1 January 2015 for Sulfur Emission Control Areas (SECA), new abatement technologies will have to be implemented.

Liquefied Natural Gas (LNG) has proven to be valuable since the year 2000 and is an environmentally attractive alternative for ship owners. It is always available and meets future legislative emission requirements.

LNG is natural gas liquefied at a very low temperature (-163 °C) in order to store the gas in larger quantities (approx. factor 600). In fact, from a distribution point of view, it is possible to “transport more gas by not transporting gas”.

With the MAN Cryo product brand, formerly known as Cryo AB, MAN Diesel & Turbo, is one of the world’s leading manufacturers of cryogenic equipment for the storage, transportation and handling of liquefied gases.

Additionally, MAN Diesel & Turbo has broad MAN Cryo experience in engineering, procurement and construction (EPC) services for both onshore and offshore applications. The portfolio includes marine LNG fuel gas systems with more than 30 systems operating today, LNG bunkering systems for bunker vessels and LNG bunkering systems for onshore installation.
Two different MAN Cryo bunkering concepts have been developed for the safe and environmentally friendly supply of LNG to the maritime client.

Onshore bunker system

A high degree of standardisation and flexibility in the different operational modes allows for speedy project execution and safe installation on-site. The installation of the process equipment is facilitated by modules prefabricated in our own production facility in Gothenburg.

The basic design is a two-mode system, including LNG import by LNG truck, storage in vacuum-insulated storage tanks and export to the LNG-fuelled ship.

The truck unloading bay of onshore bunker terminals is designed for safe and reliable operation in order to avoid possible operational errors.

In addition to a basic version, the onshore bunker system can be adjusted to handle:
- LNG import from an LNG tanker
- LNG import from a train
- LNG import from an LNG-fuelled ship
- LNG export to LNG containers
- LNG export to a bunker ship

The standard concept of the onshore bunker system includes:
- High-flexibility hose
- Safety break-away coupling ensuring a safe and quick disconnection of the hose in case of unexpected movement of the vehicle
- A reliable and fast connection of the vehicle with the system
- Ship-to-shore safety system

After proper connection of the hose to the LNG vehicle, the transfer of LNG takes place with a flow rate of up to typically 35 m³ per hour, with a pressure of up to nine bar.

The LNG will be stored in pressurised and vacuum-insulated storage tanks in order to control the boil-off gas. Larger storage tanks of up to 2,000 m³ provide a cost-effective storage solution compared to smaller tanks. Therefore, a modular increase of the storage capacity allows for a moderate investment in the early stage of the onshore bunker terminal. The possibility to increase or even decrease the LNG storage capacity according to the client’s demand is an advantage compared to fixed installations such as flat-bottom tanks, thereby reducing the overall investment risk.
For safe operation of the onshore bunker system, a cost-effective boil-off gas handling system is required. Such boil-off gas is normally generated during loading in the idle period of the bunker terminal.

The pressurisation of LNG allows heat increase to the system for a certain time without outtake. The saturated pressure of the stored LNG will increase if no LNG send-out takes place to the client. Safe control of the energy input to the system can be realised by the external cooling source liquefied nitrogen (LIN, -194 °C).

The heat and cold transfer, respectively, from LIN to the medium takes place in the vacuum-insulated pressurised storage tanks. Two different methods have been developed: The installations can either sub-cool LNG directly in order to lower the saturated pressure and reduce the flash gas significantly, or the gas will be recondensed directly in the gas phase of the vacuum-insulated storage tank.

The export of LNG to the end customer takes place at the quay, pontoon or jetty. The system includes a skid unit that contains:
- Valves
- Instruments
- Loading hose system
- Drop-free couplings
- Breakaway couplings

A manually operated crane, supplied with a breakaway coupling, can be optionally installed to safely handle the hose.

The loading rate from the onshore bunker system is typically in the range from 50 to 500 m³/hour. The export pumps are situated in a pump skid unit near or below the tanks.

The onshore bunker system is designed according to the standards EN 13645, EN 13648, EN 1160 and also the latest developed ship/shore standards created by SIGGTO.
**Offshore bunker system**

Two different concepts have been developed for offshore bunkering. A pressurised system has been designed for LNG supply up to 300 m³. For supply in larger quantities, a pump system has been designed.

**Pressurised bunker system**

The pressurised offshore bunker system concept follows the idea of minimising maintenance on key units such as rotating equipment. LNG is transferred to the customer by increasing the pressure in the IMO C-Type tank. Pressure build-up units (PBU) ensure the necessary pressure level. The required energy comes from the waste heat of the ship’s engines. The process unit as well as the instrumentation and automation are installed in the “coldbox” and receive constant ventilation. This concept has been deployed in the LNG bunker vessel SeaGas.

**Bunker ship with pump system**

Supply of larger quantities of LNG to clients requires a higher flow rate during bunkering. The LNG is stored in horizontal or vertical C-Type tanks that are either vacuum insulated or externally insulated, depending on the holding time of the bunker ship. The storage capacity is designed for tanks of up to 1,000 m³. Submerged pumps, installed in C-Type tanks, transfer the LNG to the customer.

Boil-off gas is generated during loading of the C-Type tanks or during the holding time. MAN Cryo can adjust the boil-off gas handling system to the customer’s needs. Typically, the boil-off gas is consumed by the ship’s engine. Boil-off gas compressors provide the required pressure level.
In addition to its role as provider for LNG-based propulsion systems – and by means of the MAN Cyro products, MAN Diesel & Turbo now also designs and manufactures much of the core cryogenic equipment installed in the onshore and offshore bunker systems.

**Large vacuum-insulated, pressurised storage tanks**

LNG can be stored in large vacuum-insulated and pressurised storage tanks in order to reduce storage costs. MAN Cryo storage tank solutions have been developed for onshore installation with a capacity of up to 2,000 m³ per tank, with a pressure of up to 8 bar.

**Vacuum-insulated IMO C-Type tanks**

A long-standing record exists in the design and manufacturing of MAN Cryo vacuum-insulated IMO C-Type tanks with capacities of up to 450 m³. The tanks can be installed either horizontally or vertically in the LNG fuelling vessel.

**Centrifugal Pumps**

Stationary centrifugal pumps are used to transfer LNG to the customer. These pumps fill low-, medium- or high-pressure tanks at a high flow rate. Fully skidded unit-mounted systems with control panel are available if a turnkey pumping system is required.

Pumps are supplied with all safety devices according to ATEX or IECEx requirements depending on the country of installation.
Basic engineering by Bomin Linde
In 2013, Cryo AB, now branded as MAN Cryo, and Bomin Linde LNG teamed up to develop the standardised bunker terminal concept. The basic engineering comprises the evaluation of the locations in Rotterdam, Hamburg and Bremerhaven with unloading facility at the jetty, unloading line, vacuum-insulated and pressurised storage tanks, process units (cryogenic centrifugal pumps), truck loading bay, control system, and firefighting system.

Ågotsnes, Norway
In 2003, MAN Cryo, the former Cryo AB, designed and installed the first LNG bunkering terminal in Norway. The core equipment of the system is a vacuum-insulated storage tank for 200 tons of LNG manufactured in our own production facility in Gothenburg. The LNG is transferred by a cryogenic pump with a flow rate of 100 m³/hr. to the refuelled vessel. The installation was performed with a Cryo AB team.

SeaGas
In 2012, The Linde Group delivered the first LNG bunker vessel of its kind in the Baltic Sea, the SeaGas.

The entire cryogenic system comprising vacuum-insulated storage tank, the attached coldbox with pressure build-up units and required E&I installation were designed and manufactured by today’s MAN Cryo in our own production facility in Gothenburg.

From the location at Loudden in Stockholm, the vessel provides 60–70 tons of LNG in approximately 45 min. to the ferry M/S Viking Grace on a daily basis, while the ferry is moored at Stadsgården in Stockholm.

The system works without rotating equipment. Pressure build-up units increase the pressure in the vacuum-insulated tank up to 18 bar in order to transfer the LNG to the customer. The fuelling process takes less than an hour and is done from ship to ship.

The interface between “ship to ship” or “truck to ship” is designed to avoid any escape of LNG/NG to the atmosphere. The project team developed a new quick/non-drip connection to allow smooth and easy handling. The concept is now state-of-the-art.

Safety and services.
The vessel is classified under the same regulations that apply to ocean-going LNG tankers (IMO/IGC by DNV).
MAN Diesel & Turbo offers world-class MAN Cryo gas equipment and, through MAN PrimeServ, after-sales services for the whole lifecycle of its products. After successful installation of the system, MAN PrimeServ thus also provides long-term maintenance and ensures high reliability of the installation.

MAN Diesel & Turbo – with its MAN Cryo product brand since 2016 – develops and delivers high-tech equipment and supporting services for customers in the industrial gases industry. Broad competence, combined with innovative technologies and extensive experience, puts the company in a unique position to provide technical solutions designed to significantly improve its customers’ profitability.

Core competencies:
- Marine fuel gas systems
- Offshore and onshore bunkering systems

Our services comprise:
- On-site assistance (including overhaul inspections, repair and start-up supervision)
- Training and education
- Maintenance and inspection
- Repair works
- Supply of spare parts
- Refurbishments / Upgrades of cryogenic products

Safety and quality – HSE
Process and occupational health, safety and environment considerations (HSE) always have top priority throughout all MAN Cryo project phases, namely engineering, procurement, construction, start-up and operation.
World-Class Service Network
Marine propulsion, gensets, and stationary plants

The PrimeServ offering
The MAN Diesel & Turbo Group offers worldwide, round-the-clock service, 365 days a year. In addition to MAN Diesel & Turbo’s service headquarters in Augsburg, Copenhagen, Frederikshavn, Saint-Nazaire, Hamburg and Stockport, service centers on all continents provide comprehensive and continuous support.

MAN Diesel & Turbo engines are renowned for their quality and durability. We are a global organization with a strong local presence, delivering exceptional field service management, tailor-made solutions, and first-class technical support.

PrimeServ provides advice and assistance to customers throughout the product life cycle, from delivery to resale. With our far-reaching network of service centers, we respond rapidly to customer needs. Furthermore, we offer outstanding service and unrivaled technical expertise. Plus, we only use genuine spare parts – safeguarding the longevity of your equipment.

PrimeServ’s aim is to provide:
- Prompt delivery of high-demand OEM spare parts within 24 hours
- Fast, reliable and competent customer support
- Individually tailored O&M contracts
- Ongoing training and qualification of operators and maintenance staff
- Global service, 24 hours a day, 365 days a year
- Diagnosis and troubleshooting with our high-performance Online Service