

Liquefied Gas Tankers
Offshore Units
LNG Fuel Gas Systems
Naval Architecture



Introduction

TGE Marine Gas Engineering:

- More than 30 years of experience
- An approx. 70% market share of highly sophisticated ethylene carrier segment
- Market leader for small LNG carriers based on type C tank technology
- More than 190 gas tankers supplied with cargo handling systems and cargo tanks
- Patented tank concept for LNG carriers of up to 35,000 m³
- Experience in FSOs, FPSOs and FSRUs (LPG, LNG)
- Competence in innovative LPG and LNG offshore projects
- Design packages for all types of modern gas tankers
- Customised LNG fuel gas systems for merchant and passenger vessels

TGE Marine Gas Engineering GmbH (hereinafter referred to as "TGE Marine") is a market leading engineering contractor for the design and supply of gas handling systems for gas carriers and offshore units. We deliver turnkey solutions (engineering, procurement, and construction supervision (EPCS)) for the storage and handling of cryogenic gases (LNG, Ethylene, LPG, Ammonia) onboard of gas carriers, floating units and merchant ships operating with LNG as fuel. We specialise in the containment system and processing of liquefied gases (these are often both highly toxic and flammable), and are market leader in the ethylene and small LNG carrier segment.

Most of our customers are commercial shipyards which build gas carrier ships. To date, we have supplied gas handling and storage systems to more than 190 gas carriers constructed at more than 20 shipyards across Europe, Asia and South America. Since 1989, we have been operating in China and have supplied gas plants for most gas carriers built for international shipowners.



Strategic goals:

Providing technical excellence at highly competitive prices:

Our two most important goals are technological excellence and execution efficiency in delivering outstanding value to shipyards and shipowners alike.

Capturing new opportunities in LNG and fuel gas systems:

We have committed substantial research and development expenditure toward evolving our core products in order to address new markets (e.g. small LNG carriers and fuel gas systems) and utilise new technologies.



History

TGE Marine was founded in 1980 in Bonn under the name Liquid Gas International Ingenieurgesellschaft GmbH (LGI) by Mr. Horst Schierack and Mr. Vladimir Puklavec. The company was an engineering contractor for the design and supply of gas handling systems for gas carriers which were primarily delivered to small shipyards in northern Germany and Holland. At the end of the 80s the scope of services was extended to cover the onshore cryogenic terminal business. In 1989 the first contract for a gas handling system for the mainland China's first ever gas carrier was

signed with Jiangnan Shipyard Group. Since then TGE Marine has become the dominant engineering contractor for gas handling systems and cargo tanks.

In 1993 LGI was acquired by the Belgian Tractebel Group and renamed Tractebel Gas Engineering GmbH (TGE). With a strong industrial group as shareholder, TGE's business was expanding and at the end of the 90s all gas engineering activities within Tractebel Group were merged with

TGE Group. At the same time the product range was extended to cover LNG storage and logistics systems. During 2005 Tractebel Group decided to divest the contracting entities and TGE proposed an MBO which was concluded in 2007. As a strong financial partner, Caledonia Investments (UK) became the majority shareholder and management controlled 40% of shares. The company was renamed TGE Gas Engineering GmbH and operated with two core business units: Offshore/Gas Carrier and Onshore Terminal & Sto-

rage. In 2007 management decided to demerge the onshore business into a separate company.

At this point the company was renamed again, becoming TGE Marine AG – as the holding company – and TGE Marine Gas Engineering GmbH as its operating counterpart.

In September 2015 Mitsui Engineering & Shipbuilding Co., Ltd. (MES) acquired TGE Marine from Caledonia Investments and Gasfin Investment.

Founded as LGI - Liquid Gas International
Ingenieurgesellschaft GmbH

1980

1993

LGI becomes TGE (Tractebel Gas Engineering GmbH) after acquisition by Tractebel Group

After split of onshore and offshore business TGE becomes TGE Marine AG (holding company)/TGE Marine Gas Engineering GmbH (operating company)

2007

2015

Mitsui Engineering & Shipbuilding Co., Ltd.(MES) acquired TGE Marine from Caledonia Investments and Gasfin Investment



Product Lines

Gas carriers / floating storages

To date TGE Marine has designed and supplied complete cargo handling systems and cargo tanks to more than 190 gas carriers and gas offshore units built at more than 20 shipyards across Europe, Asia, and South America for all major gas shipping companies and pools.

Over the last 15 years TGE Marine has become the industry leader for sophisticated ethylene carriers holding a market share of approx. 70%. Our references include pioneering projects such as

- **30,000 m³ LNG carrier** – the largest LNG carrier with IMO type C cargo tanks under construction

- **Navigator Aurora** – the biggest Ethylene/Ethane carrier to date (35,000 m³)
- **Liberdade** – when delivered in 2003, the LPG FSO for the Bayu-Undan gas field was the world's biggest floating LPG storage solution
- **Coral Methane** – the world's first combined LNG/ethylene carrier with capacity of 7,500 m³ with a dual fuel electric propulsion system
- **Coral Energy** – the world's first direct driven LNG carrier of 15,600 m³
- **16,100 m³ Caribbean FLNG** – the world's first floating liquefaction unit under construction

LNG as fuel

TGE Marine has developed LNG fuel gas systems (FGS) which ensure fuel gas is delivered at conditions and quantities required by ship engines, thus meeting the requirements of environmentally-friendly ship propulsion. Based on its vast experience in supplying IMO type C cargo tanks, TGE Marine can deliver LNG fuel tanks of any size meeting specific customer requirements.

Our references include:

- FGS for “Coral Methane” and “Coral Energy”
- FGS for the conversion of the first Qatari Q-MAX LNG carrier “Rasheeda”
- FGS for the next generation of AIDA cruise ships

TGE Marine’s technical solutions for LNG fuel gas systems can be implemented with 4-stroke or 2-stroke main engines of any size and thanks to a cooperation agreement with MAN Diesel & Turbo also includes delivery of medium-speed dual fuel engines.

Delivering LNG onboard the ship requires new infrastructure for the bunkering industry. TGE Marine’s naval architects and engineers have developed sophisticated designs for new bunker ships and safe LNG transfer systems.





Small-scale LNG

Based on its extensive experience in the design of gas handling systems for Ethylene carriers, TGE Marine has developed cost-efficient and innovative offshore storage and shipping solutions for the evolving small-scale LNG market.

- LNG tankers with IMO type C tanks: “Coral Methane” and “Coral Energy” convincingly demonstrate the advantages of IMO type C tanks as cargo containment systems for small LNG ships due to improved operational flexibility at highly competitive prices. TGE Marine has a patent for the tank support structure of this type of LNG containment system. Ship de-

signs with approval in principle from a classification society are available for LNG carriers up to 30,000 m³ and above with bilobe cargo tanks.

- LNG floating storage units with IMO type C tanks: The advantages of TGE Marine’s design approach for small to medium size floating LNG storages can be used for FSRUs (regasification barges) and FPSOs (LNG production units). TGE Marine carried out a FEED (front end engineering and design) study regarding an LNG import project to the Caribbean islands consisting of two FSRUs plus a shuttle tanker, all with IMO type C tanks.



LNG/LEG/LPG cargo tanks

TGE Marine is a world leading contractor specialising in the fabrication and delivery of cargo tanks for cryogenic gases (LNG, LEG, LPG, Ammonia).

The company has delivered more than 350 cylindrical, bi-lobe or prismatic cargo tanks to shipyards in China, Korea and Europe.





Naval architecture and marine engineering

TGE Marine's naval architects and marine engineers offer sophisticated design packages ranging from feasibility studies to complete sets of class-approved design documents for all types of modern gas tankers.

TGE Marine provides its clients with solid technical expertise and state-of-the-art software tools throughout the entire construction phase.

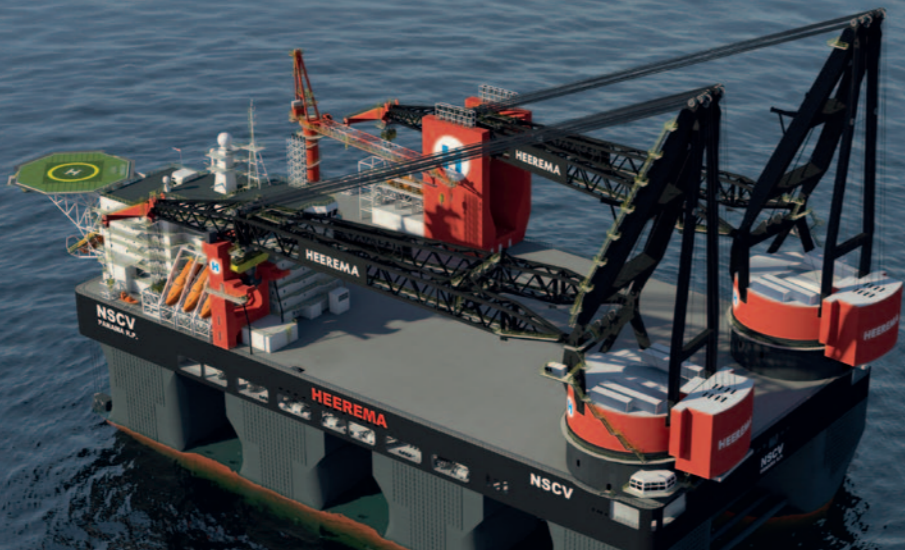
- Ship theoretical evaluations in respect to hydrostatics such as longitudinal strength, intact and damage stability

- Optimisation of principal particulars and ship lines for highly efficient hydrodynamic speed/power performance and low fuel consumption
 - Steel structure classification documents based on finite element calculations
 - Propulsion machinery and auxiliary systems
 - Outfitting and safety systems
-

References

New Semi Submersible Crane Vessel for Heerema, The Netherlands

Shipyard: Sembcorp Marine, Singapore
Year of completion: 2018 (under construction)
Classification: LR
Scope: Low pressure fuel gas system for 4-stroke dual fuel engines with eight vertical foam insulated tanks and four parallel fuel gas processing trains



26,500 dwt ConRo vessel for Crowley Maritime, USA

Shipyard: VT Halter Marine, USA
Year of completion: 2017
Classification: DNV-GL
Scope: High pressure fuel gas system with 3 x 770 m³ vacuum insulated tanks

124,000 GT Cruise vessel for Aida, Germany

Shipyard: Mitsubishi Heavy Industries, Japan
Year of completion: 2016
Classification: DNV-GL
Scope: Fuel gas system for shore gas supply



6,500 m³ LNG Bunker-Vessel for Shell, United Kingdom

Shipyard: STX, Korea
Year of completion: 2016
Classification: LR
Scope: Cargo handling system with cargo tanks, LNG fuel gas system



16,100 m³ Caribbean FLNG for Exmar, Belgium

Shipyard: Wison Offshore & Marine, China
Place of Installation: Columbia
Year of completion: 2016
Classification: BV
Scope: Complete gas handling system with LNG fuel gas system, complete tanks



5,800 m³ LNG bunker vessel for Sirius Veder Gas AB, Sweden/The Netherlands

Shipyard: Royal Bodewes, The Netherlands
Year of completion: 2016
Classification: BV
Scope: Cargo handling system with cargo tanks, LNG fuel gas system



260,000 m³ LNG carrier for Nakilat, Qatar

Shipyard: N-KOM, Qatar
Year of completion: 2015
Classification: ABS
Scope: Skid-fabricated high pressure fuel gas system



30,000 m³ LNG carrier for CNOOC, China

Shipyard: Jiangnan Shipyard Group, China
Year of completion: 2015
Classification: CCS
Scope: Complete gas handling and fuel supply system, cargo tank design and material package

21,000 m³ LEG carrier "Navigator Atlas" for Navigator Gas

Shipyard: Jiangnan Shipyard Group, China
Year of completion: 2014
Classification: DNV-GL
Scope: EPCS-contract, gas handling and fuel supply system, cargo tank design and material package



15,600 m³ LNG carrier "Coral Energy" for Anthony Veder

Shipyard: Meyer Werft, Germany
Year of completion: 2013
Classification: BV
Scope: Complete gas handling and fuel supply system

17,000 m³ Ethylene/LPG carrier for Harpain Shipping, Germany

Shipyard: Meyer Werft, Germany
Year of completion: 2009-2010
Classification: DNV
Scope: EPCS-contract, gas handling system



7,500 m³ LNG/Ethylene/LPG carrier "Coral Methane" for Anthony Veder

Shipyard: Remontowa, Poland
Year of completion: 2009
Classification: BV
Scope: EPCS-contract, gas handling system & cargo tanks, ship design development

95,000 m³ LPG-FSO “Liberdade” for ConocoPhillips (Bayu-Undan gas field)

Shipyard: Samsung Heavy Industries, Korea

Year of completion: 2003

Classification: LR

Scope: EPCS-contract, gas handling system



TGE Marine Gas Engineering GmbH
Mildred-Scheel-Straße 1
53175 Bonn
Germany
Phone: +49 228 50218 0
Fax: +49 228 50218 880
info@tge-marine.com

TGE Marine Gas Engineering Technology (Shanghai) Co. Ltd.
Hang Seng Bank Tower
No. 1000 Lujiazui Ring Road
12th floor, Room 1211
Pudong New Area
Shanghai 200120
P.R. China
Phone: +86 21 6886 2091
Fax: +86 21 5876 0973
shanghai@tge-marine.com