TGE Marine Gas Engineering

LNG Fuel Gas Systeme – Stand der Technik, Praxis & Bunkern

MARIKO Workshop „Alternative Kraftstoffe II"

Company introduction

- TGE Marine Gas Engineering is one of the world's leading engineering contractors specialising in gas carriers, offshore units and LNG fuel gas systems

- Almost 40 years of experience with more than 200 gas carrier and fuel gas systems contracted

- The Group was founded in 1980 as "Liquid Gas International" (LGI) and in 1993, was acquired by Tractebel/Suez operating as "Tractebel Gas Engineering". Since an MBO in 2006 supported by Caledonia Investment and Gasfin Investment, the Group has been called "TGE Marine AG" ("TGE Marine Gas Engineering GmbH").
  In September 2015 Mitsui E&S acquired TGE Marine from Caledonia Investment plc. and Gasfin Investment S.A.

- Shareholder: Mitsui E&S

- Address: Mildred-Scheel-Str. 1, 53175 Bonn, Germany

- Web: www.tge-marine.com

Business activities and expertise

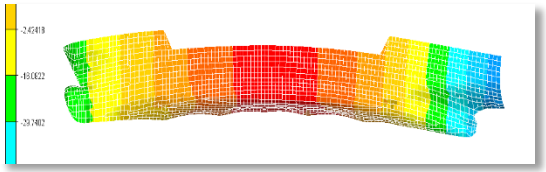
- **Cargo handling systems and tanks for gas carriers**
  - LPG carriers
  - Ethylene carriers
  - LNG carriers
  - LNG bunker vessels

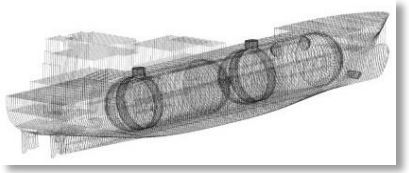
Cargo handling systems & tanks

- **Cargo handling systems for offshore units**
  - FSO / FPSO for LPG
  - FSRU and FPSO for LNG

Key expertise & process know-how

Ship design packages



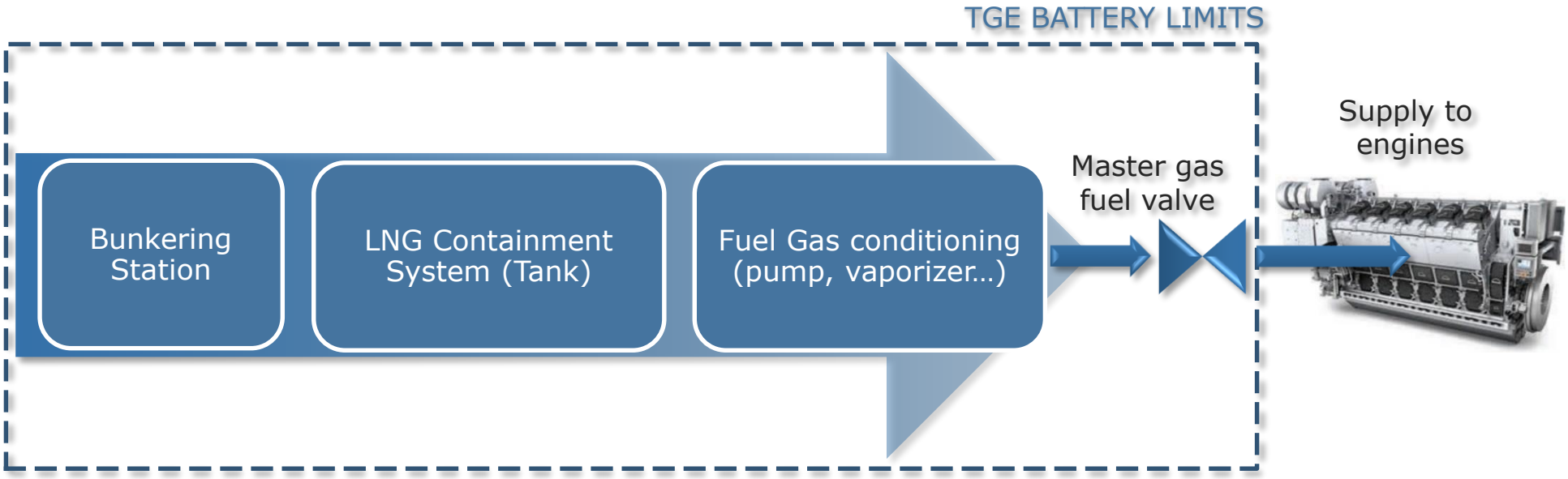


- **Ship design packages**
  - Basic Ship Classification drawings
  - Complete design package including steel drawings

Fuel gas systems

- **Fuel gas systems**
  - Type C LNG tanks or vacuum insulated type
  - Gas processing system

LNG fuel gas systems – basic components



Auxiliary systems:

- Water-glycol heating system
- Inert gas system
- Valve remote operation
- Safety systems
- Automation & control
- Vent
- Hydraulic system and instrument air

LNG as fuel – Engine types

	lean burn spark ignited	dual fuel Otto principle		dual fuel Diesel principle
working principle	4S Otto cycle, external mixing	4S Otto cycle, external mixing	2S Otto cycle, external mixing	2S Diesel, injection after compression
fuel supply pressure	4 – 6 barg	4 – 6 barg	16 barg	150 – 300 barg
ignition	spark plug	pilot fuel injection	pilot fuel injection	pilot fuel injection
fuel	gas only	HFO, MDO, MGO, natural gas	HFO, MDO, MGO, natural gas	HFO, MDO, MGO, natural gas, mix, LPG, Ethane
redundancy	independent gas supply systems	liquid fuel as back-up	liquid fuel as back-up	liquid fuel as back-up
NO_X	Tier III	Tier III (gas mode)	Tier III (gas mode)	well below Tier II, with EGR/SCR Tier III
efficiency	+	+	++	+++
Methane slip	about 1 % ?	less than 3 % ?	?	almost none
fuel quality	MN > 70	MN > 70	MN > 70	no sensitivity
engines	Rolls-Royce, Mitsubishi	MAN 4S, MaK, Wärtsilä 4S	WinGD 2S	MAN ME-GI

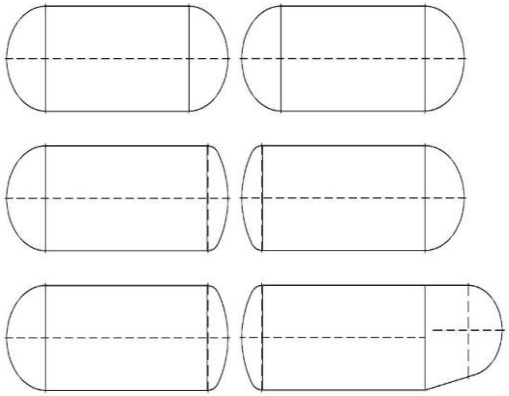
LNG fuel tanks

Tank Type	Design Concept	Max. Design Pressure	2nd Barrier	Dis-Advantages	Advantages
Membrane	Integrated in hull	< 0.25 barg (max. 0.7 barg)	full	Very sensitive against pressure variations; Pressure holding necessary; leakage detection required	Can be adapted to hull shape
Independent Tanks					
Type A	Prismatic	< 0.7 barg	full	Pressure holding necessary; Very voluminous vent system due to low pressure; no references for LNG	Can be adapted to hull shape
Type B	Prismatic Spherical (Moss) (Other shapes)	< 0.7 barg as per design as per design	partly partly partly	Pressure holding necessary; Very voluminous vent system due to low pressure; very few references (no fuel tanks) Pressure holding necessary; Required space bigger than prismatic tank	Can be adapted to hull shape
Type C	Pressure Vessel	> 2.0 barg	no	Required space bigger than prismatic tank	Very solid design; Flexible pressure; Easy installation; No leakages: Little maintenance

Adaption of type C Tank design to Ship Size / Shape

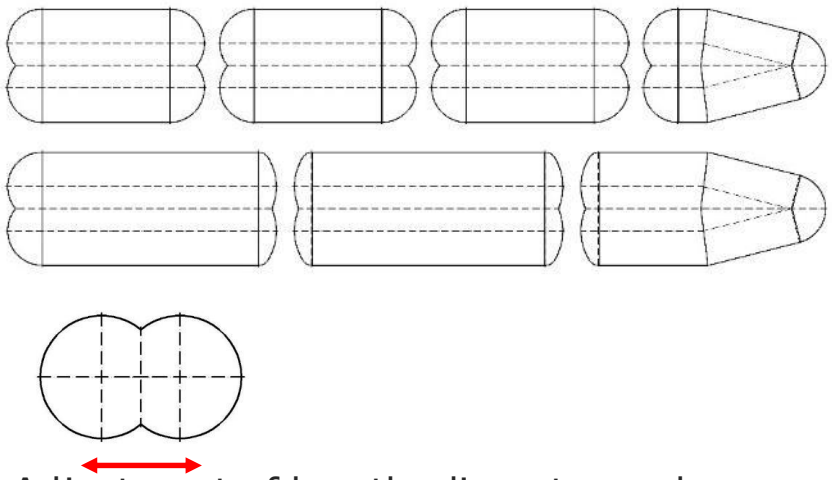
Typical Sizing without restriction for principal dimensions

- Cylindrical tank design



- Adjustment of length and diameter
- Adjustment of heads
  - Hemispherical vs Ellipsoidal
- Adjustment of shape - conical

- Bilobe tank design

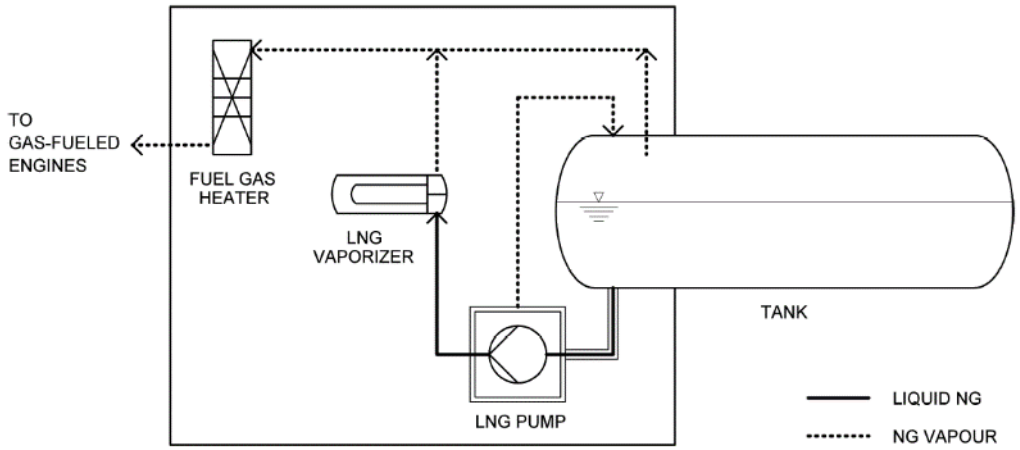


- Adjustment of length, diameter and centreline distance
- Adjustment of heads
  - Hemispherical vs Ellipsoidal
- Adjustment of shape - conical

LNG fuel gas systems – basic components

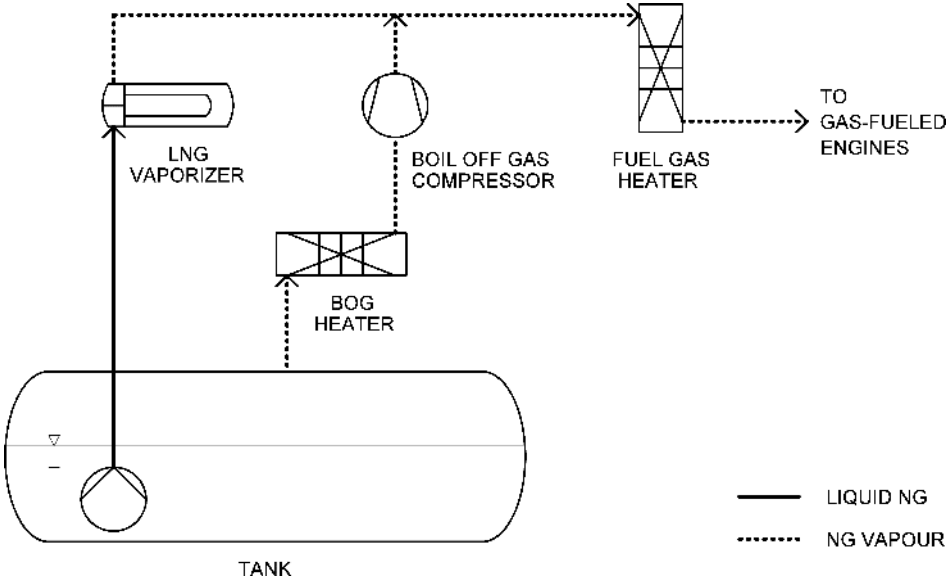
	Small systems for Otto engines	General systems for Otto engines	Systems for Diesel engines
tank/insulation system	vacuum insulated tanks	foam or vacuum insulated type C tanks	foam or vacuum insulated type C tanks
typical tank design pressure	8 – 10 barg	4 barg	4 barg
typical tank operation pressure	6 – 8 barg	0 – 3 barg	0 – 3 barg
pressurizing method	pressure build-up vaporizer or submerged motor pump (bottom outlet)	Submerged motor pump	Submerged motor pump and HP piston pump
BOG handling	Direct vapour supply to engine at high tank pressure (via heater)	BOG compressor may be used to supply BOG to engines	BOG compressor may be used to supply BOG to low pressure consumer (if available)
Special features	All cryogenic components inside tank connection space (TCS)	Flexible arrangement possible	Slip stream of HP pumps adds to BOG and needs to be handled

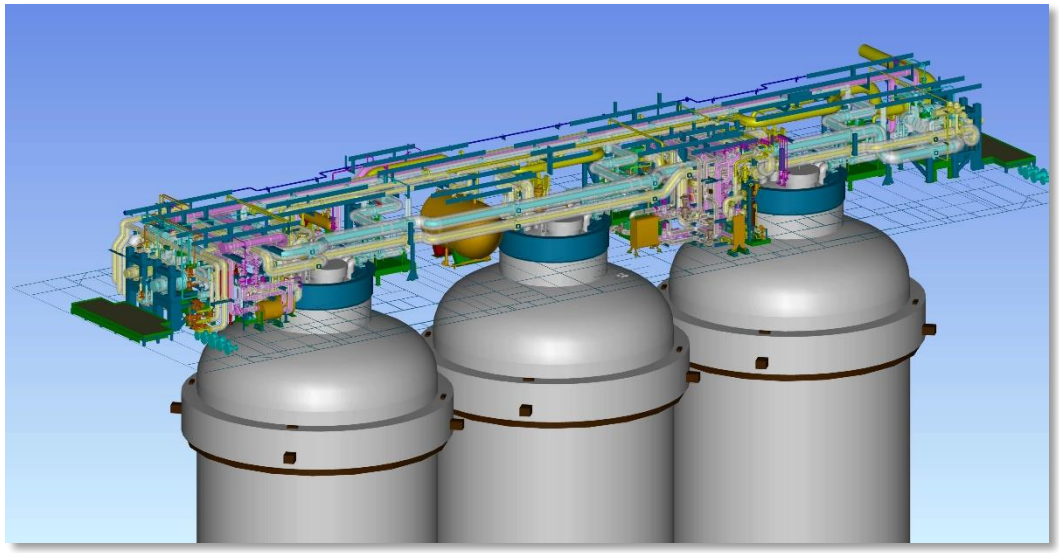
LNG fuel gas systems – vacuum insulated tank with tank connection room



- Highly-efficient vacuum insulation
- Equipment inside “tank connection room”
- Bottom outlet to feed fuel gas pump
- LP LNG pump in barrel for LP engines/consumers
- Tank design pressure 8 to 10 barg
- Tank operation pressure 6 to 8 barg

LNG fuel gas systems – Foam insulated tank for low pressure engines, 4-stroke



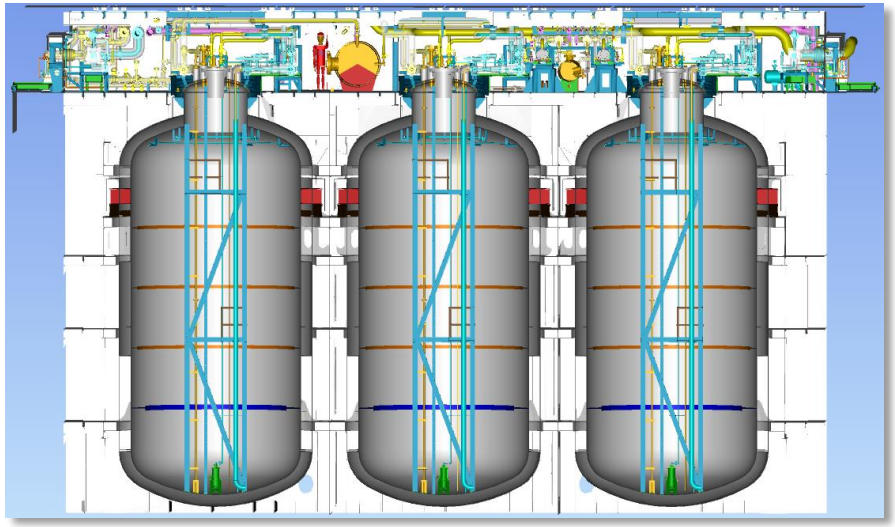


- Type C single shell foam insulated tank
- Pump inside, all outlets on top
- Tank operation pressure 0 to 3 barg
- Tank design pressure about 4 barg
- Equipment in ventilated processing room in flexible arrangement

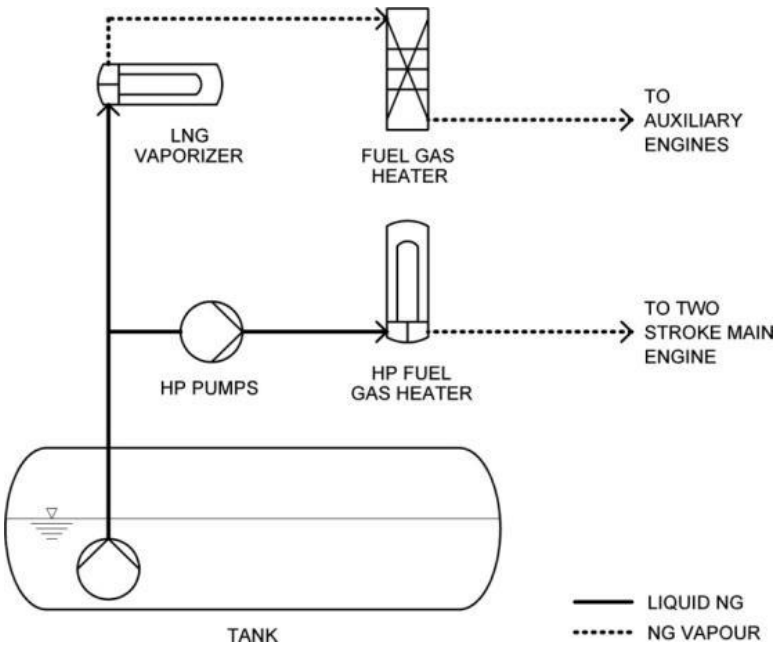
System Example:

4 x 1,400 TEU Container Vessel:

- Owner: Containerships, Finland
- Yard: Guangzhou Wenchong Shipyard, China
- Classification: ABS
- Completion: 2018 (under construction)
- Scope: LNG fuel tanks (foam insulated) and low pressure fuel gas system for WinGD two-stroke dual fuel main engine and four-stroke auxiliary engine



LNG fuel gas systems – high pressure 2-stroke ME plus low pressure 4-stroke AE

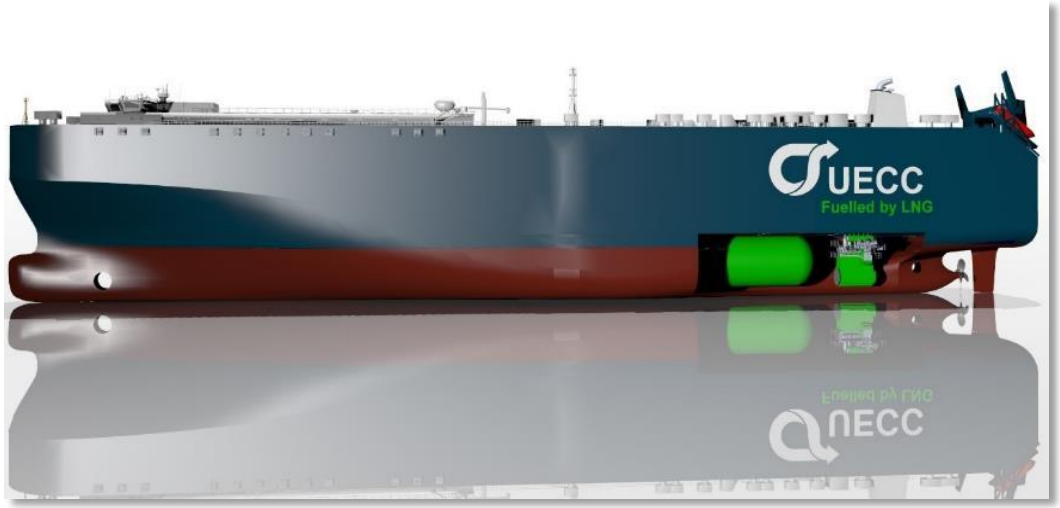


- 2 stroke DF engines require high injection pressure (150 – 300 barg)
- HP pumps for high pressure vaporizer
- HP heater for high pressure engines
- LP pumps for LP vaporizers and heaters and booster pump for HP pump
- LP vaporizers and heaters for LP engines/consumers
- Tank design pressure 4 barg

System Example:

2 x 3,800 Pure car carrier:

- Owner: UECC (Wallenius/NYK), Norway
- Yard: NACKS, China
- Classification: LR
- Completion: 2016
- Scope: LNG fuel tanks (type C) and high pressure fuel gas system for MAN-ME-GI dual fuel main engine



LNG as fuel – Utility Requirements LP FGS

Show Case:

1.2 t/h Output Capacity (LP Dual Fuel, 8.160kW):

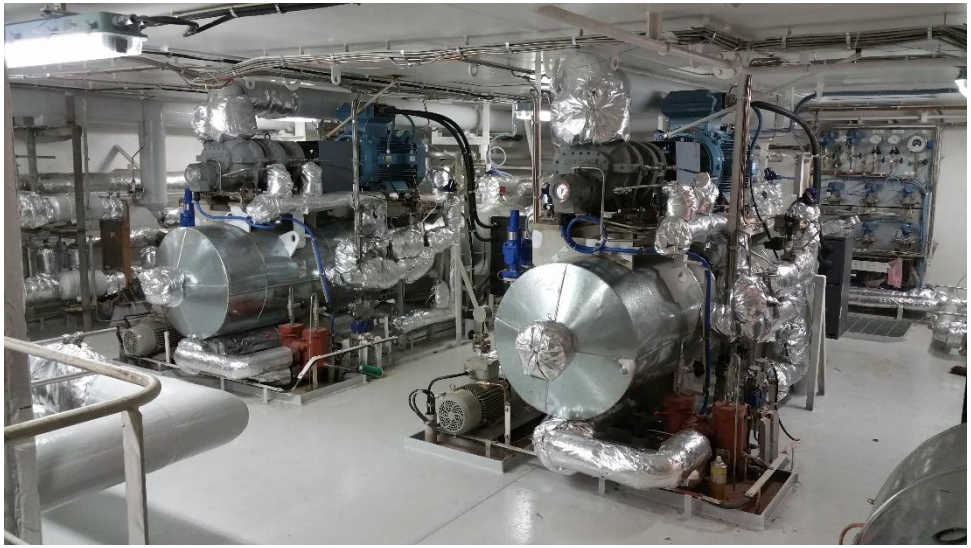
El. Shaft Power Requirements:

- LNG pump: 7 kW
- Water-glycol pump: 10 kW
- *BOG Compressor* *60 kW (if applicable)*
- Miscellaneous 2 kW

Sum: 79 kW / 19 kW

Heat Requirements from LTCW, HTCW or Steam:

abt. 340kW



LNG as fuel – Utility Requirements HP FGS

Show Case:

ME: 1.5 t/h Output Capacity (MAN ME-GI; 11,000kW MCR)

AE: 500kg/h LP Dual Fuel (Total Engine Output 3,000kW)

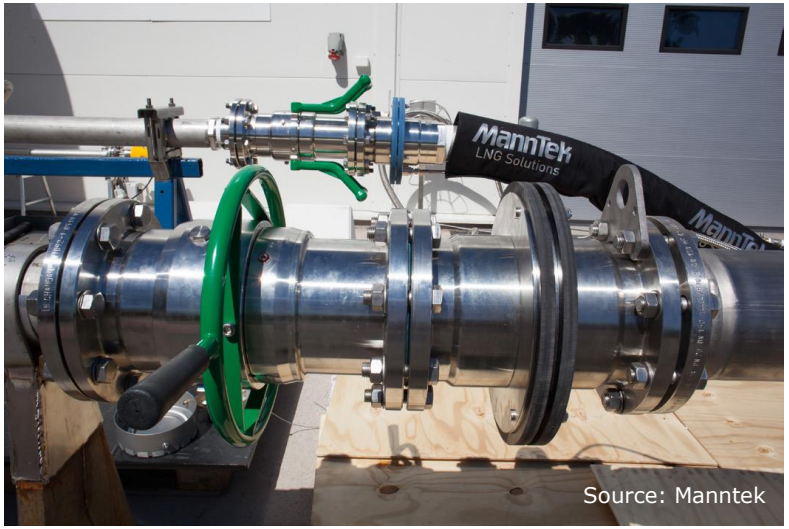
El. Shaft Power Requirements:

• LNG pump:	7 kW
• HP (300barg) LNG pump:	75 kW
• Water-glycol pump 1:	11 kW
• Water-glycol pump 2:	5 kW
• BOG Compressor	60 kW
• Miscellaneous	2 kW
Sum:	**160 kW**

Heat Requirements from LTCW, HTCW or Steam:

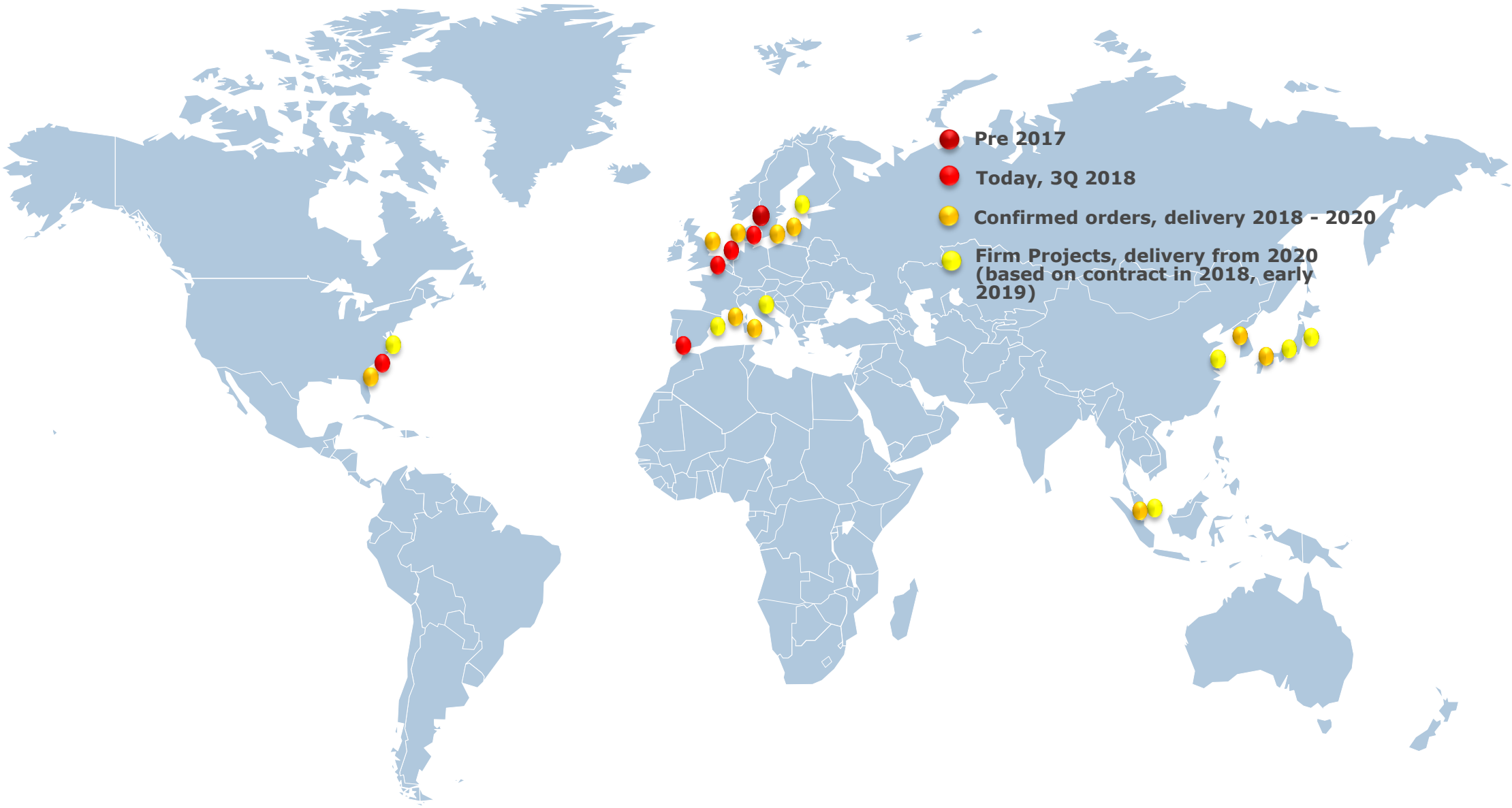
- **abt. 260 kW HP FGS Water-Glycol System**
- **abt. 140 kW LP FGS Water-Glycol System**

LNG Bunkering



Source: Manntek

Bunker Vessel Operation Areas



LNG Bunkering – Interface requirements

	Coastal Vessel	Passenger Vessel	Large Container Vessel
LNG volume	50 - 500 m³	2,000 – 3,000 m³	up to 20,000 m³
Tank type	Vacuum insulated or conventional insulated	Type C tanks or atmospheric tanks	Atmospheric or type C tanks
Bunker time	max. 4 h	4 h	approx. 4 - 11 h
Bunker rate	25 - 200 m³/h	750 m³/h	up to 1,600 m³/h
Bunker connection	abt. 6"	abt. 8"	estimated min. 8" (or even 2 x 8")
Bunker manifold height	max. 4 m above waterline	3 – 4 m above waterline	6 – 8 m above waterline
Bunker station location	approx. 50 m from steven	midships	¼ of ship length

LNG Bunkering – Interface requirements

Essential / recommended equipment and components:

- Discharge/receiving valves at bunker supply/receiving vessel
- Loading arm or hose for LNG and vapour return
- Emergency break away coupling (ERC)
- Connect/dry disconnect coupling (QCDC)
- Fall arrest system
- Means for draining after completion of bunker transfer
- Means for inerting and gas freeing
- Ship-to-Ship link for communication and automatic/manual ESD
- Vessel separation detection
- Fenders
- Water Curtains

Source: Klaw LNG

Marine Gas Engineering

For further information please email:

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