

Study of Small Scale LNG Carrier /Bunkering Ship with DF Engine



July 2014

Principal Design Project of Small Scale LNG Carrier/bunkering
ship with DF Engine, CAJS

Presented by
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Project Manager
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1. Member of Study

Principal Design Project of Small Scale LNG Carrier / Bunkering Ship with DF Engine Project Member

The Cooperative Association of Japan Shipbuilders	Association
Kobe Senpaku Kaisha	Shipping
Higaki Shipbuilding Co., Ltd. 桧垣造船股份有限公司	Shipbuilding
Sanwa Dock Co., Ltd.	Shipbuilding
Izumi Steel Works, Ltd.	Tank Plant
Daihatsu Diesel Mfg. Co., Ltd. 大发柴油机株式会社	Engine
ClassNK	Class

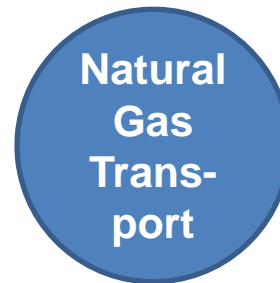
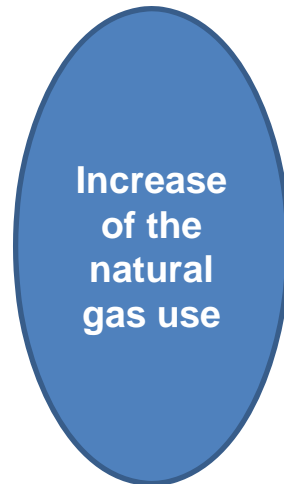
Project Leader : Mr. Haruhisa Nagai, Kobe Senpaku Kaisha

Project Manager : Mr. Kei Tanaka

2.1 Target of Study

Background

Economical Issue



Target

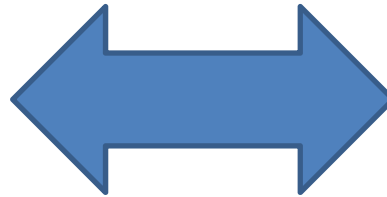
Environmental Issue

2.1 Target of Study

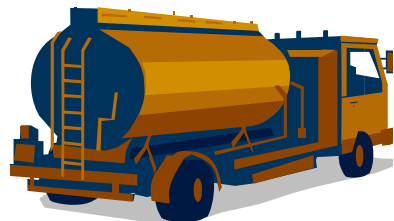
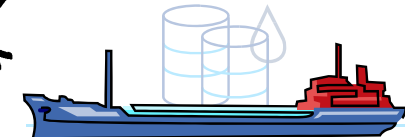
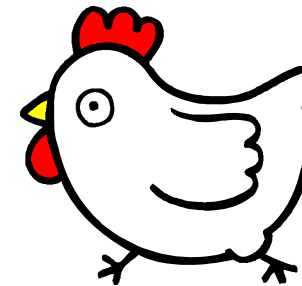
LNG Supply Infrastructure

LNG User

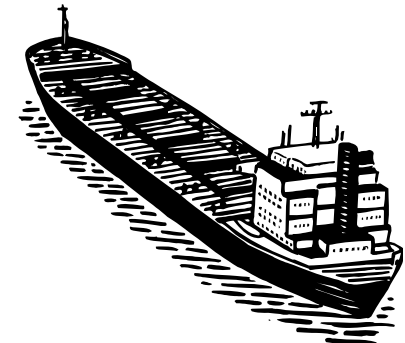
LNG Bunkering Ship
Only 1



Gas Fuelled Ships
About 50



LNG Carrier / Bunkering Ship





2.2 Study Process

Japanese Coastal
LNG Carrier



Gas fuelled
Electrical Propulsion
Requirement of LNG
Bunkering



Base Plan

Type of Ship : LNG Carrier /Bunkering Ship

Operation Route : Tokyo Bay – Hokkaido for LNG Transport

Speed : 13.0kt

Main Engine for Alternator : Natural Gas Use

Cargo Tank : IMO Type C Independent Tank

Capacity : 3,500m³

3.1 Selection of Engine

Dual Fuel

Gas Fuel only

Lean Burn (at Gas Mode)

Lean Burn

IMO MARPOL Annex VI

NOx : Tier III Regulation (Required in ECA)

Without SCR Equipment

SOx : No Sulfur Content

Gas & Marine Diesel Oil
Select the Cheaper Fuel
MDO can be use in Emergency
(Long Term Storage)

Gas only

One LNG Fuel Tank

Two LNG Fuel Tanks



Select Dual Fuel Engine

3.2 Selection of Propulsion System

Electrical Propulsion System

Good for Low Speed Operation

Maneuverability

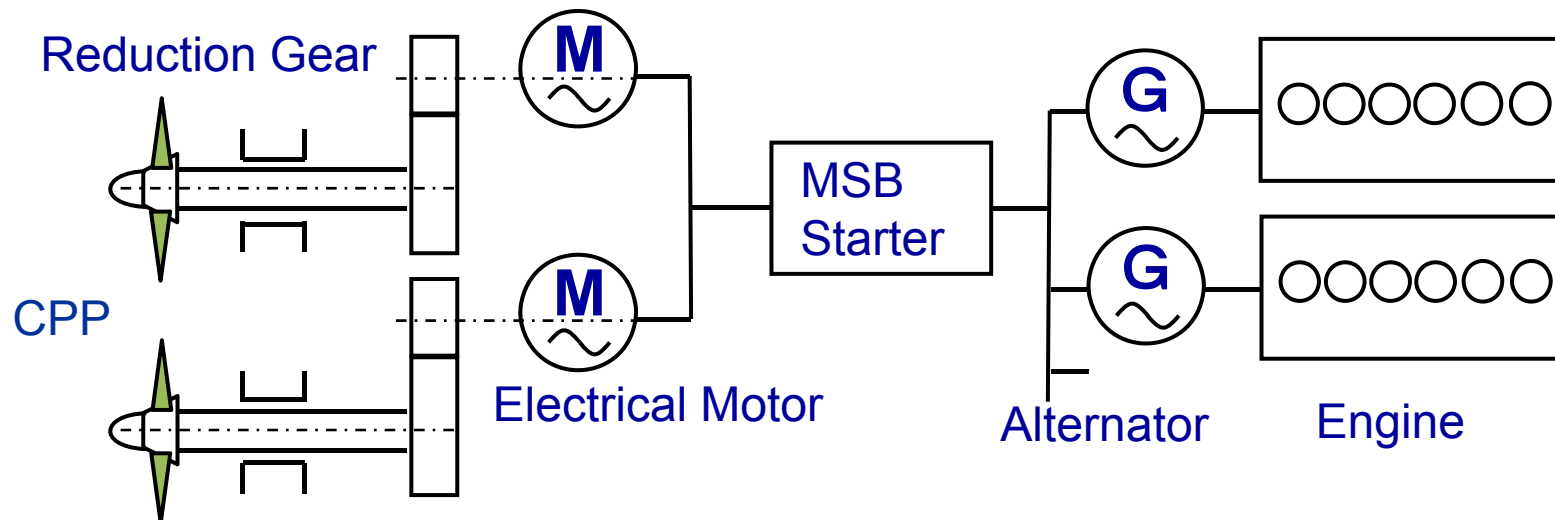
No. of Propeller : 2
Given by Propulsion Efficiency
& Redundant propulsion

FPP
Fixed Pitched Propeller
with Inverter

CPP
Controllable Pitched Propeller

High Cost

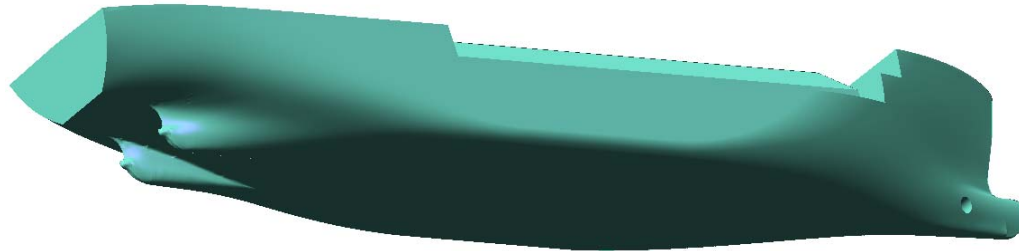
Select CPP System



3.3 Performance

Hull Form

Twin-Skeg



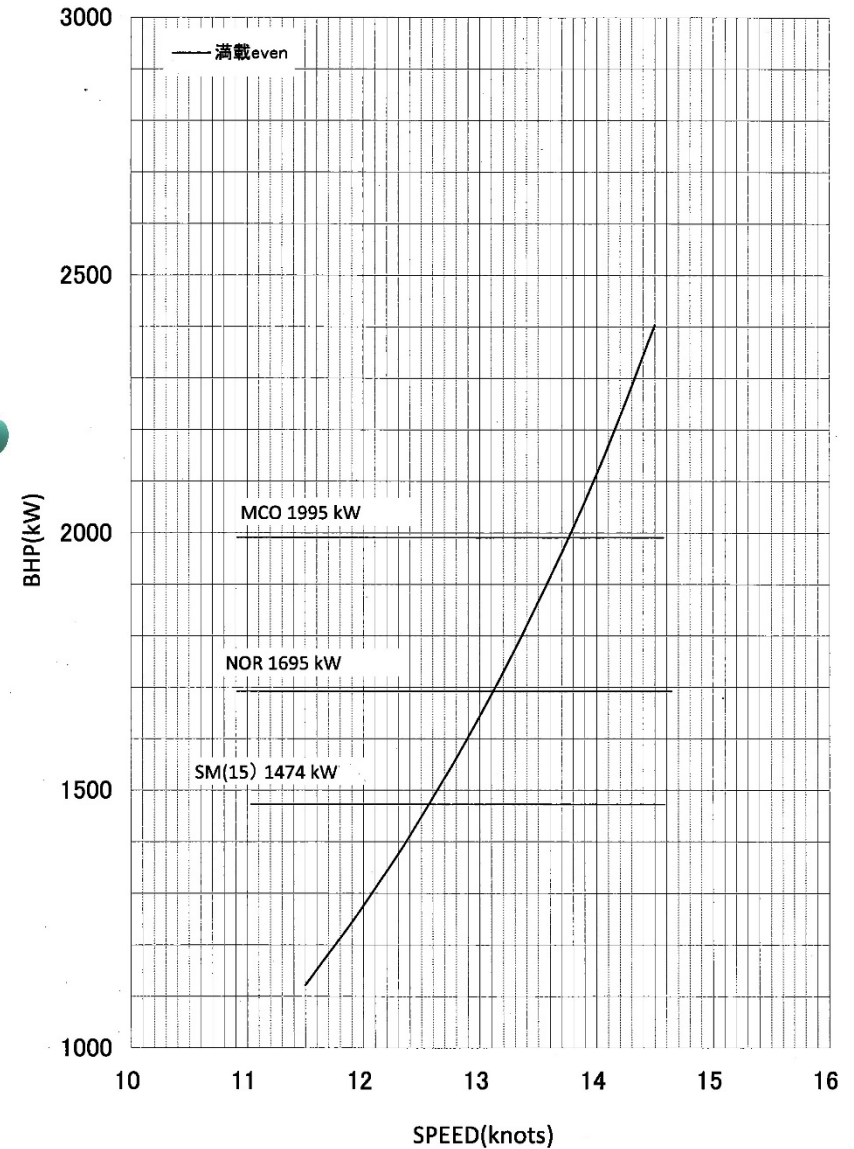
Hull Design Model

Normal Rating
at 13.0kt
BHP : 1,695kWe

Maximum Continuous Rating
BHP : 1,995kWe

Performance Curve

BHP/DHP=1/0.893



3.4 Electrical Power Supply Demand

Electrical Power for Propulsion

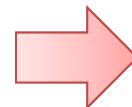
MCR : 1,995kW NOR : 1,665kW

Electrical Power for Ship Equipment

Voyage : 235kW D & A Condition : 735kW

	MCR Condition	NOR Condition	Departure & Arrival Condition	Port Condition	Cargo Loading	Cargo Unloading
Propulsion Power (kW)	1,781	1,514	534	0	0	0
Electrical Power for Propulsion (KW)	1,995	1,695	599	0	0	0
Electrical Power for Ship Equipment (kW)	235	235	735	160	315	514
Total Electrical Power (kW)	2,230	1,930	1,334	160	315	514
No. of Alternator	4	3	3	1	1	1
Power Factor	74%	85%	59%	21%	42%	68%

Operation Engine Number
 3 Engines 85% Load
 1 Engine Stand-by



Alternator Output
>757kW

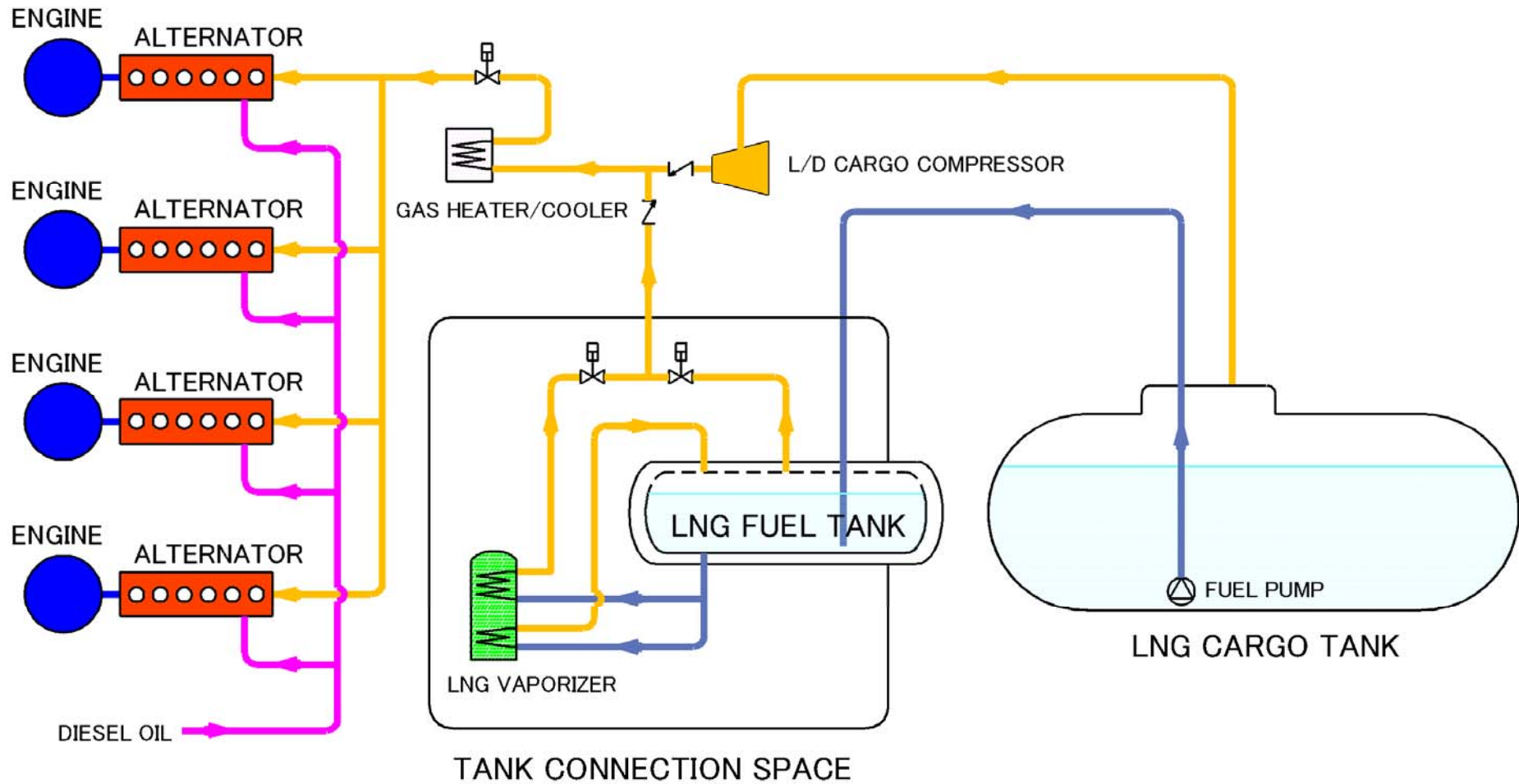
3.5 Study of LNG Fuel Supply System

	Case 1	Case 2	Case 3
Natural Gas is supplied by	LNG Cargo Tank	LNG Fuel Tank	LNG Fuel Tank
LNG Fuel Tank	No	Yes	Yes
Re-liquefaction Plant	No	No	Yes (For BOG of LNG Cargo Tank)
Gas Compressor	Yes	Yes Small Scale (For BOG of LNG Cargo Tank)	No
Vaporizer	Main	Main & PBU	Main & PBU
Result	Steady supply of the LNG fuel is difficult.	Steady supply of the LNG fuel is easy. Minimum Size.	System is Complicated & Expensive.

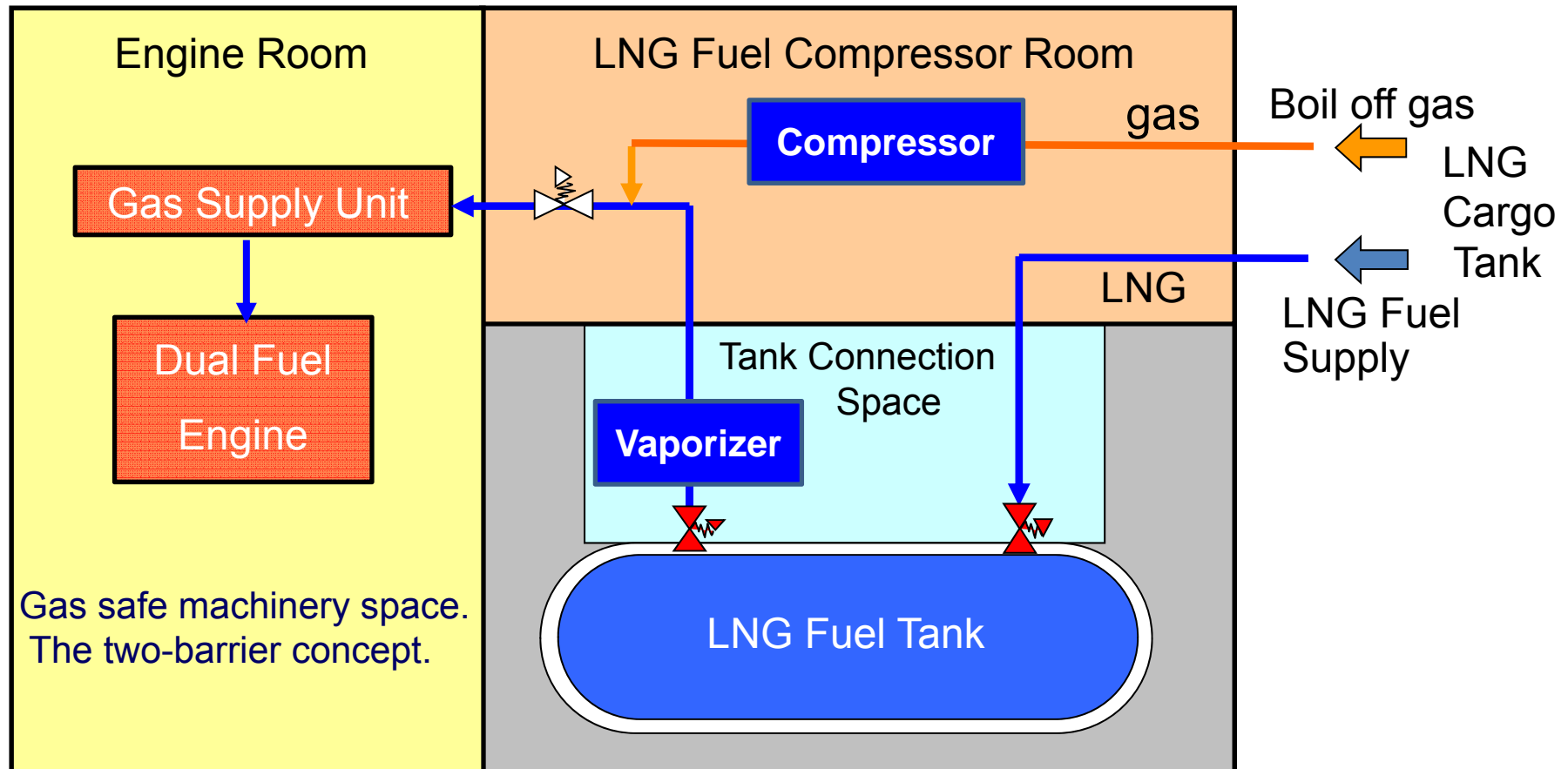


LNG Fuel is supplied From LNG Cargo Tank to LNG Fuel Tank
 No re-liquefaction plant
 Boil off gas of LNG Cargo Tank is used as Fuel

3.6 Diagram of LNG Fuel Supply System



3.7 Arrangement of LNG Fuel Supply System



The mechanical ventilation capacity is at least 30 air changes per hour. Independent access direct from the open deck.

3.8 Requirement for Bunkering Vessel

Detail of bunkering systems should be decided according to the details of the gas-fuelled ship.

Hardware

Freeboard height difference between both ships.

Treatment of Boil-Off-Gas of Gas fuelled ship.

Mooring of ships.

Software

The bunkering procedure.

The urgent detached mooring

Risk assessment.

Seafarers training, qualification.

LNG transportation regime.

The marine disaster prevention system.

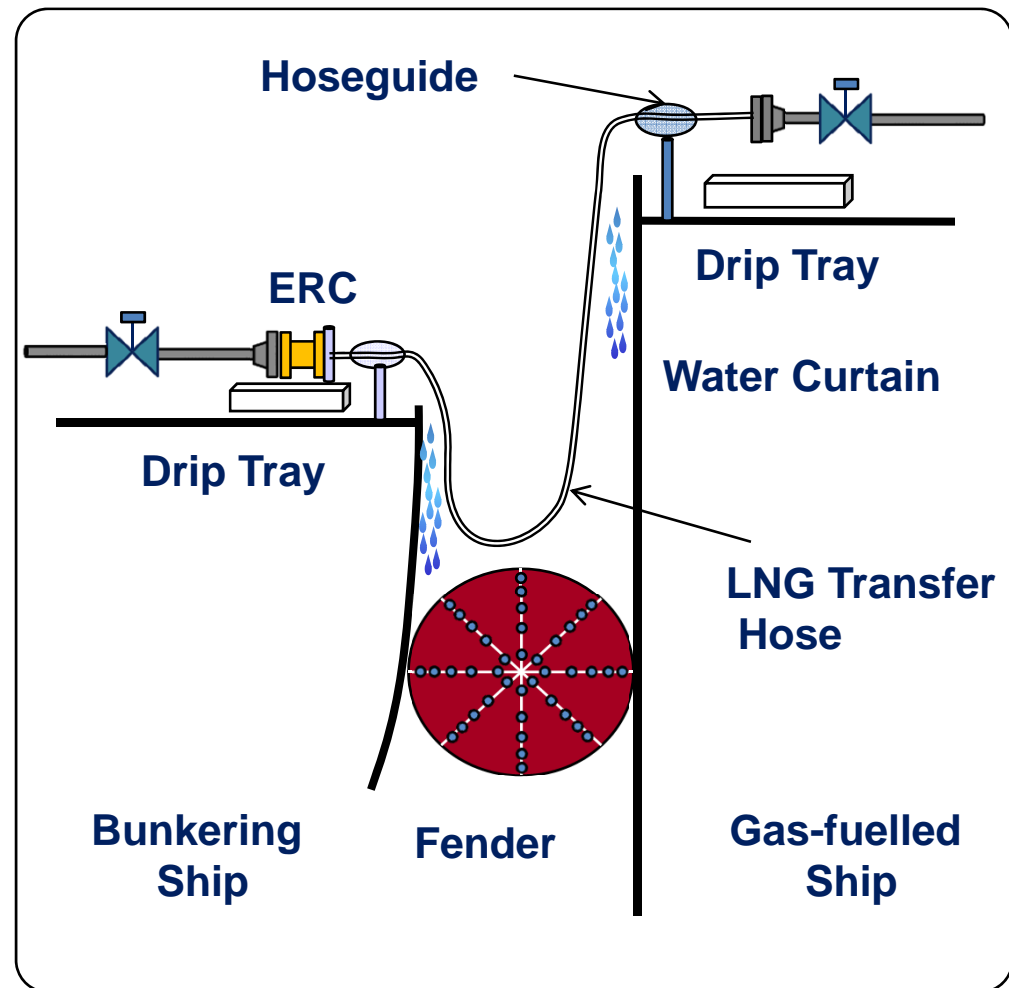
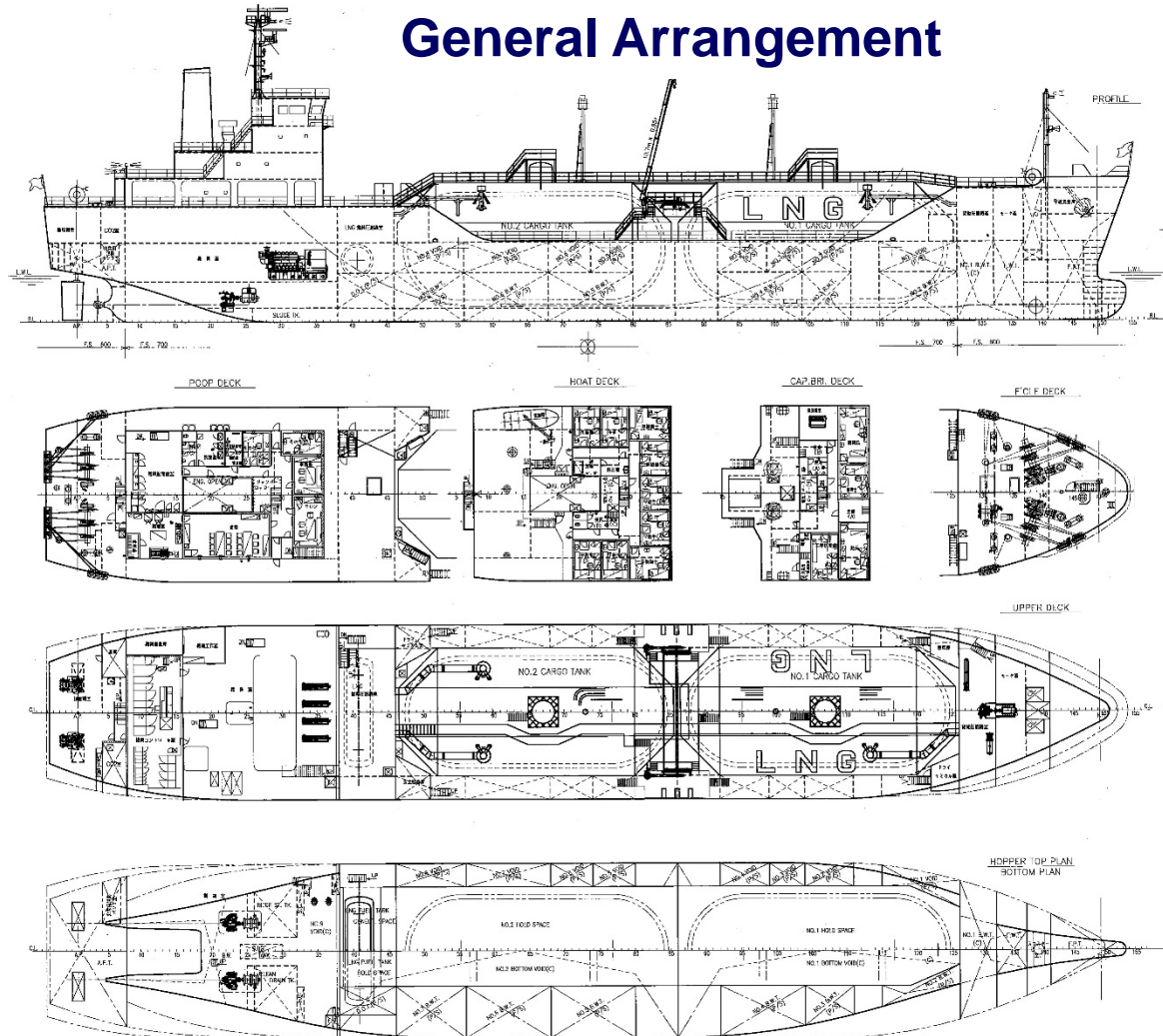


Image of LNG Bunkering

4.1 Main Particular

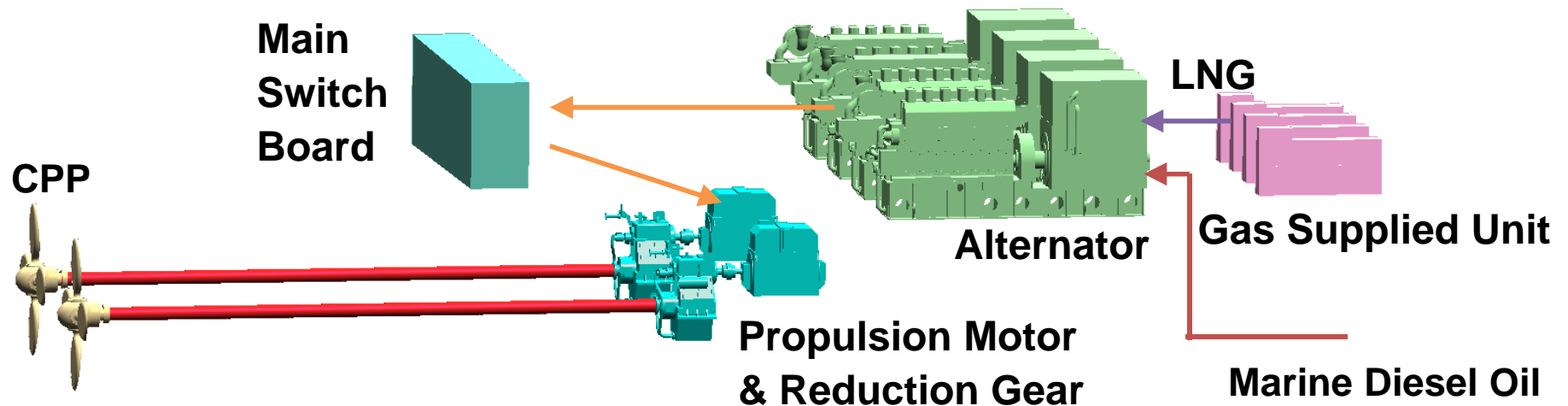
Main Particular	
Type	LNG Carrier / Bunkering Ship
Gross Tonnage	Ab 5,200ton
Loa	107.80 m
Lpp	101.40 m
B	17.20 m
D	7.80 m
d	Ab 4.60m
DW	Ab 2,650 ton
Speed	13.0 knots (85%NOR)
Cargo Tank Volume	3,500 m ³

General Arrangement



4.2 Machinery Systems

Machinery Systems	
Propulsion System	Electrical Propulsion System
Main Generator Engine	Dual Fuel Engine Output : 796 kwm x 900min ⁻¹ x 4sets
Alternator	3φAC 440V Brushless Alternator Output : 757kwe x 8P x 900min ⁻¹ 60Hz x 4sets
Propulsion Motor	3φAC 450V Induction Motor Output : 950kw x 6P x 1200min ⁻¹ 60Hz x 2sets
Reduction Gear	2 sets
Propeller	Controllable Pitched Propeller x 2 sets





4.3 LNG Fuel Supply Equipment

LNG Fuel Tank	
Type	Cylindrical with Both Ellipsoidal Heads IMO Type C Independent Tank
Type of Thermal Insulation	Vacuum Perlite Insulation
Capacity	38 m ³
No.	1 set
Design Vapor Pressure	10 bar g
Minimum LNG Operating Temperature	-163°C
Materials	Inner Vessel SUS304, Outer Vessel SUS304
LNG Fuel Supply System	
Design Gas Supply Volume	Ab 500Nm ³ /h (MCR)
Design Gas Supply Pressure	5.5 ~ 6.5 bar g
Design Gas Supply Temperature	5 ~ 40°C
Pressure Build-up Vaporizer	50kg/h
LNG Vaporizer	500kg/h

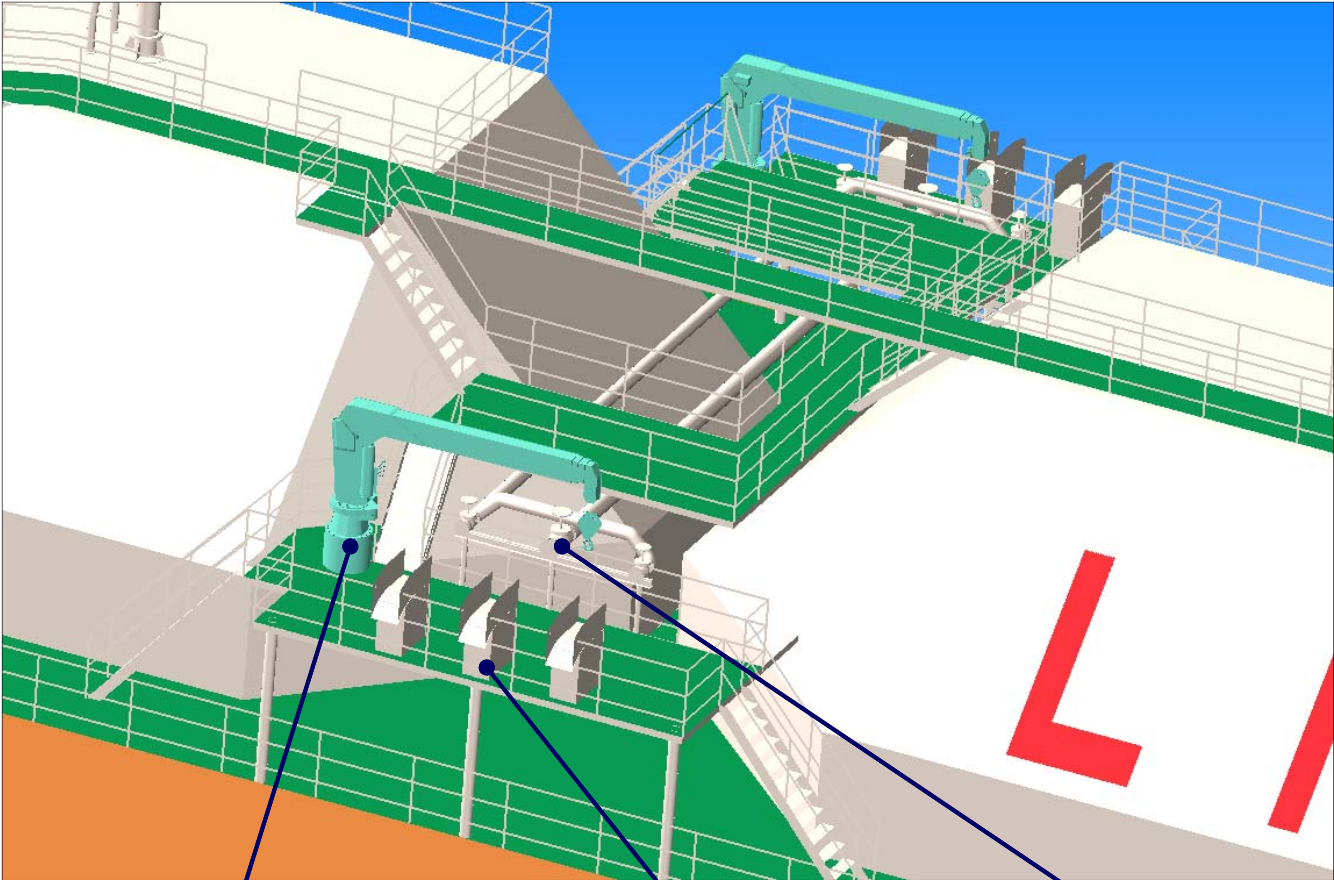
4.4 LNG Cargo Tank & Cargo Handling System

LNG Cargo Tank	
Type	Cylindrical with Both Hemi-spherical Heads IMO Type C Independent Tank
Type of Thermal Insulation	External Wall Insulation Made of Rigid Polyurethane Foam
Capacity	Ab 3,500m ³
No.	2 sets (1,750m ³ x 2 sets)
Design Vapour Pressure	7.0 bar g
Minimum Design Temperature	-163 °C
Materials	Nickel Steel
LNG Cargo Handling System	
Loading Time (Design)	Ab 3 Hours (1,200m ³ /h)
Unloading Time (Design)	Ab 3 Hours (1,200m ³ /h)
Type of Cargo Pump	Electric Motor Driven Submerged Pumps 300m ³ /h x 120mLC x 4 sets
Other Equipment	Cargo Compressor, Gas Heater, LNG Vaporizer, etc.

5.1 Aspect of Vessel



5.2 Central Area

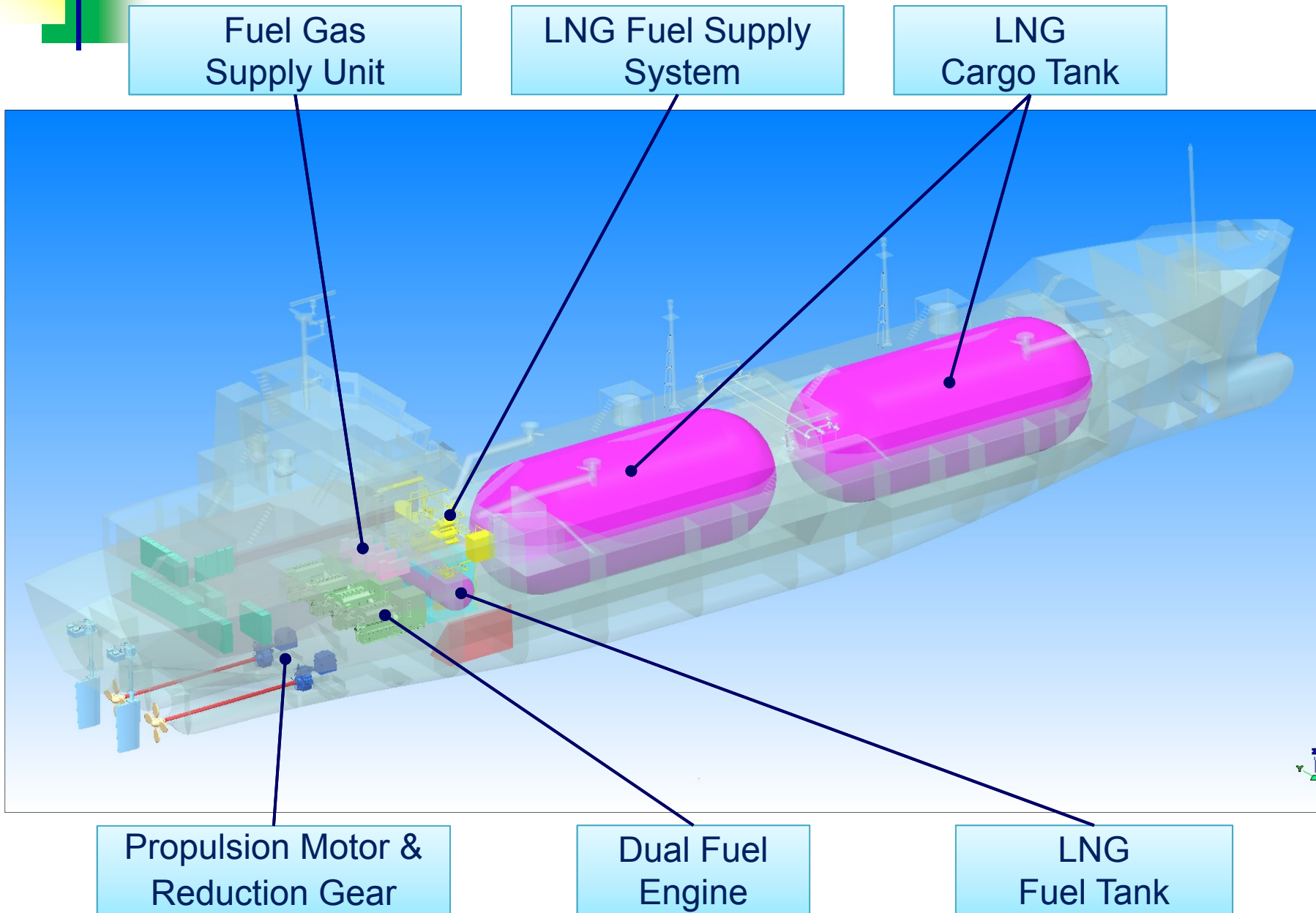


Hose Handling Crane

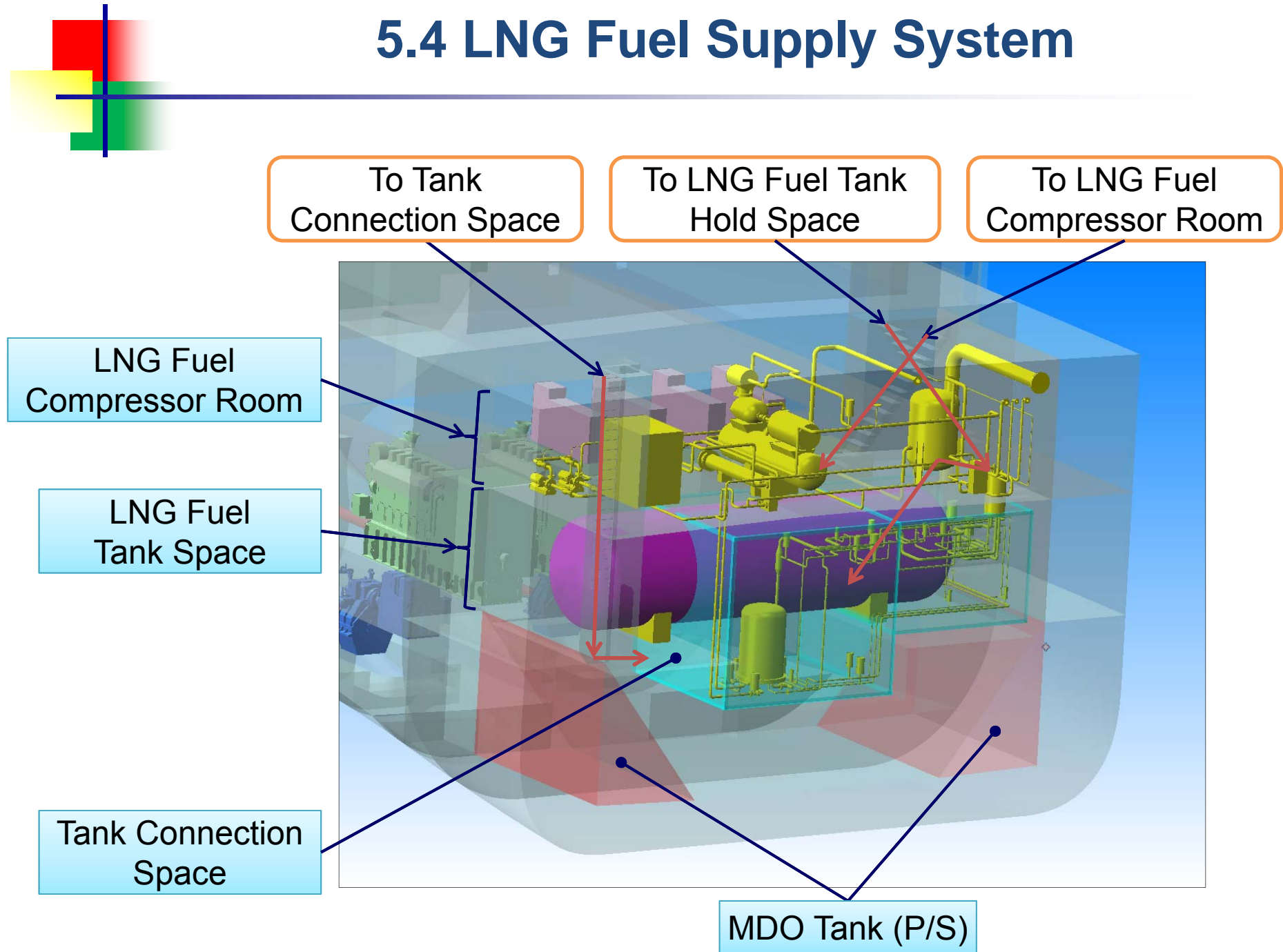
Hose Guide

Cargo Handling Manifold

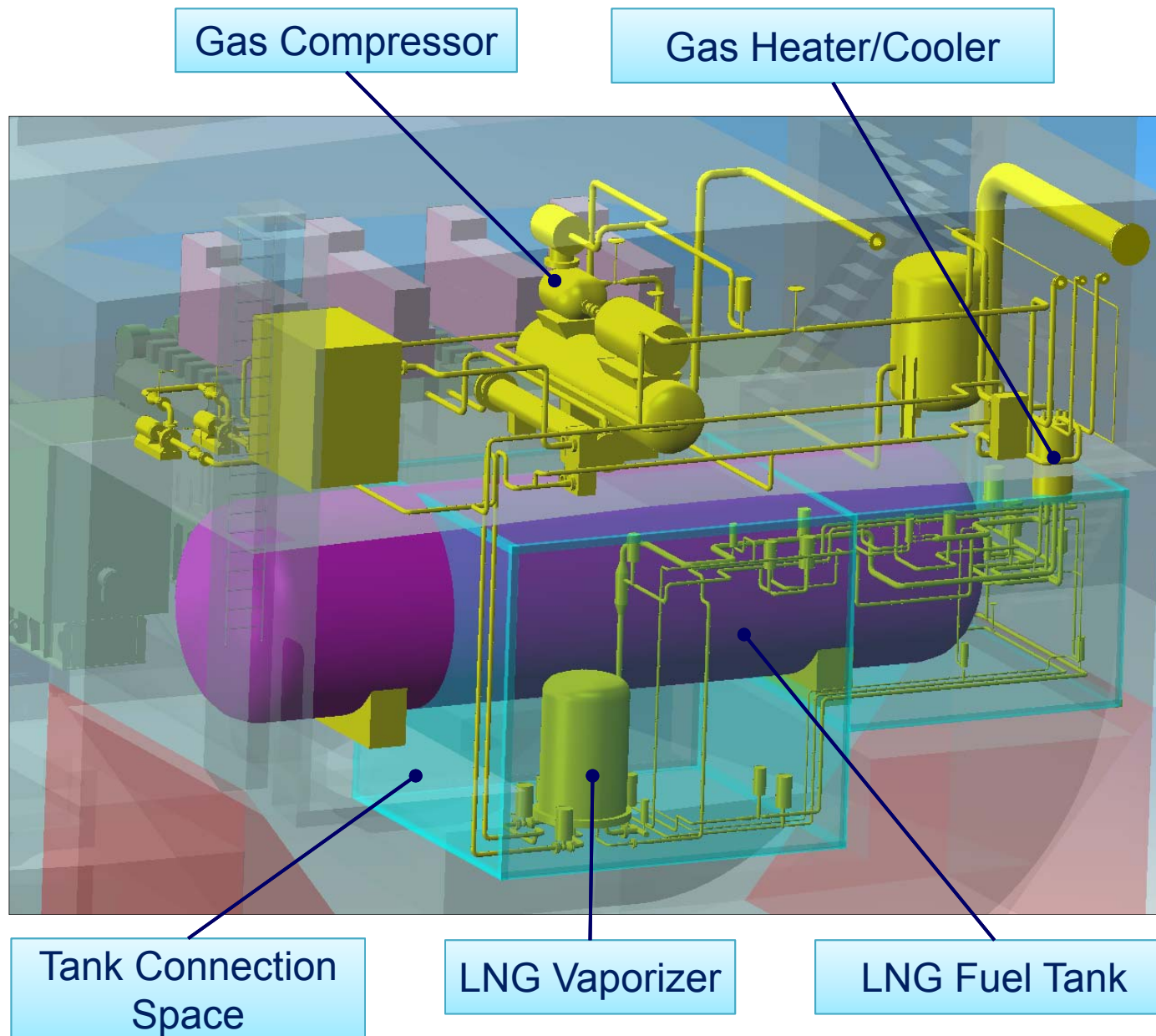
5.3 See-through Model



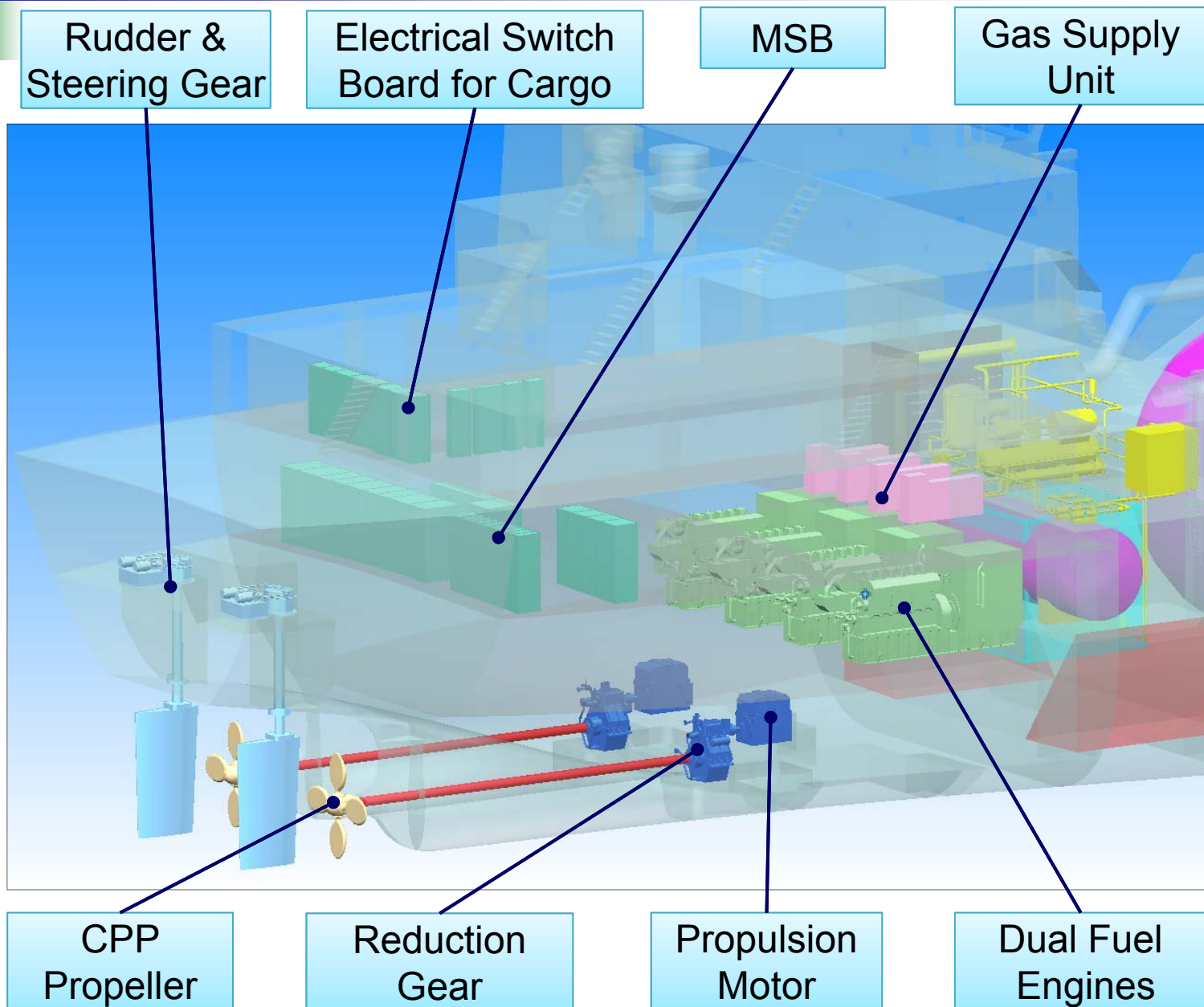
5.4 LNG Fuel Supply System



5.5 LNG Fuel Supply System

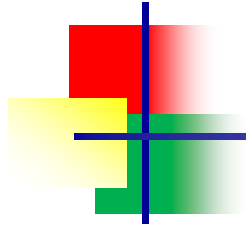


5.6 Stern Area



Conclusion





ClassNK

R & D P R O J E C T

This project was carried out with the support of ClassNK as part of the ClassNK Joint R&D for Industry Program.

Thanks for your Attention!

- END -