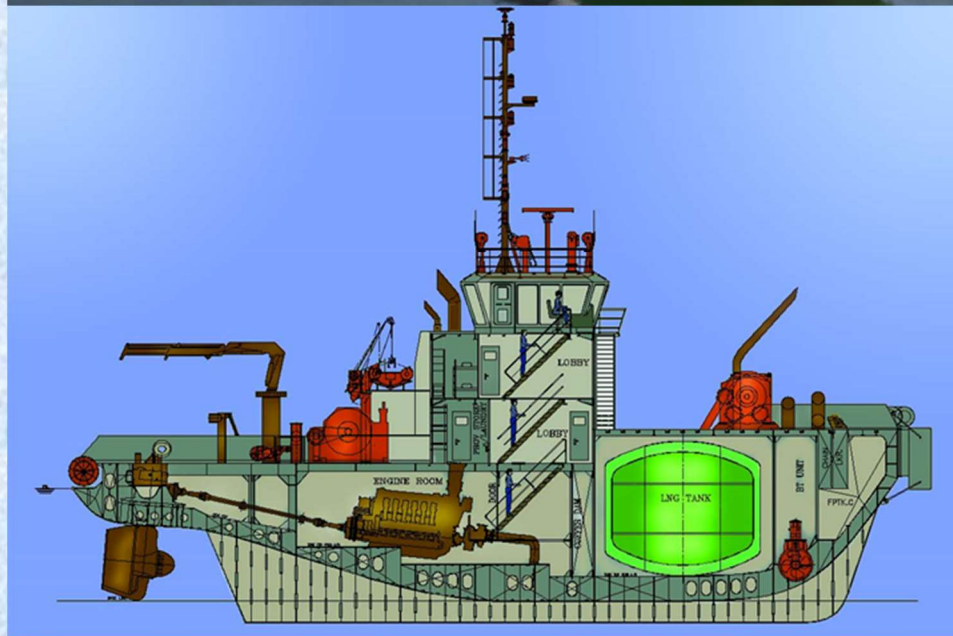


DESIGN PROPOSALS FOR LNG BUNKER VESSEL (LBV), DUAL-FUEL AHT & LNG FUELED TUGS (CONVERSION & NEW CONSTRUCTION)



PRESENTED BY NAVNAUTIK PTE LTD

NAVNAUTIK'S PROPOSALS FOR VARIOUS CLIENTS AND PILOT PROJECTS INCLUDE:

a) CONVERSIONS:

- CONVERSION OF LAID-UP PSV TO LBV
 - CONVERSION OF EXISTING TANKER / CARGO CARRIER TO LBV
 - CONVERSION OF EXISTING CARGO BARGES TO LNG BARGE
 - CONVERSION OF EXISTING AHT TO DUAL-FUEL (LNG/MDO) AHT
- } SMALL SCALE LNG

b) NEW CONSTRUCTION:

- LNG LCT
- LNG BUNKER VESSEL (INCLUDING OPTION OF COMBINED LNG & MDO BUNKER CARRIER) OF VARIOUS SIZES TO SUIT OPERATOR'S REQUIREMENTS AND PROJECTS
- LNG FUELED TOWING TUGS (ASD / VOITH) AND ESCORT TUGS

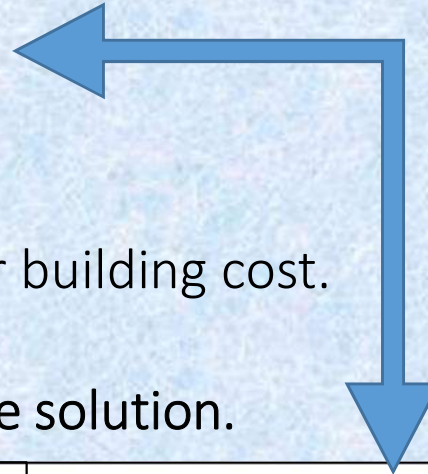
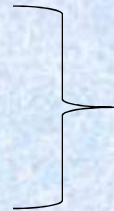
Small scale LNG is a new concept to operate 'laid-up' vessels.

A new build has high capex & not viable specially in a new growing market.

Due to oil price crash there are hundreds of laid-up OSVs.

They have:

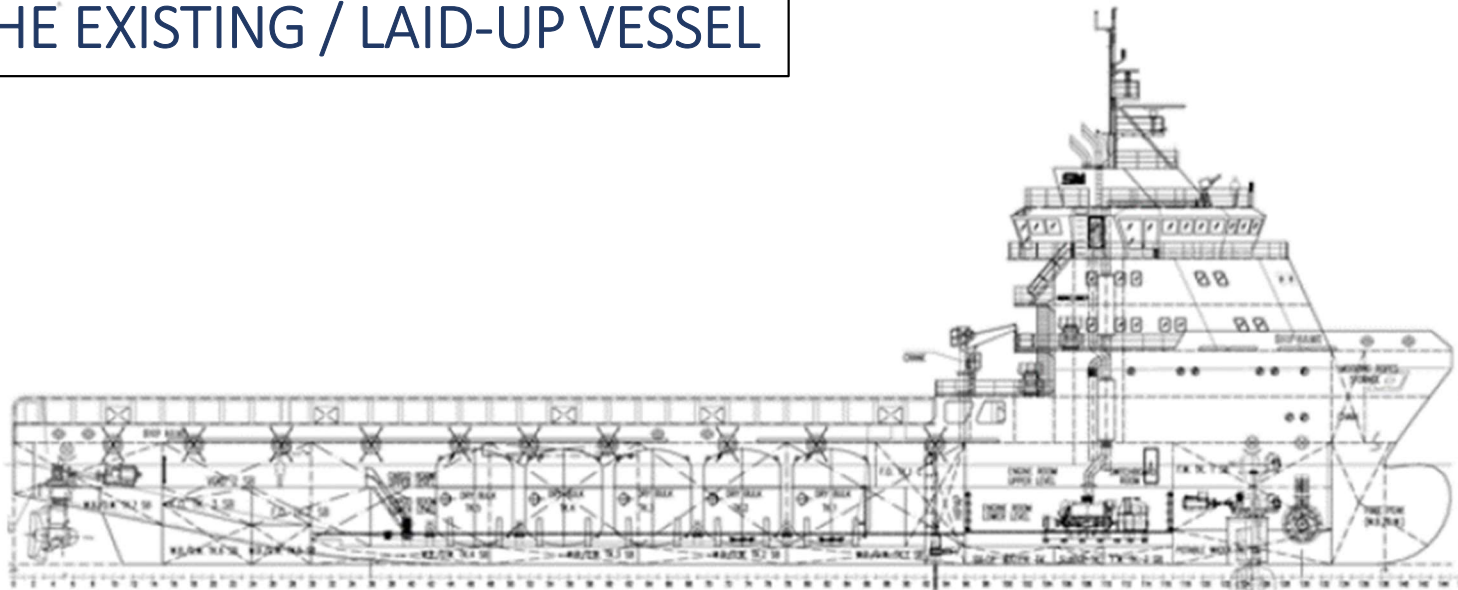
- large deck space
- reasonably high power
- high deck loading capacity



They are now worth the fraction of their building cost.

So NAVNAUTIK is proposing an innovative solution.

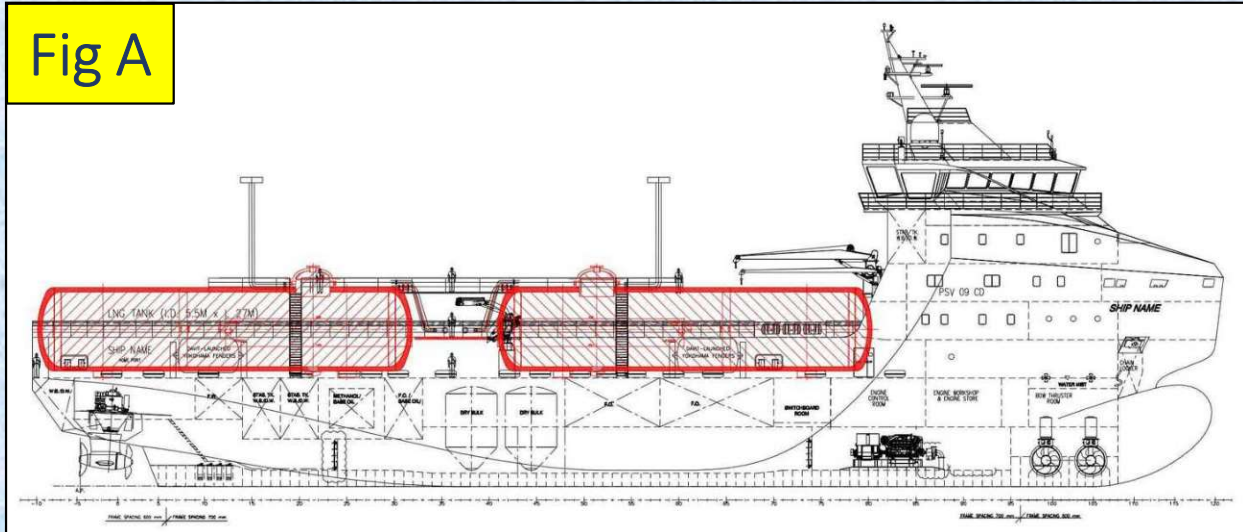
THE EXISTING / LAID-UP VESSEL



They are quite suitable for converting to small scale LNG of :

- Deck mounted type C LNG tank cargo containment system having equivalent capacity of original allowable deck load. (Fig A)
- Hold mounted type C LNG tank cargo containment system having equivalent capacity of original dead weight. (Fig B)

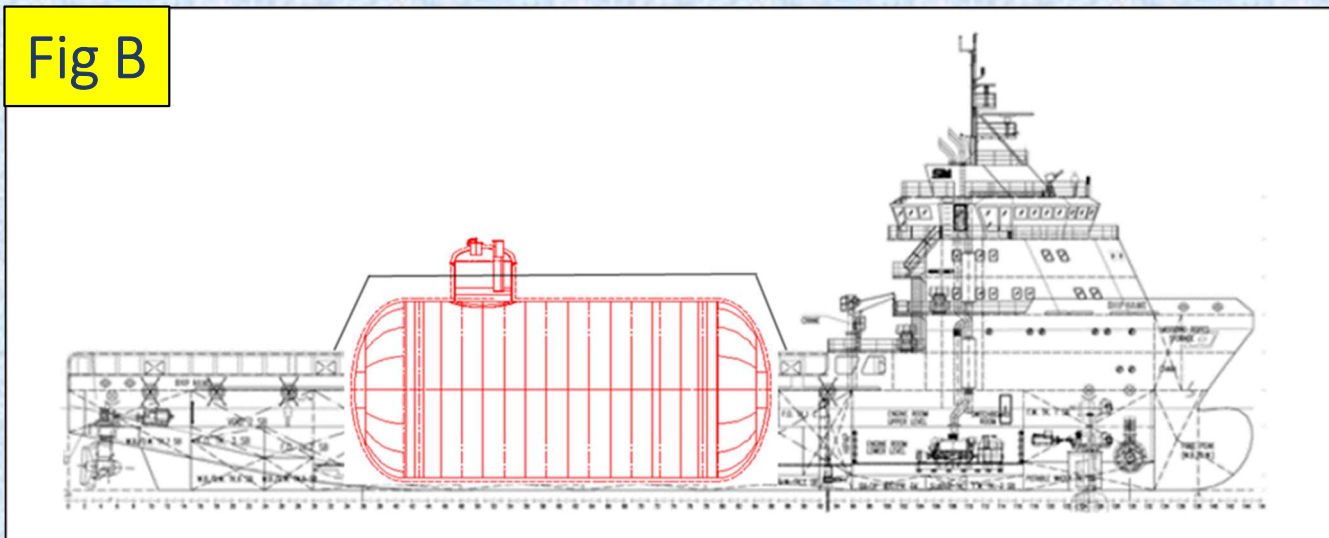
Fig A



Main areas of considerations are:

- Ship's arrangement.
- Hazardous zone
- Intact stability
- Damage stability

Fig B

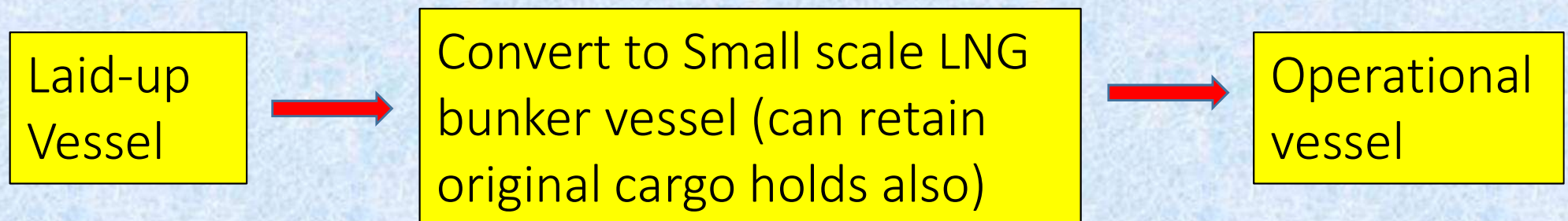


The approach:

Considering that the original OSV had been laid up, the conversion cost is a fraction of that of a new built vessel. Though the capacity is limited by the original vessel's capacity, considering the cost, a number of vessels can be converted in order to achieve the required total capacity in a certain market situation and still be cost effective. This also allows simultaneous deployment of the vessels in most situations.

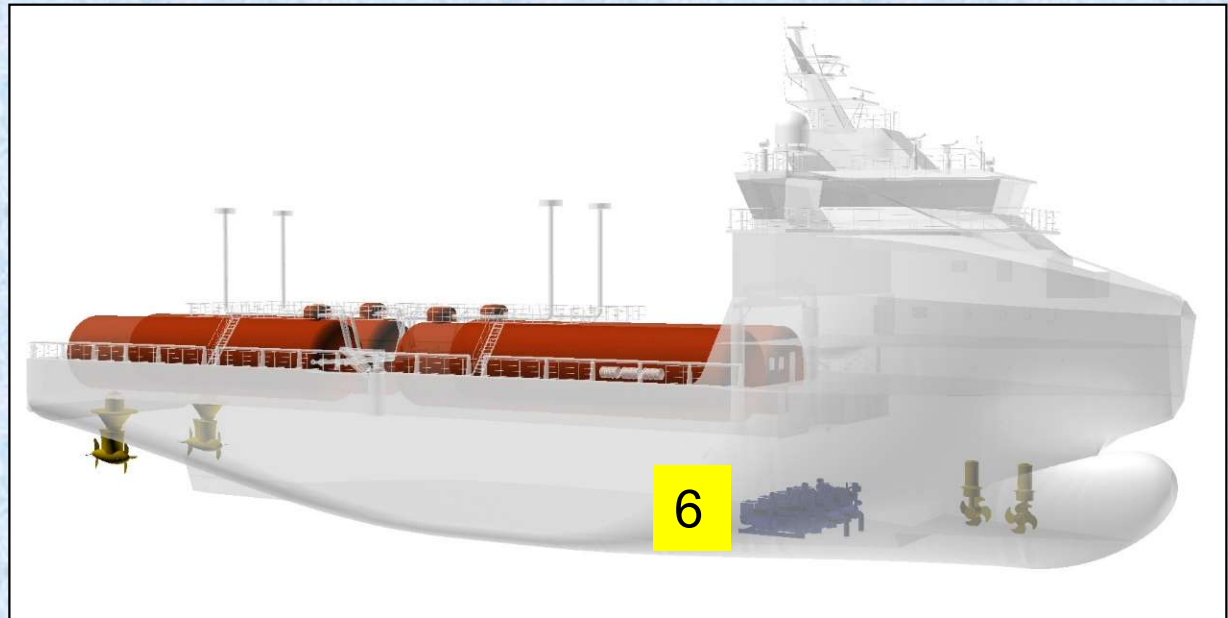
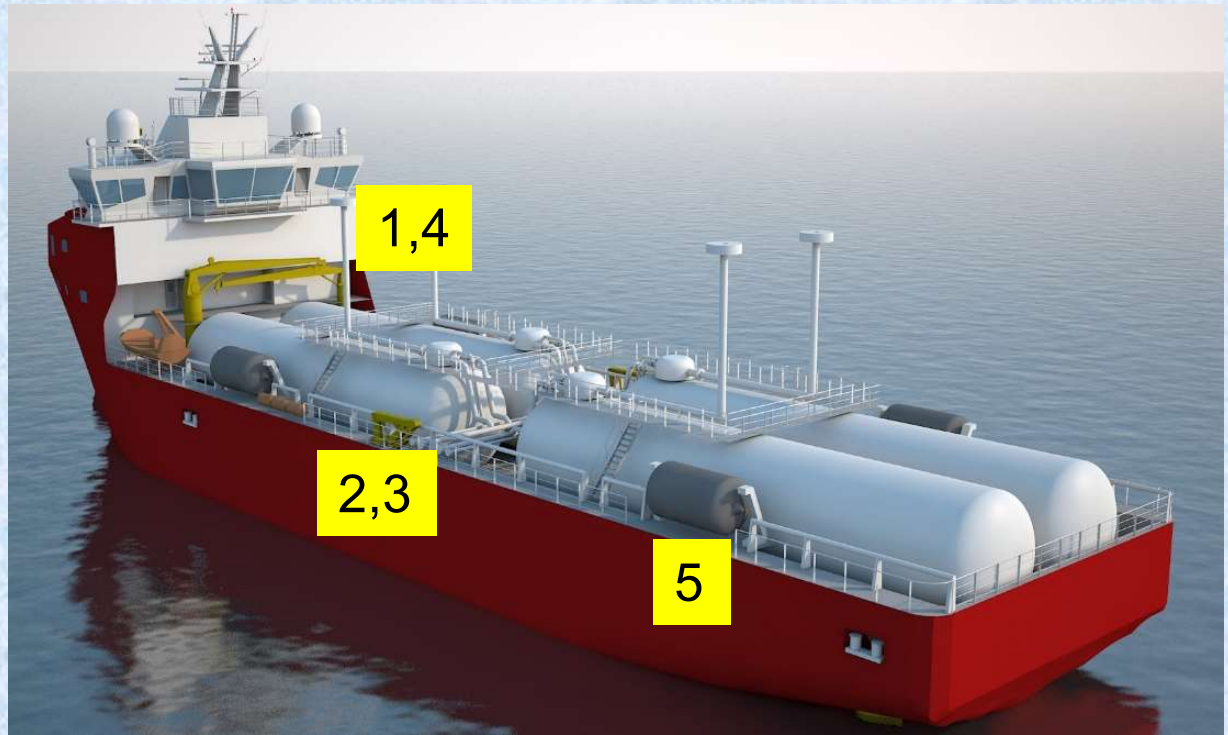
Additional Features:

1. SHIP TO SHIP BUNKERING (STS): Most of these OSVs are DP2. This gives them an added capability to provide STS bunkering service & operate outside the port limit.
2. Carriage of MDO/HFO: If the original vessel is a PSV it usually has a capability of substantial FO tank capacity. In that case it can supply both LNG & FO.
3. Supply of LNG to Islands: Standard ISO tank filling facility can be incorporated on board which can be off loaded in an existing wharf facility & no LNG shore facility is required. Empty ISO containers can be retrieved at the same time.
4. Operating in EPA & ECA Areas: Some of these OSVs are fitted with scrubbers in their engine exhaust & have the capability of operating in EPA & ECA areas. These can take advantage in operating in LNG active areas.



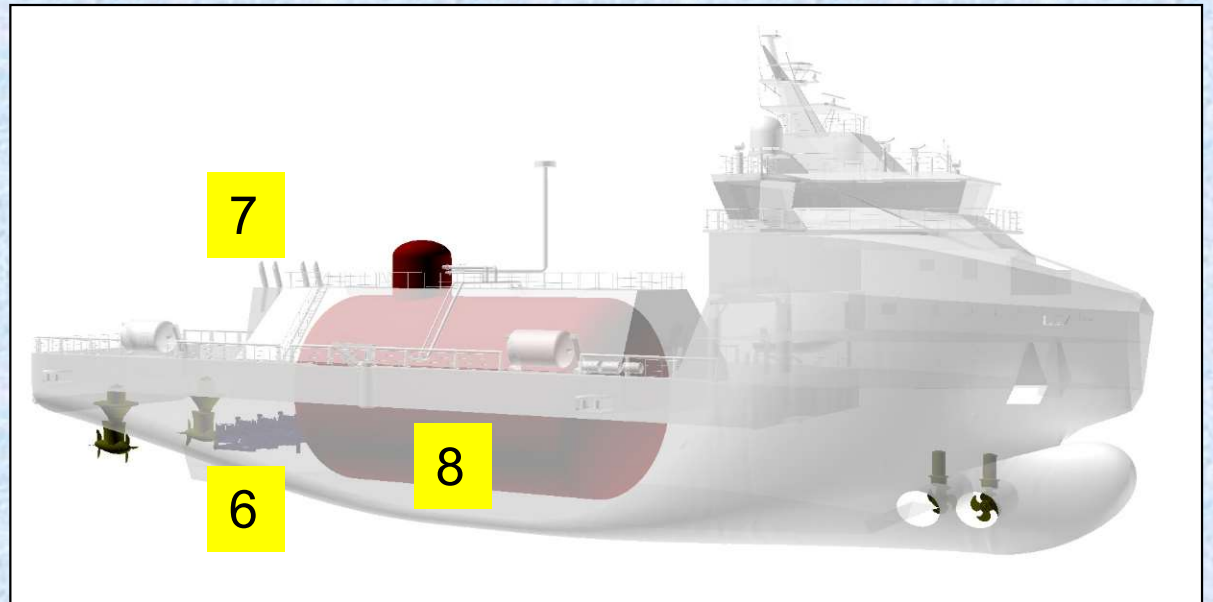
A sample list of changes for deck mounted LNG tanks:

1. All windows and doors facing aft (now facing LNG tanks) blanked off.
2. All obstructions on main deck relocated or removed as necessary.
3. Cargo rails removed.
4. External access to deckhouse relocated outside hazardous zone.
5. Yokohama fenders added for deployment during STS bunkering operation.
6. In this conversion proposal, main engines need not be relocated aft as per risk assessment report.



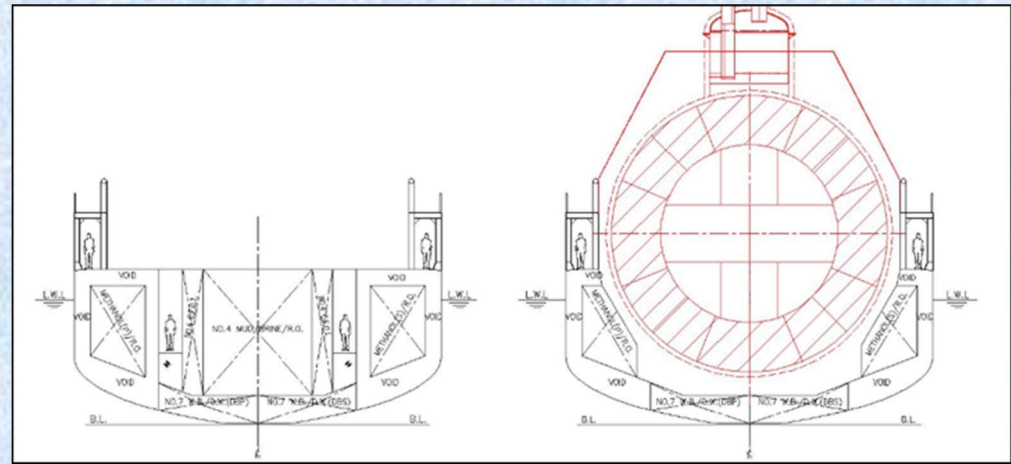
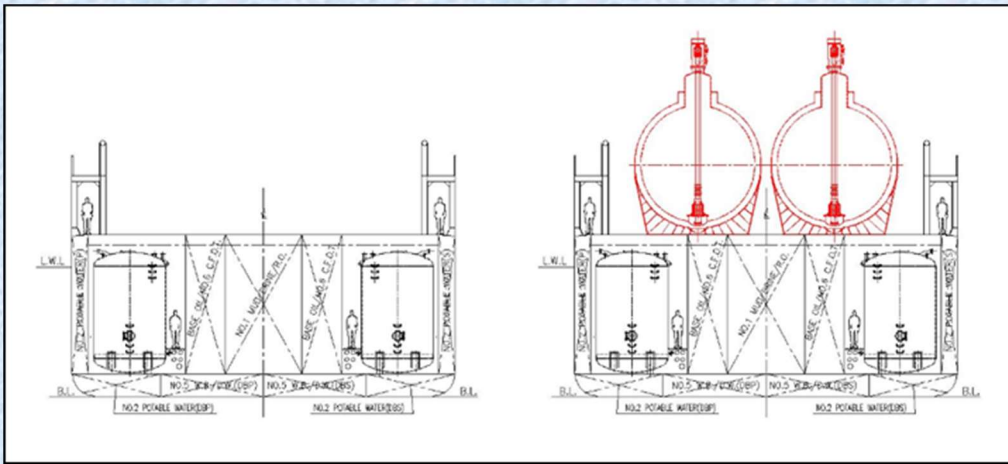
A sample list of changes for HOLD mounted LNG tank:

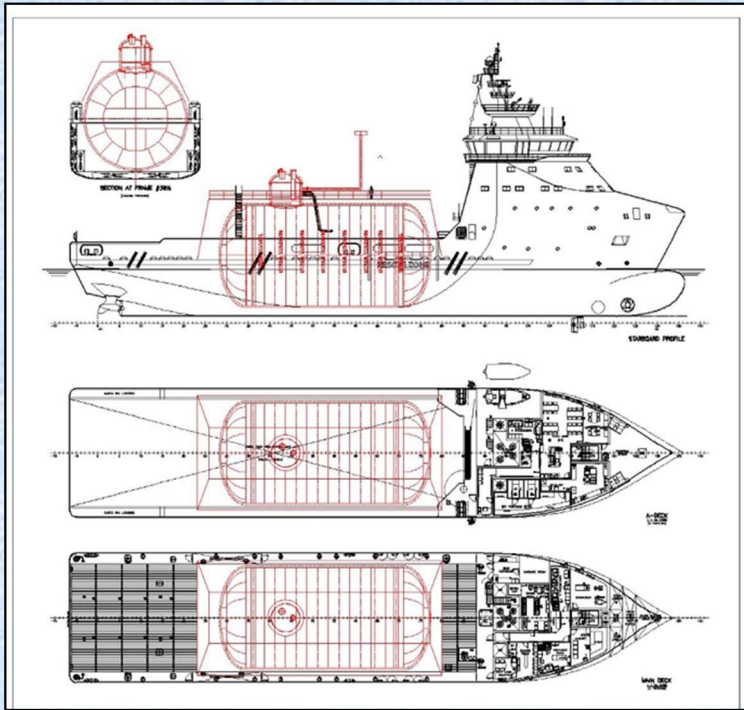
1. All windows and doors facing aft (now facing LNG tanks) blanked off.
2. All obstructions on main deck relocated or removed as necessary.
3. Cargo rails removed.
4. External access to deckhouse relocated outside hazardous zone.
5. Yokohama fenders added for deployment during STS bunkering operation.
6. Main Engines may be relocated to aft of LNG tanks as per risk assessment advise.
7. Exhaust trunks may be relocated aft.
8. Under deck existing tanks and structure cut to accommodate LNG tank.
9. Dome added around LNG tank for damage control.



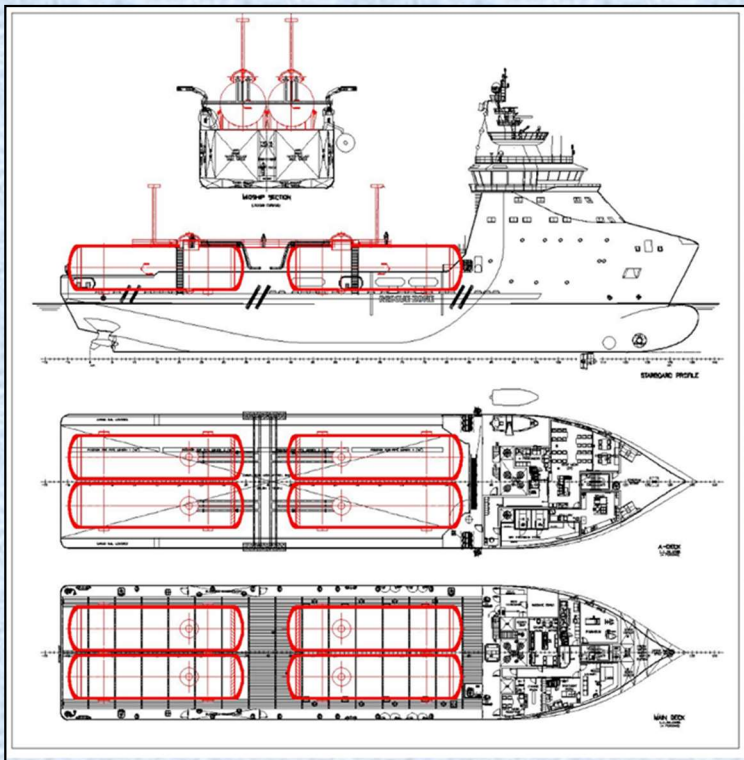
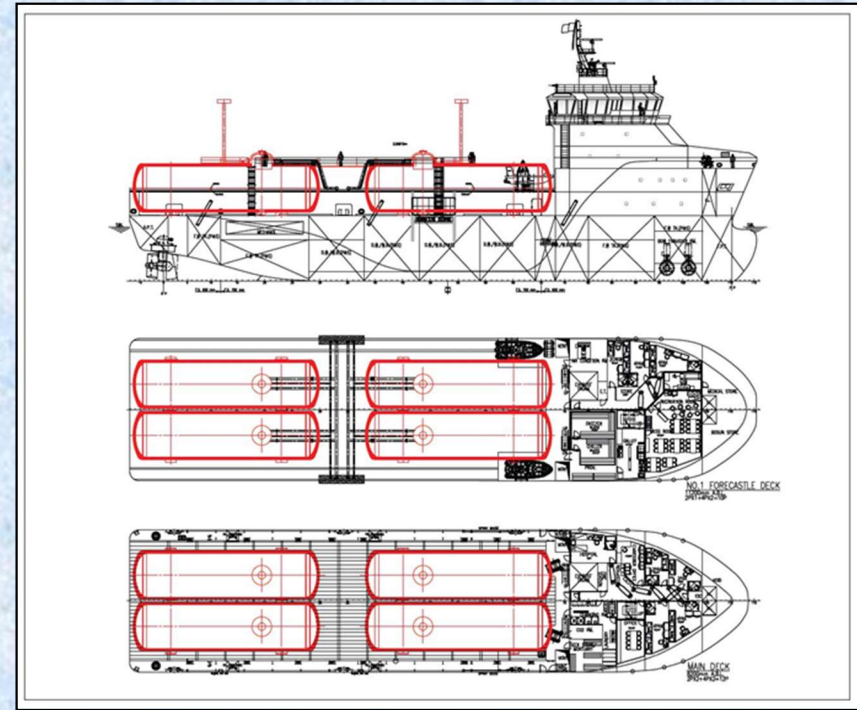
FACTORS GOVERNING THE CONVERSION COST:

- Estimated cost of conversion depends on the original configuration & properties of the vessel and feedback from shipyard.
- Cost of 4000 m³ LNG cargo containment system & controls to be obtained from vendor.
- Engine relocation / replacement depends upon operator's requirements – whether to go for Dual-Fuel engines or Pure Gas Engines. Separate cost towards engine modification has to be considered.
- Tentatively, the conversion cost should not be more than 10-15% of the vessel's original building cost subject to detailed analysis at next stage of the project.

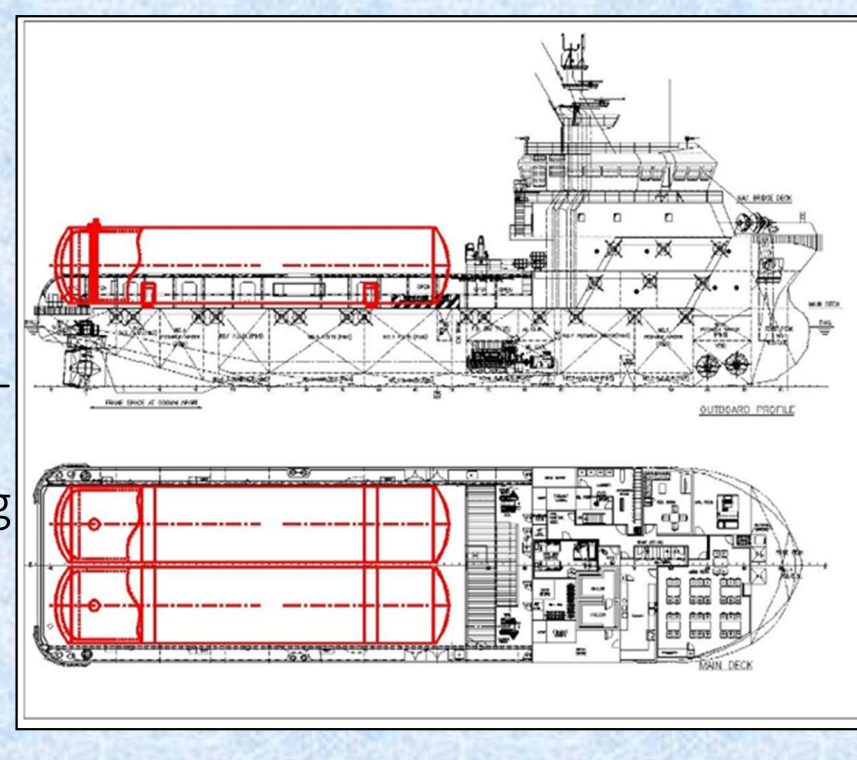


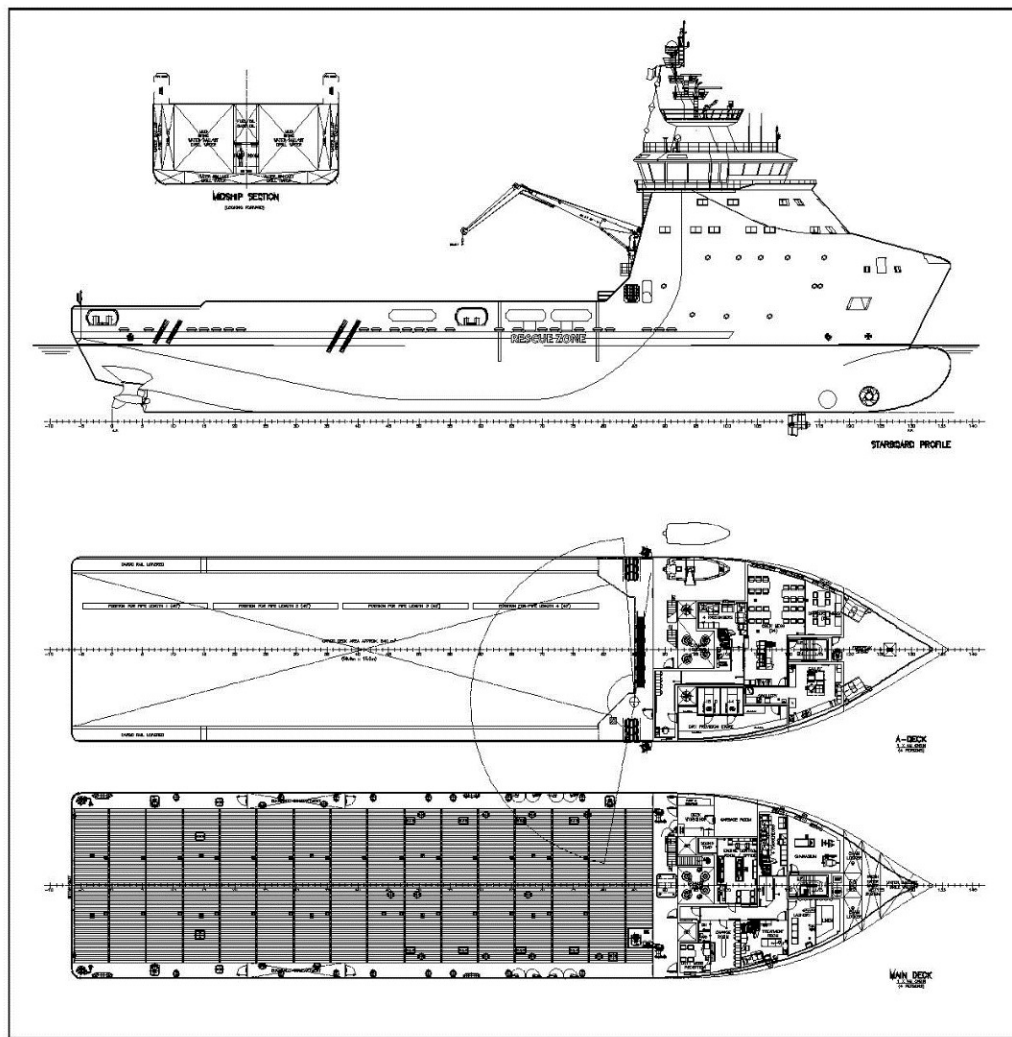


SOME OF THE AVAILABLE VESSELS & CONVERSION OPTIONS.

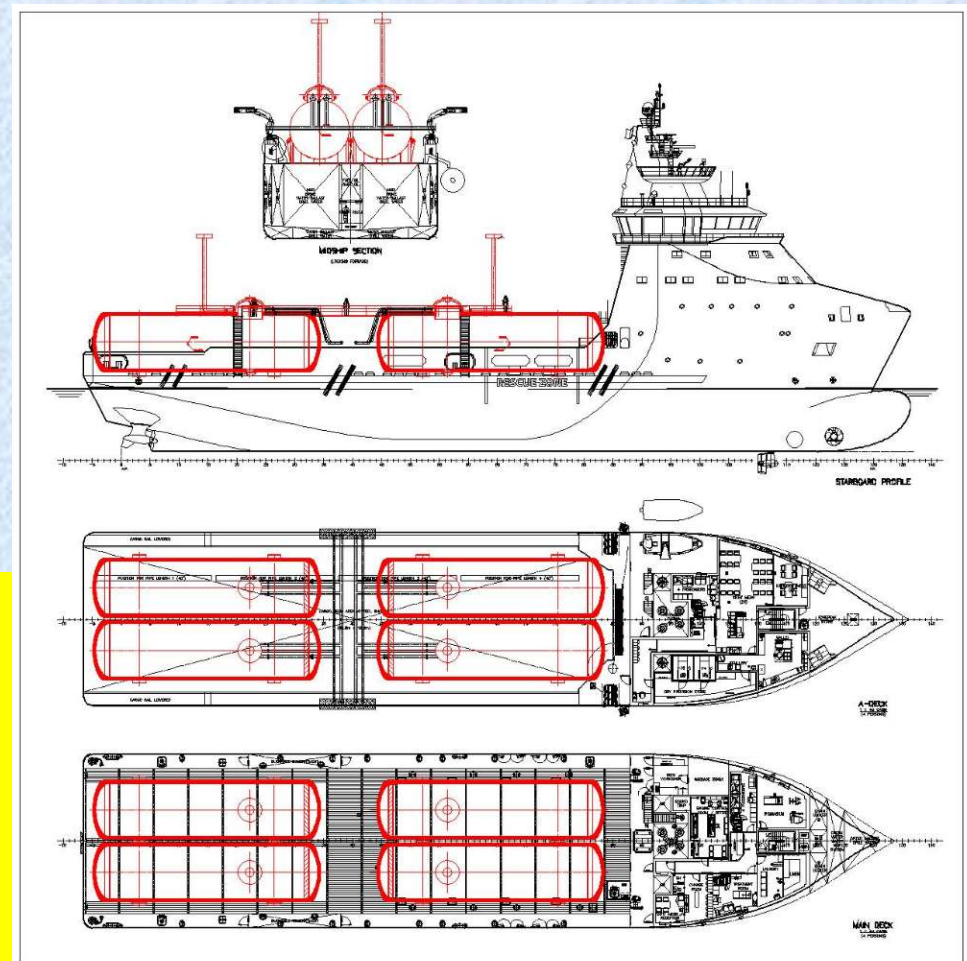


For deck mounted options, the PSV capability of under-deck cargo may be retained depending upon the vessel's existing design.



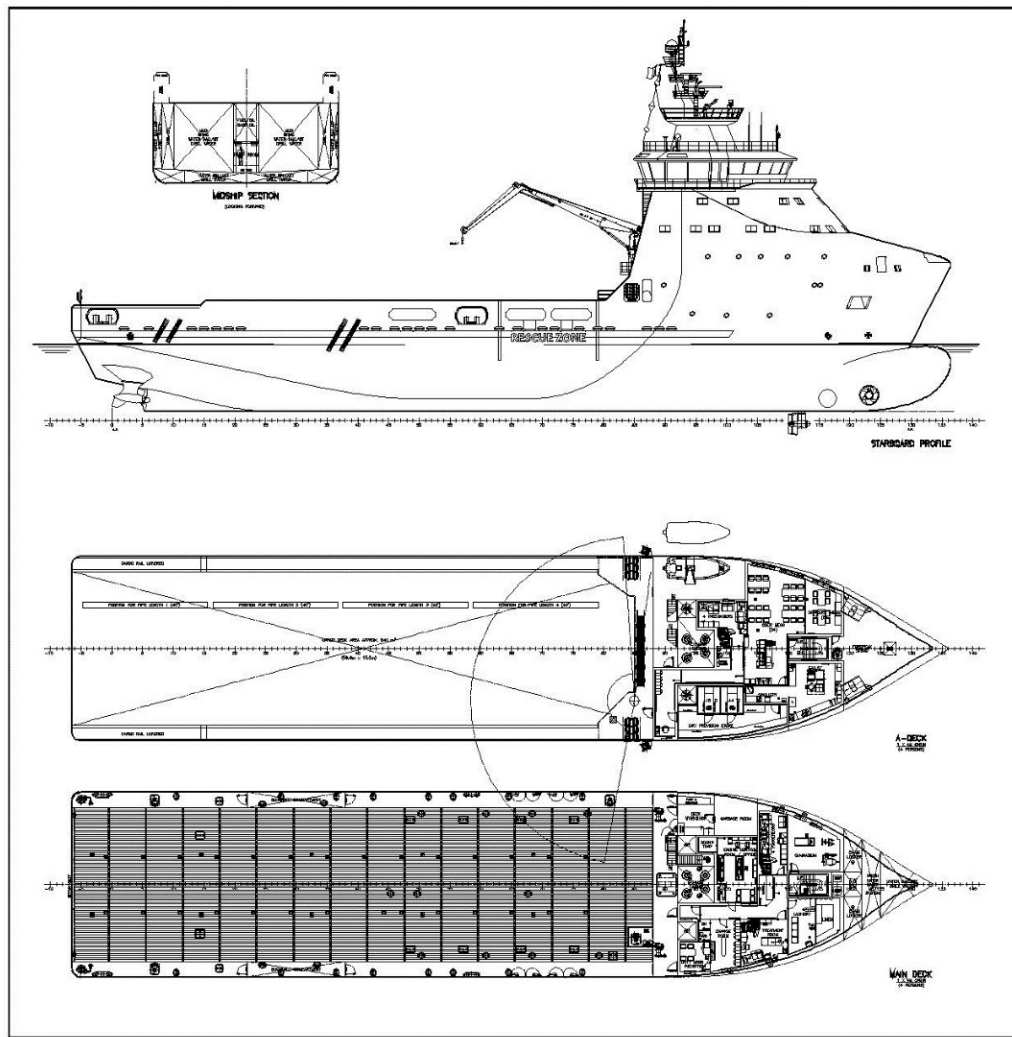


Existing PSV
 L.O.A – 85 M
 Breadth – 18 M
 Depth – 7.80 M

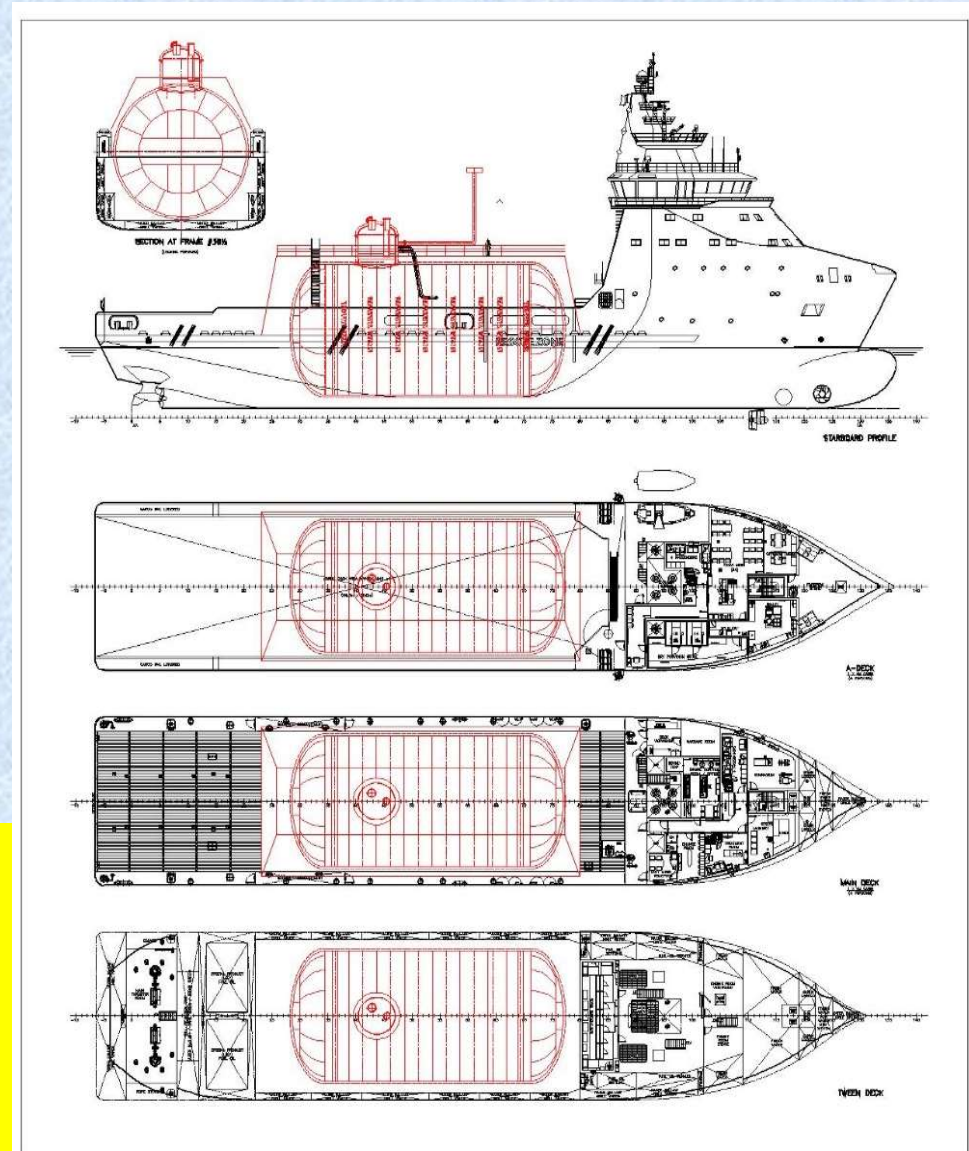


OUR PROPOSAL

LNG bunker vessel with 4 x 500 m³ LNG tanks above deck. For deck mounted options, the PSV capability of under-deck cargo may be retained depending upon the vessel's existing design

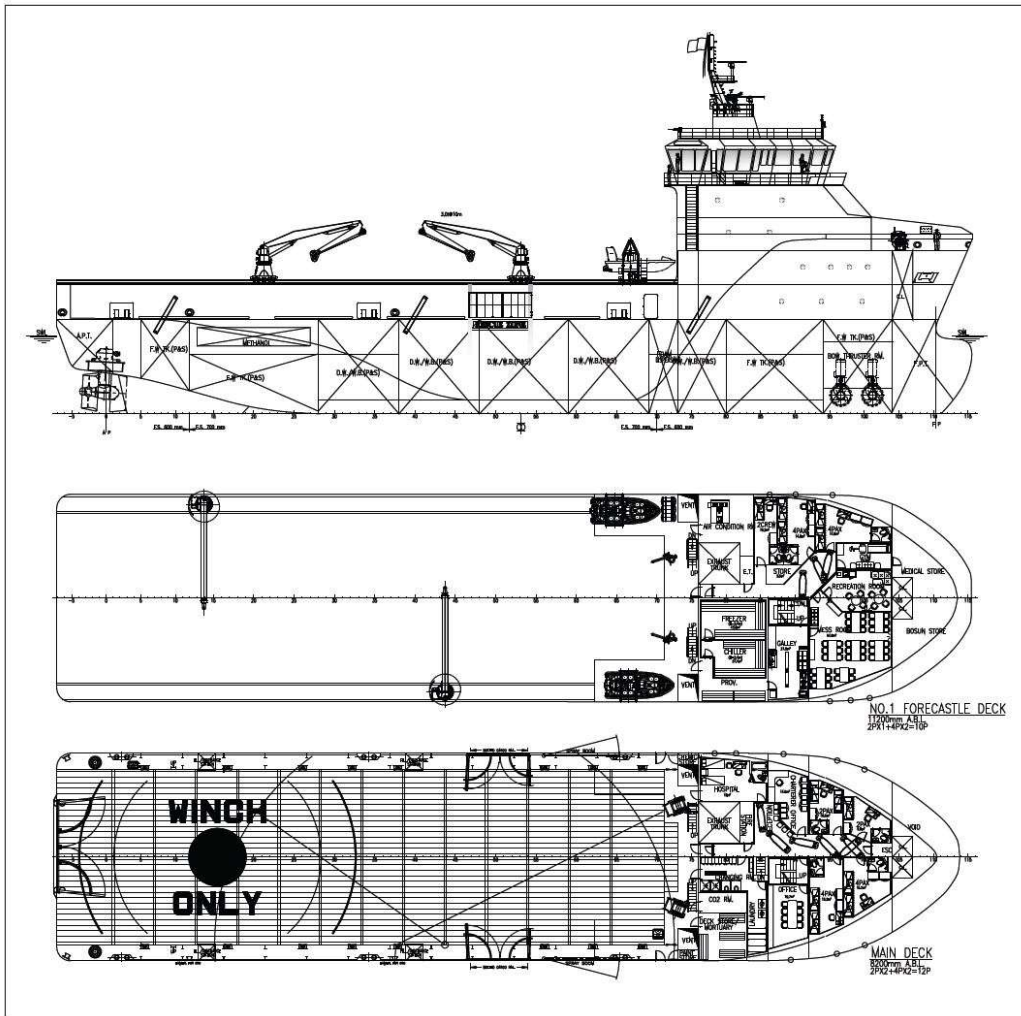


Existing PSV
 L.O.A – 85 M
 Breadth – 18 M
 Depth – 7.80 M



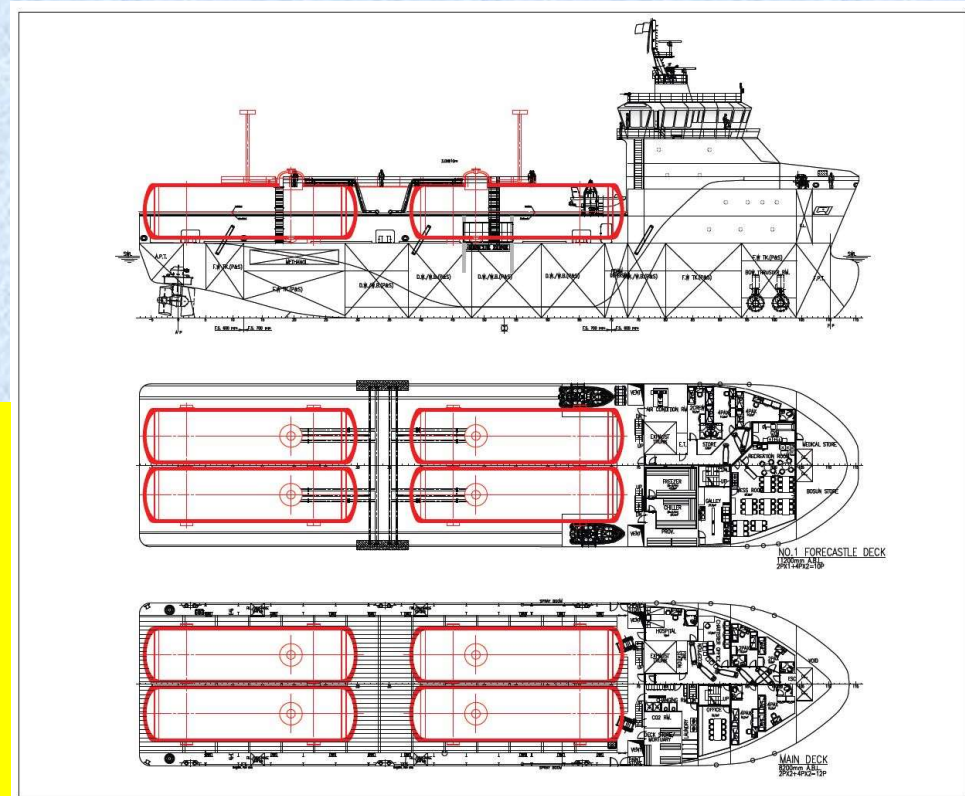
OUR PROPOSAL
 LNG bunker vessel
 with 1 x 4000 m³ LNG
 tank (hold-mounted)
 & dome on top.

Existing PSV
L.O.A – 80 M
Breadth – 18 M
Depth – 8.20 M



OUR PROPOSAL

LNG bunker vessel with 4 x 500 m³ LNG tanks above deck. For deck mounted options, the PSV capability of under-deck cargo may be retained depending upon the vessel's existing design

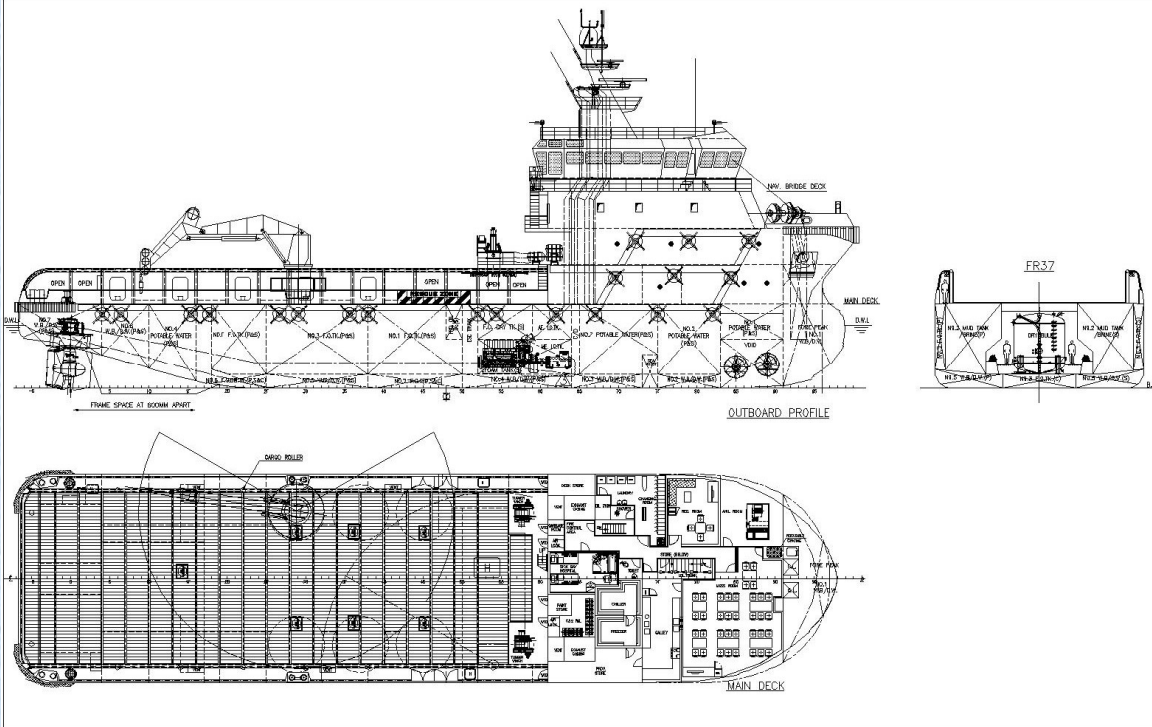


Existing PSV

L.O.A – 64 M

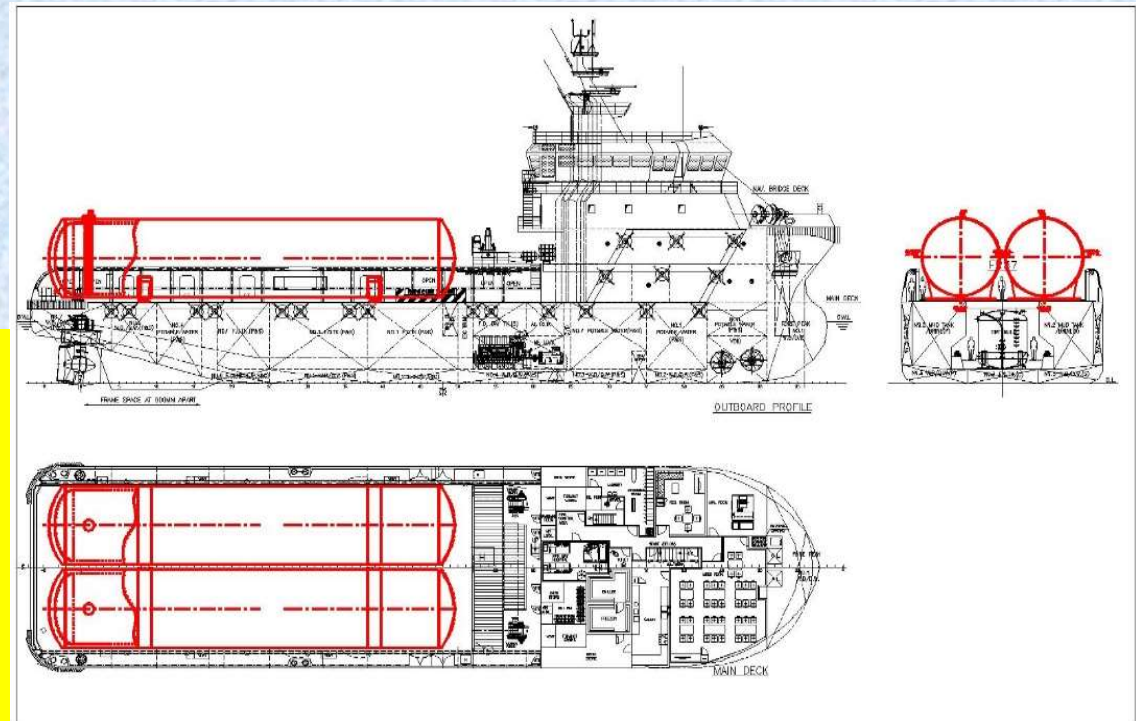
Breadth – 16 M

Depth – 6.50 M



OUR PROPOSAL

LNG bunker vessel with 2 x 700 m³ LNG tanks above deck. For deck mounted options, the PSV capability of under-deck cargo may be retained depending upon the vessel's existing design



CONVERSION : PSV TO LNG

2400 m³ LNG STS BUNKERING VESSEL



Main Particulars (Approx.)

Length Overall Hull	87.90 m
Breadth, moulded	19.00 m
Depth, main deck	8.00 m
Draught Design	6.60 m
LNG Tanks	4x600 m ³

Classification Society: ABS

Proposed notation: A1, Liquefied Gas Carrier, AMS, ACCU, IHM, HAB(WB), ENVIRO, NBLES

Optional notation: LNG Bunkering



CONVERSION : PSV TO LNG

4000 m³ LNG STS BUNKERING VESSEL



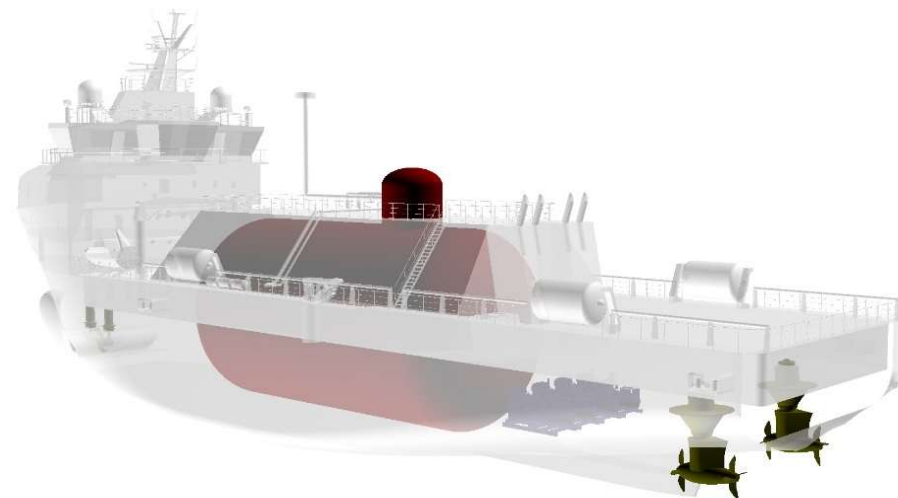
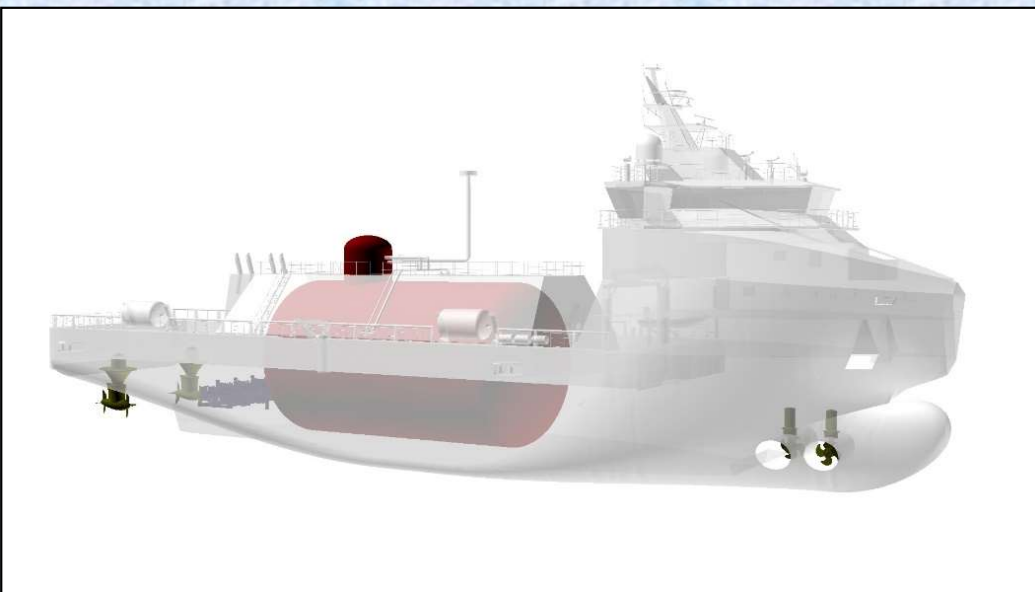
Main Particulars (Approx.)

Length Overall Hull	87.90 m
Breadth, moulded	19.00 m
Depth, main deck	8.00 m
Draught Design	6.60 m
LNG Tanks	1x4000 m ³

Classification Society: ABS

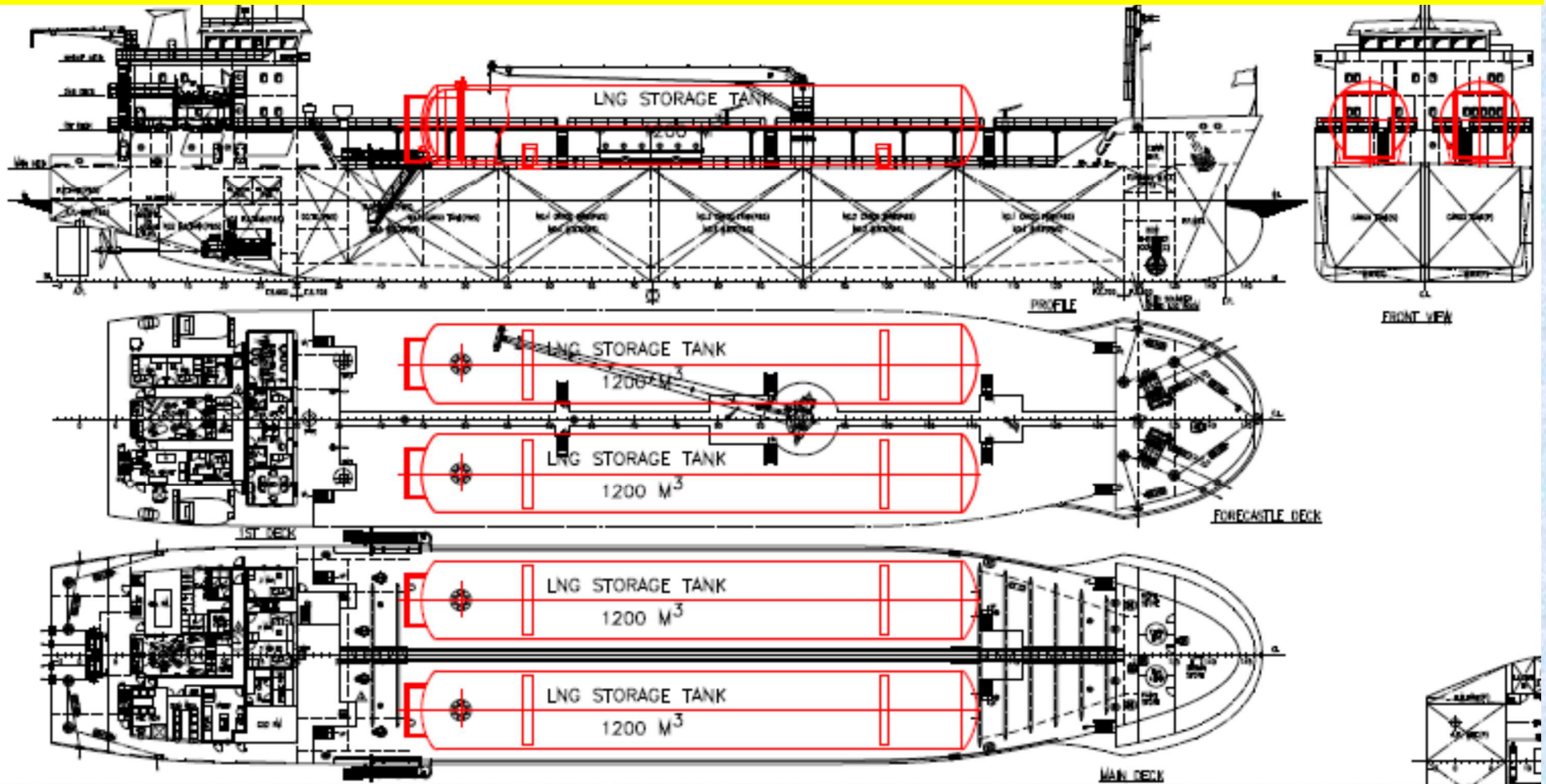
Proposed notation: A1, Liquefied Gas Carrier, AMS, ACCU, IHM, HAB(WB), ENVIRO, NBLES

Optional notation: LNG Bunkering



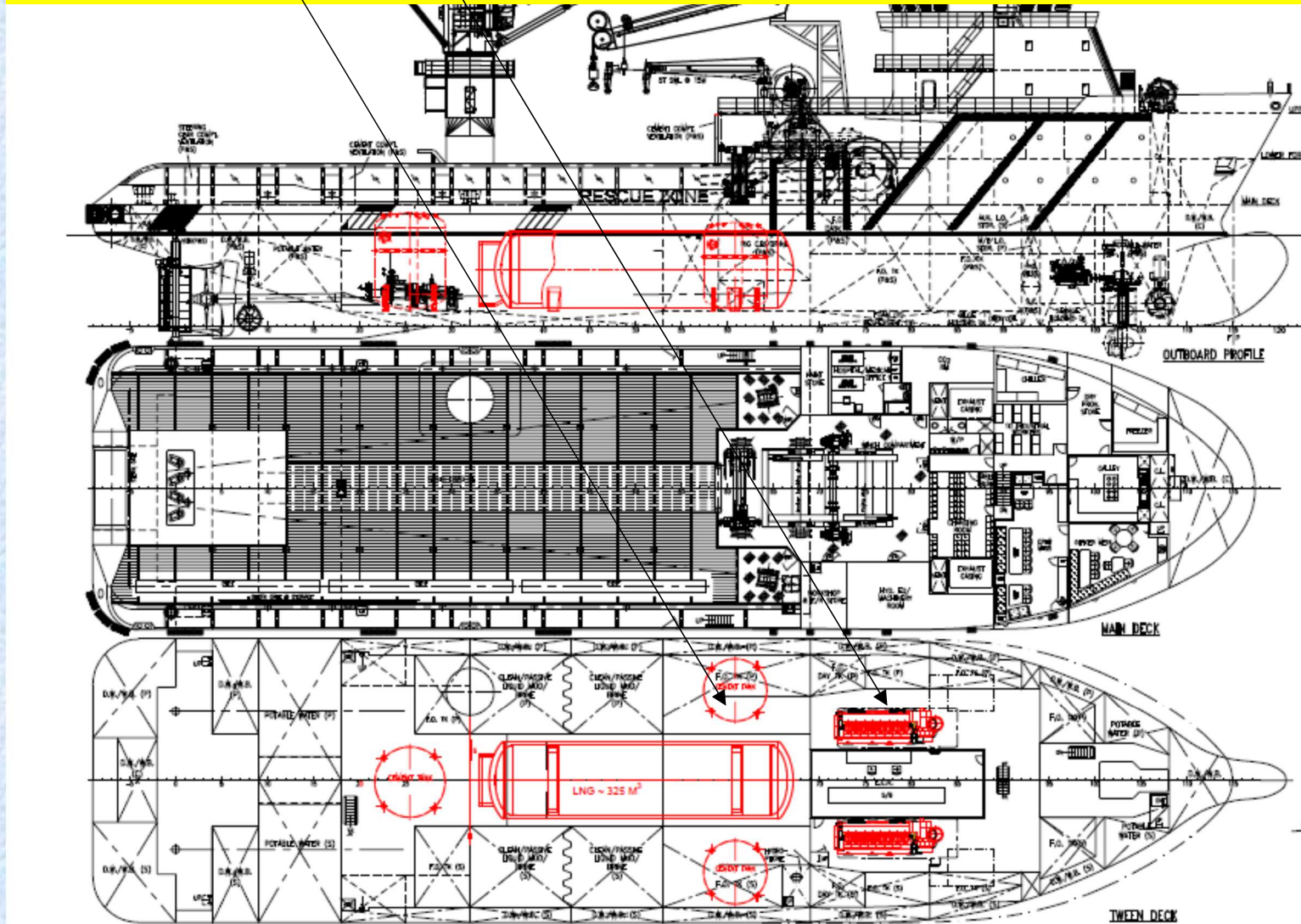
EXISTING BUNKER TANKER RETROFITTED WITH LNG TANKS (FOR LNG BUNKER OPERATIONS)

Navnautik's proposal is to add 2 x 1200 m³ LNG tanks on main deck of existing bunker tanker, thereby providing scope for LNG bunkering operations.



CONVERSION OF EXISTING AHT TO DUAL-FUEL (LNG/MDO)AHT

Navnautik's proposal includes rearranging tanks below main deck in order to accommodate LNG fuel tank & replacing existing Main Engines with Dual-Fuel Engines.

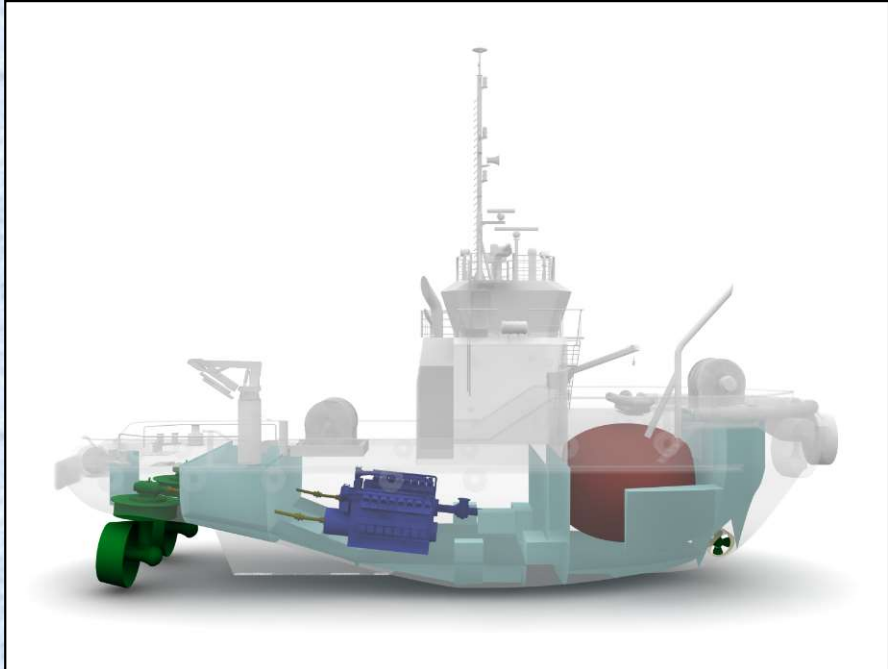


SCOPE OF WORK ENVISAGED FOR CONVERSION OF AN EXISTING VESSEL TO LNG BUNKERING VESSEL

Stage 1-	
1	Establish of the conversion is feasible
2	Identify the issues/ show stoppers related to conversion
3	Analyze donor vessels for suitability
4	Life extension program of donor vessel
5	Incase donor vessel is a 'lengthened vessel', then further structural analysis is to be done as per Class requirements.
6	Hazard analysis for IC engines placed fwd of LNG tank as per Class rules and IGC code. (depends upon donor vessel's layout)
7	Primary intact and damage stability analysis
8	Prepare a concept design of selected vessel.
9	Estimate costs for conversion and envisage timeline for the conversion
10	Advise on tank design and how to optimize carriage capacity for the given/chosen vessel
11	Propose minimum modifications to accommodate LNG tank inside main hull - existing tanks under deck will be compromised as required.
12	The following aspects need to be addressed as soon as we are ready with the donor vessel and its intended conversion: a) Discuss the project and its intricacies with Classification Society. b) Decide the geographical region (if possible) for this conversion project. c) Shortlist LNG tank and system vendor.

Stage 2-	
1	Detailed design once donor vessel is finalized
2	Updated tech specs of the LNG bunker vessel
3	Detailed stability analysis
4	Draw/ compose the stability information booklet
5	Make the stability program
6	Advise on Engine/ upgrade or renewal
7	Analyse speed/consumption performance
8	Get design approved by Classification Society

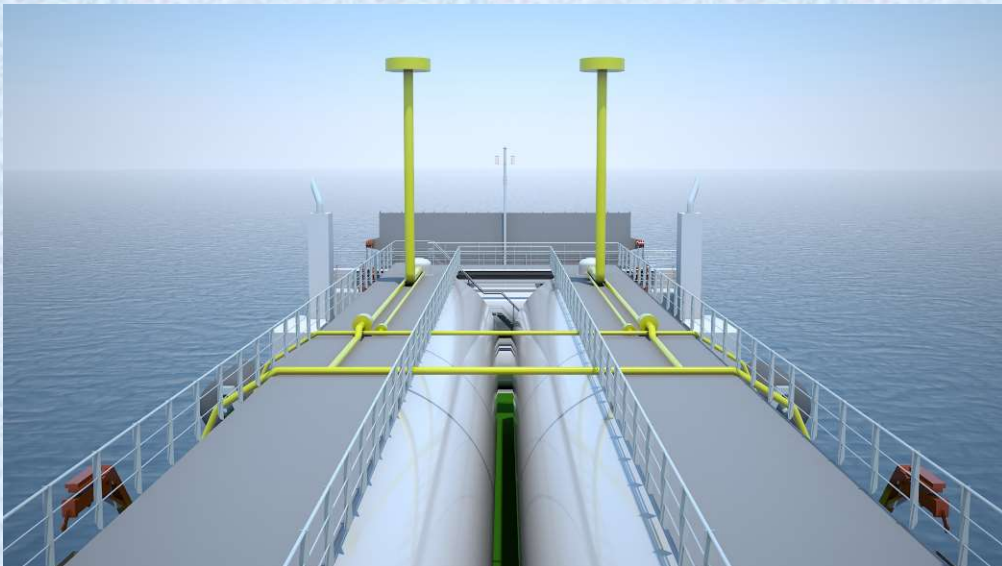
PILOT PROJECTS FOR NEW CONSTRUCTION



2400 M³ LNG LCT

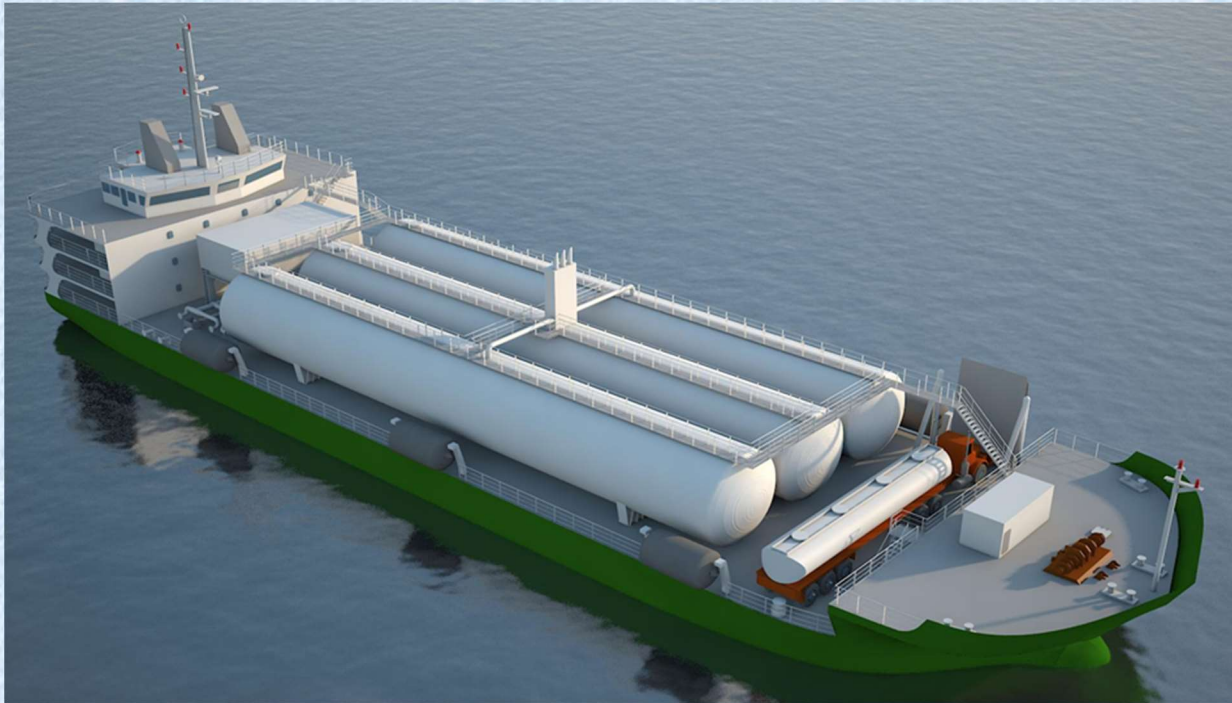
Principal Particulars:

Length Over All	- 75.00m
Breadth (mld)	- 22.00m
Depth (mld)	- 4.80m
Design Draft (mld)	- 2.50m
Speed	- 9 knots
LNG tanks (cargo)	- 2x1200 m ³
Main Engine	- 3 x 600 KW
Gensets	- 2 x 250 KW
Aux / Harbour Genset	- 1 x 120 KW
ASD Thrusters	- 3 nos.
MDO Cargo (<u>optional</u> under deck)	- 1200 m ³
Complements	- 16 (incl 4 officers)
LNG powered propulsion (<u>optional</u>)	



7200 m³ STS LNG BUNKERING VESSEL / OFFSHIP SUPPLY TANKER

OPTION 1



Main Particulars (Approx.)

Length Overall Hull	90.00 m
Breadth, moulded	24.00 m
Depth, main deck	8.50 m
Draught Design	6.00 m
Service Speed	10 knots @ 100% MCR

Classification Society and Notation:

ABS / BV / DNV-GL / LRS
ESP, Liquid Gas Carrier, Ship Type 2G, LNG,
Independent Type C, Min Temp – 164° C,
Oil Tanker FP>60° C, Unrestricted
Navigation, Clean Design, In Water Survey

OPTION 1 :

- Side ramp (SWL ~ 60 TONS)
- Road trailer filling on-board

Multiple Deployment Capability

- Bunkering LNG and MDO simultaneously Ship to Ship.
- Supply small batches of LNG and MDO to Shore Facilities.
- Supply LNG from Onboard Road Tankers to Islands without LNG Shore Facility.
- On-board filling up ISO tanks for offship supply.

7200 m³ STS LNG BUNKERING VESSEL / OFFSHIP SUPPLY TANKER

OPTION 2



Main Particulars (Approx.)

Length Overall Hull	90.00 m
Breadth, moulded	24.00 m
Depth, main deck	8.50 m
Draught Design	6.00 m
Service Speed	10 knots @ 100% MCR

Classification Society and Notation:

ABS / BV / DNV-GL / LRS
ESP, Liquid Gas Carrier, Ship Type 2G, LNG,
Independent Type C, Min Temp – 164° C,
Oil Tanker FP>60° C, Unrestricted
Navigation, Clean Design, In Water Survey

OPTION 2 :

- Crane (SWL ~ 50 TONS)
- Offloading 20/40ft ISO LNG Tank container onto road trailer on jetty.

Rule Compliance :

• Ship-to-Ship Transfer Guide (Liquefied Gases)	ICS/OCIMF/SIGTTO
• IGC Code	IMO
• IGF Code (Interim)	IMO
• SOLAS	IMO
• MARPOL 73/98	IMO
• STCW 78/95	STCW
• Standard Marine Communication Phrases	IMO
• ESD arrangement & linked ship/shore systems for Liquefied gas carriers	SIGTTO

5000 m³ LNG/ 5000 m³ MDO/HFO COMBINED BUNKERING VESSEL

NAVNAUTIK PROPOSES A COMBINED BUNKERING VESSEL i.e. TWO-IN-ONE APPROACH

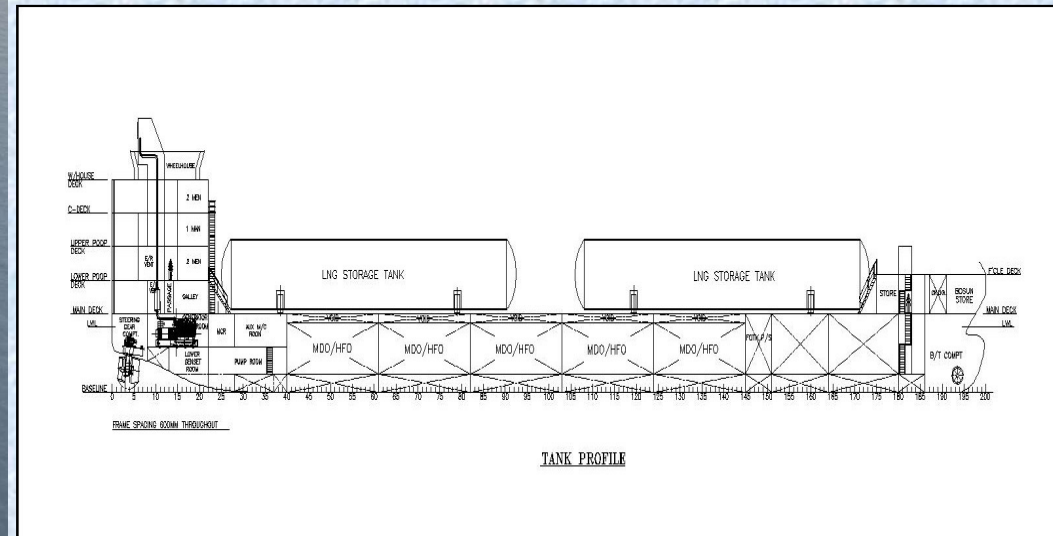
- Type 'C' tanks c/w bunkering system on deck.
- Under deck tanks to supply HFO or MDO.

Main Particulars (Approx.)

Length Overall Hull	120.00 m
Breadth, moulded	24.00 m
Depth, main deck	7.00 m
Draught Design	5.80 m
Draught Scantling	6.00 m
Service Speed	10 knots @ 100% MCR

Classification Society and Notation:

ABS / BV / DNV-GL / LRS
 ESP, Liquid Gas Carrier, Ship Type 2G, LNG,
 Independent Type C, Min Temp – 164° C,
 Oil Tanker FP>60° C, Unrestricted
 Navigation, Clean Design, In Water Survey



5000 m³ LNG BUNKERING VESSEL

General Vessel Specification (Preliminary)

LNG CARGO TANKS:

Make : TBA
 Number : Six (6)
 Capacity (each) : 900 m³
 Type : 'C'
 Material : SS1.4311 X2 CrNi N18-10
 or equivalent.
 Insulation : Vacuum + Perlite
 Allowable Pressure : 4.2 bar

LNG CARGO PUMPS:

Number : Three (3)
 Type : Frequency Controlled
 Capacity (each) : 400 m³/hr @ 8 bar

LNG RE-LIQUIFACTION:

As per vendor's specification to suit boil off control.

HFO / MDO Cargo Tanks:

Number : Five (5)
 Grades of cargo carried: Two (2)
 Product range : MDO / HFO

HFO / MDO Cargo Pumps:

Number : Four (4)
 Capacity (each) : 400 m³/hr @ 10 bar

POWER & PROPULSION

Diesel-Driven Alternators:
 Number : Four (4)
 Type of Fuel : MDO
 Output : 920KW

Harbour Generator:
 Number : One (1)
 Type of Fuel : MDO
 Output : 250 kW

Emergency Generator:

Number : One (1)
 Type of Fuel : MDO
 Output : 99 kW

ASD Thruster:

Number : Two (2)

Bow Thruster:

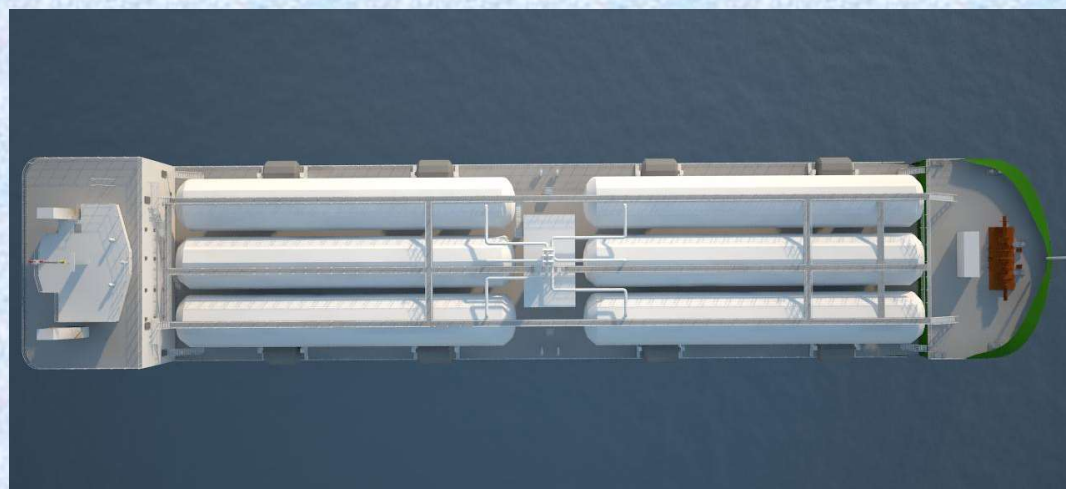
Number : One (1)
 Output : 500 Kw
 Type : CPP

Capacities (Ship's use):

MDO : 300 m³
 FW : 100 m³

Accommodation:

Total Complement : 20 men



3600 m³ LNG/ 2000 m³ MDO/HFO COMBINED BUNKERING VESSEL

NAVNAUTIK PROPOSES A COMBINED BUNKERING VESSEL i.e. TWO-IN-ONE APPROACH

- Type 'C' tanks c/w bunkering system on deck.
- Under deck tanks to supply HFO or MDO.

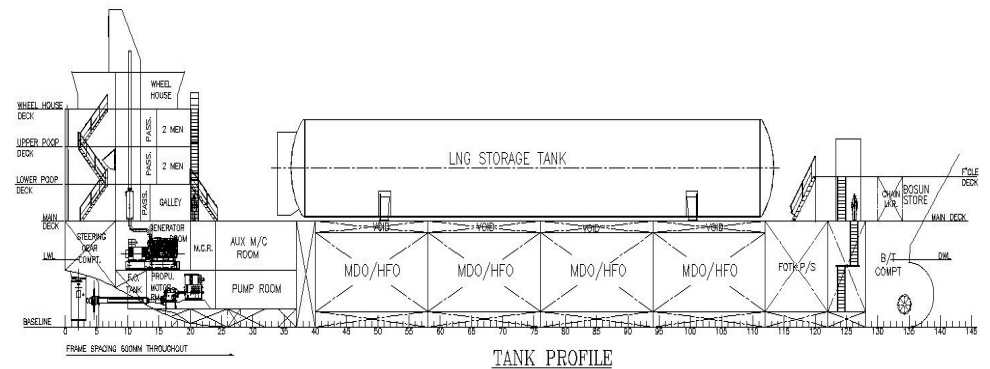
Main Particulars (Approx.)

Length Overall Hull	85.80 m
Breadth, moulded	22.40 m
Depth, main deck	7.10 m
Draught Design	5.80 m
Draught Scantling	6.00 m
Service Speed	10 knots @ 100% MCR

Classification Society and Notation:

ABS / BV / DNV-GL / LRS

ESP, Liquid Gas Carrier, Ship Type 2G,
LNG, Independent Type C, Min Temp –
164° C, Oil Tanker FP>60° C, Unrestricted
Navigation, Clean Design, In Water
Survey



3600 m³ LNG BUNKERING VESSEL

General Vessel Specification (Preliminary)

LNG CARGO TANKS:

Make : TBA
 Number : Three (3)
 Capacity (each) : 1200 m³
 Type : 'C'
 Material : SS1.4311 X2 CrNi N18-10
 or equivalent.
 Insulation : Vacuum + Perlite
 Allowable Pressure : 4.2 bar

LNG CARGO PUMPS:

Number : Three (3)
 Type : Submerged
 Capacity (each) : 250 m³/hr @ 8 bar

LNG RE-LIQUIFACTION:

As per vendor's specification to suit boil off control.

HFO / MDO Cargo Tanks:

Number : Four (4)
 Grades of cargo carried: Two (2)
 Product range : MDO / HFO

HFO / MDO Cargo Pumps:

Number : Four (4)
 Capacity (each) : 250 m³/hr @ 10 bar

POWER & PROPULSION

Diesel-Driven Alternators:

Number : Three (3)
 Type of Fuel : MDO
 Output : 920KW

Harbour Generator:

Number : One (1)
 Type of Fuel : MDO
 Output : 250 kW

Emergency Generator:

Number : One (1)
 Type of Fuel : MDO
 Output : 99 kW

Electric Motor Driven

Propulsion system

Number : Two (2)

Bow Thruster:

Number : One (1)
 Output : 500 Kw
 Type : CPP

Capacities (Ship's use):

MDO : 300 m³
 FW : 100 m³

Accommodation:

Total Complement : 24 men



65T BP LNG TUG (<500T GRT)

Main Particulars (Approx.)

Length Overall Hull	33.20 m
Breadth, moulded	11.00 m
Depth, main deck	5.60 m
Design Draft (Max.)	5.00 m
Tonnage	< 500 GRT
Open Deck Space	50 m ²
Speed	12.5 knots
Bollard Pull Ahead	65 MT
Complements	8

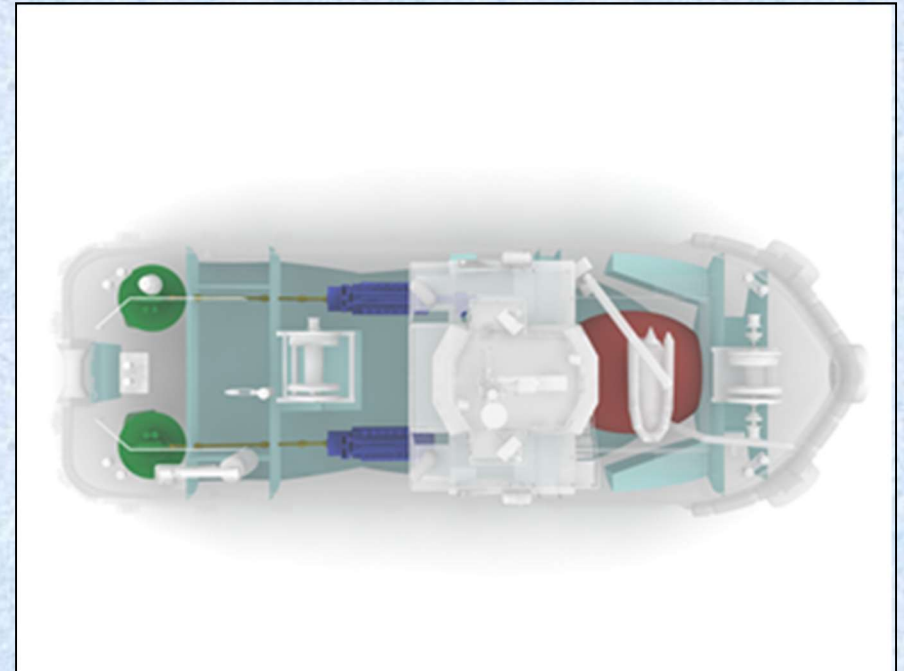
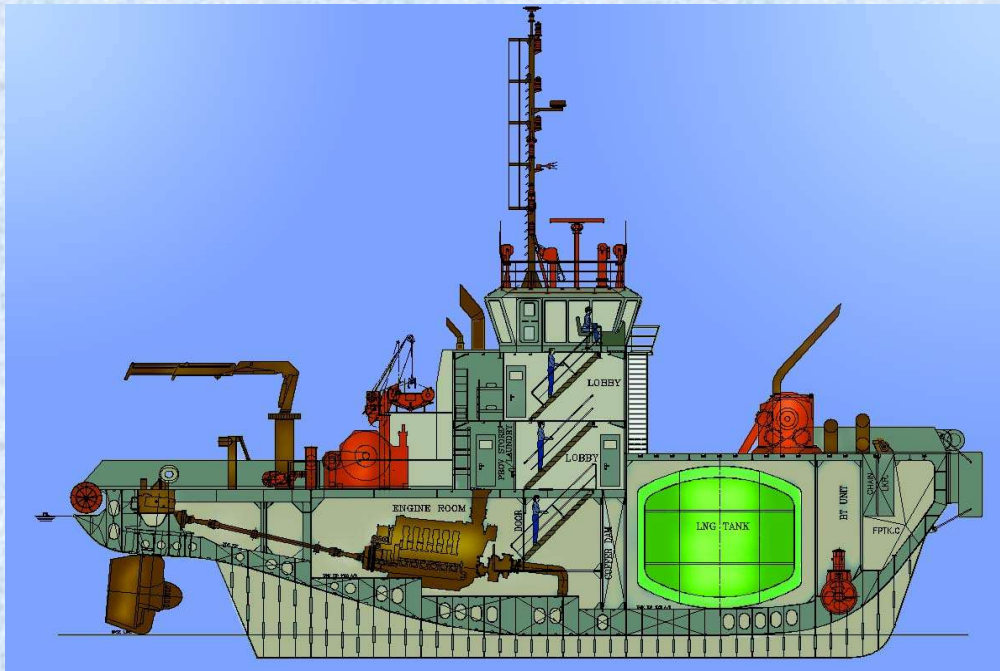


Special Features

The propulsion to be dual fuel engines.

Proposed Class notation:

LNG Tug Dual Fuel
Firefighting Vessel Class 1 to
any IACS Class.



100T BP VOITH TRACTOR TUG (ESCORT TUGS)

Main Particulars (Approx.)

Length Overall Hull	42.00 m
Breadth, moulded	15.00 m
Depth Amidship (mld)	6.00 m
Draft of Hull	3.70 m
Max Draft	6.80 m
Speed	14 knots
Bollard Pull Ahead	100T
Complements	7



Class notation:

LR + 100A1 Escort Tug, IWS, Fire Fighting Ship 1 with Water spray, Unrestricted Service – for Worldwide Service

Main Engines / Propellers

Two (2) medium speed diesel engines of 4000KW @1000RPM connected to two (2) Voith Schneider propellers via shafting.

Electrical Generating Plant

Two (2) diesel generator sets of about 200KW each consisting of one diesel engine directly coupled to one alternator for each set.

36m LNG ESCORT TUG (WITH SWAPPABLE LNG ISO CONTAINERS)

Main Particulars (Approx.)

Length Overall Hull	36.00 m
Breadth, moulded	15.00 m
Depth, main deck	6.10 m
Design Draft (Max.)	5.00 m
Extreme Draft	6.50 m
Tonnage	<1600 GRT
Open Deck Space	125 m ²
Speed	13 knots
Bollard Pull (max)	90 MT
Complements	10

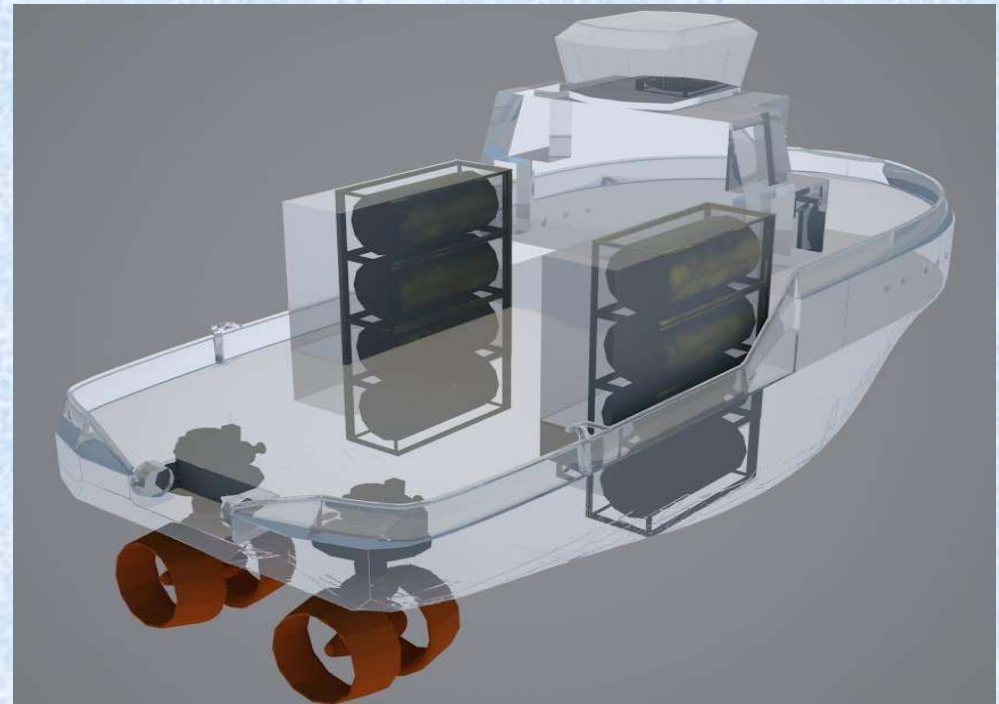
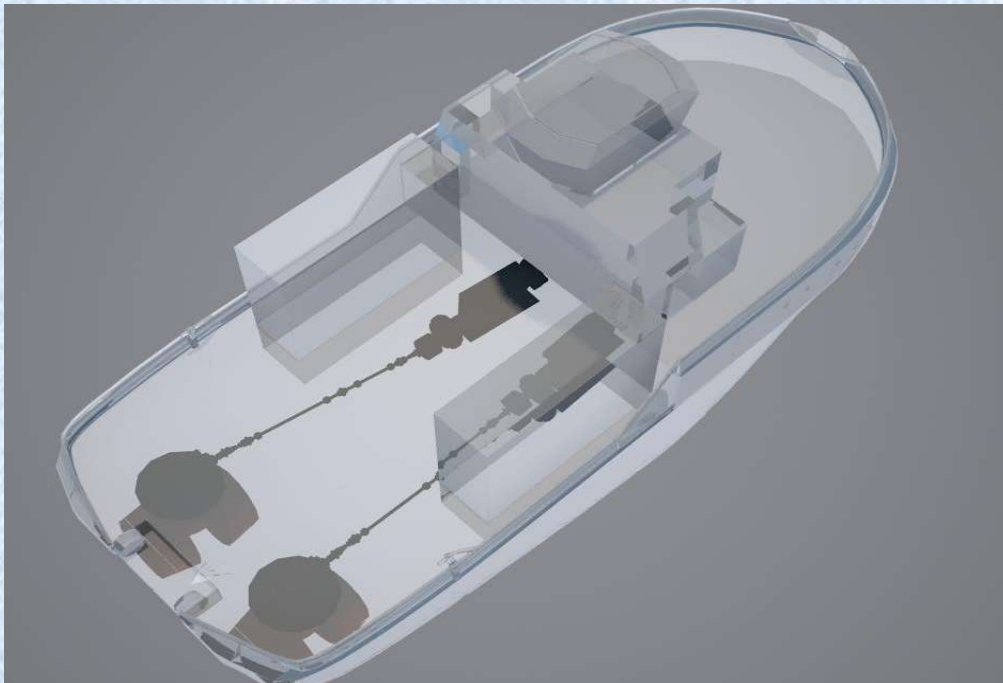


Special Features

- No LNG Bunker filling necessary.
- Tug's crane swaps 20 ft LNG container fuel tanks from any wharf facility like normal cargo handling.

Proposed Class notation:

ABS / BV / DNV-GL / LRS



TUG SPECIFICATIONScont'd.....

Tank Capacities

MDO	140.00 m ³
LNG	160.00 m ³
Fuel Oil Overflow	7.50 m ³
Dirty Oil	5.00 m ³
Oily Water	7.50 m ³
Sludge	6.00 m ³
Hydraulic Oil	2.00 m ³
Fresh Water	70.00 m ³
Gray Water	10.00 m ³
Sewage Holding	8.00 m ³
Foam Storage	12.00 m ³
Lube Oil	4.00 m ³

Accommodation

2 x Single Cabin with attached toilet
4 x Double Cabin with attached toilet

Propulsion Machinery:

• Main Engines

Up to 2x2700 kW generators using Liquid Fuel / Dual Fuel / Gas Fuel

• Generator

3 Nos : 340 kw

• Emerg Generator

_1 No : 99 kw

• ASD Thruster

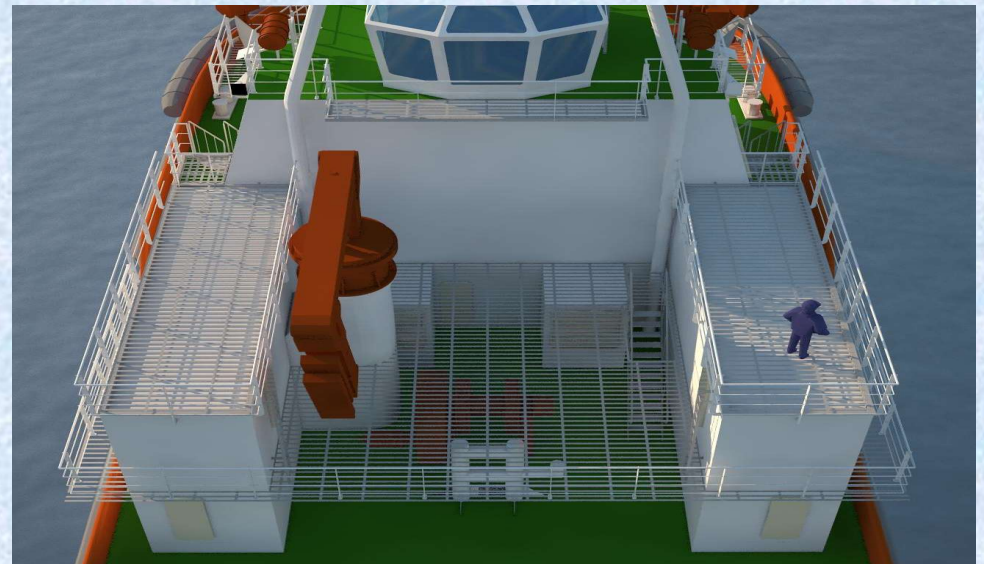
2 x (Cardan Shaft Driven) : CPP ASD Thruster

Deck Machinery:

- Crane: 1 no. on AFT Deck 22T capacity
- Wire Guide Pins: 200MT Triplex or equivalent
- Aft Towing Winch (Electr): Brake Holding 175T
- Bow Winch: Brake holding 225T
- Stern Roller: SWL 125 Ton, Length 3m at 0.8m dia

Endurance:

7 days (under normal Terminal duty cycle)



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