BRAEMAR
ENGINEERING

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180k LNG Vessel Specification

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Revision History

Issue	Description	Date	Checked	Approved
12	Updated with E-On Comments	23/09/2015	RY	AJB
11	XDF Propulsion System Selected	17/09/2015	JT	RY
10	XDF Propulsion System Selected	14/08/2015	GG	RY
9	Minimum Requirements	04/04/2014	IL	AJB
8	Revised vessel size	27/11/2013	IL	AJB
7	Incorporating builder comments	26/11/2013	IL	AJB
6	Final	22/10/2013	IL	AJB
5	Incorporating client comment	16/10/2013	IL	AJB
4	Combined Specification	08/10/2013	WR	AJB
3	Specification (Combined) after E-ON revision	26/09/2013	WR	AJB
2	Updated to include containment system, machinery options and classification details	13/09/2013	GG	AJB
1	Draft Specification excluding containment and propulsion system	30/08/2013	WR	AJB

NOTE

This document is for information to bidders as to the general requirements of E.ON for these vessels.

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Abbreviations

ABS	American Bureau of Shipping	IGC	International Gas Code
ACCU*	Automatic Centralized Control Unmanned	ILO	International Labour Org.
AMS*	Machinery Constructed Under Survey	IMO	International Maritime Org.
APS*	Bow Thruster Constructed Under Survey	INS	Integrated Navigation System
		IR	Infra-Red
AVR	Automatic Voltage Regulator		
BOG	Boil Off Gas	LD	Low Duty
BOR	Boil Off Rate	LV	Low Voltage (< 1KV)
BV	Bureau Veritas		
CCR	Cargo Control Room	LHV	Lower Heat Value
CCTV	Closed Circuit Television	LN_2	Liquefied Nitrogen Gas
CFCs	Chlorofluorocarbons	LNG	Liquefied Natural Gas
CH_4	Methane	LSA	Life Saving Appliances
CM*	Condition Monitoring	LSFO	Low Sulphur Fuel Oil
CO_2	Carbon Dioxide	MARPOL	International Convention for Prevention of Pollution from Ships
CPS*	Coating Performance Standard		
CTS	Custody Transfer System	MCR	Maximum Continuous Rating
D	Double	MPI	Magnetic Particle Inspection
DFD*	Dual Fuel Diesel	MSC	Marine Safety Committee
		NBOG	Natural Boil Off Gas
DFT	Dry Film Thickness	NDT	Non Destructive Testing
DMB	Marine Distillate Fuel (B)	NIBS*	Navigation Integrated Bridge System
DNV	Det Norske Veritas	OCIMF	Oil Companies Intl Marine Forum
ECDIS	Electronic Chart Display and Info System	PCB	Polychlorinated Biphenyl
		PCHE	Printed Circuit Heat Exchanger
ECR	Engine Control Room	PMS*	Planned Maintenance System
ER	Engine Room (Main Machinery Room)	PSPC	Protective Coating Performance Standard
ES*	Environmental Safety	PTFE	Polytetrafluoroethylene
ESD	Emergency Shut-Down	QC	Quality Control
FAT	Factory Acceptance Test	+R*	Data Recording
FF	Fire-Fighting	R*	Propulsion Redundancy
FMEA	Failure Modes Events Analysis	R1*	Propulsion Redundancy (single shaft)
FRC	Foul Release Coating	R2*	Propulsion Redundancy (twin shaft)
FW	Fresh Water	RELIQ*	Reliquefaction Unit
GCU*	Gas Combustion Unit	SFA*	Spectral Fatigue Analysis
GRP	Glass Reinforced Plastic	SH-DLA*	Safe-Hull Dynamic Loading Analysis
GP*	Green Passport	SHCM*	Safe Hull Construction Monitoring

GVU	Gas Valve Unit	SIGTTO	Society of International Gas Tanker and Terminal Operators
HAB+*	Stringent Habitation Standards For Sea Staff.		
HCFC	Hydro chlorofluorocarbons	SMS	Ship Management System
HD	High Duty	SPC	Self-Polishing Co-polymer
HFO	Heavy Fuel Oil	SPS	Ship Performance System
HHV	Higher Heating Value	SW	Sea Water
HM*	Hull Monitoring	TCM*	Tail shaft Condition Monitoring
HSQE*	Health, Safety, Environmental and Quality Cert.	UHF	Ultra High Frequency
		UPS	Uninterruptable Power Supply
HSSE	Health Safety Security and Environment	USCG	United States Coast Guard
HV	High Voltage (>1 kV)	UT	Ultrasonic Testing
IACS	International Association of Classification Societies	UWILD*	Under-Water Inspection In Lieu of Dry-Docking
		VHF	Very High Frequency
IAS	Integrated Automation System	VDR	Voyage Data Recorder
ICCP	Impressed Current Cathodic Protection	VFD	Variable Frequency Drive
IEC	International Electro-technical Commission	WB	Water Ballast
IEEE	Institute of Electrical and Electronics Engineers	WL	Water-line
		XLPE	Cross Linked Polyethylene
IG	Inert Gas	*= Class Notation	

GENERAL

PRINCIPLE PROVISIONS

Introduction and General Clauses

Introduction

The purpose of this Outline Specification is to give direction and purpose to shipyards in developing and proposing designs for high efficiency LNG carrier powered by an XDF slow speed two stroke dual fuel diesel engine.

The vessel will be thermally efficient with a maximum, guaranteed boil off rate (BOR) of not more than 0.1% per day.

The vessel will be efficient and flexible in their ability to trade in a very wide range of geographic areas and in a wide range of modes. In addition to a normal case of 100% loaded, tanks 98.5% full, the vessels will be capable of operating with:-

a) No.1 Cargo Tank empty all other cargo tanks full

b) No. 2 or 3 Cargo Tank empty all other cargo tanks full

Ballast may be used to achieve this but yards are to provide definition as to how this will be achieved and are to provide details of procedures to achieve this.

In considering and developing designs builders will design the vessel to operate at a service speed of 19.5 knots as defined in Section 1.3 Powering and Speed, Sub-section 1.3.3 Speed. However builders will design and develop propulsion systems such that the vessels can operate safely and efficiently at speeds as low as at which only natural boil off gas (NBOG) is consumed for extended periods. Builders shall indicate the speed at which maximum natural boil off gas (NBOG) is consumed. The hull form should be optimized, without impeding the delivery performance criteria, the power speed curves between 15 and 19.5 knots that the ballast and design loaded conditions should reflect the amount of boil off gas being produced in that the power speed curve for the ballast voyage is below the design loaded curve.

The vessel will be designed to operate utilizing gas as primary fuel for extended periods and in all operating conditions. Note that the LHV of the initial boil off gas may be as low as 26 MJ/Nm3

In all cases builders will submit copies of safety cases for all propulsion system.

Builders will provide operating, speed and consumption data for the twin skeg design. Builders will define, and provide data, for vessels operating capability in the event of a single propulsion failure.

Builders may offer Moss or Membrane Containment Systems. In offering containment systems builders will offer only the most robust, proven versions of containment systems. Containment systems will offer a maximum guaranteed boil of rate of 0.1% per day for membrane and 0.08% for Moss.

Builders are to ensure that gas management systems ensure minimum gas is sent to the GCU.

A Partial Reliquefaction System (PRS) shall be installed to recover excess BOG and return it to the cargo tanks. A BOG Booster Compressor shall be installed, where a Joule-Thomson system is used.

Builders are to ensure that maintenance requirements are a) minimized and that b) space, lifting arrangements and provisions will allow for safe, optimum maintenance.

Materials and Workmanship

Only environmentally safe and hazard free materials are to be used in the construction of the vessel.

All materials and system contents used during construction and fitted to the ship are to be non-toxic smoke emitting, non-PVC and shall be fire retardant as well as being Halon, CFC, PCB's and asbestos free throughout.

The Builder shall aim at selecting a single maker for similar types of equipment of such groups, such as pumps, motors, instruments, control valves etc.

The builder shall procure equipment from sources as specified in the agreed 'Manufacture List'. The builder's proposed manufacture list shall be agreed with the buyer prior to contract award. Any modification or alteration of manufacture list must be approved by buyer.

The principle of using a single Maker (supplier) for all hardware, software and documentation shall be applied to the major systems (propulsion system, integrated automation system) as far as practicable. While the Builder shall be the SPOR for the Shipboard System, and appoint an Integrator mutually agreed by the Buyer, it is acceptable that the equipment Maker shall assume technical responsibility, on behalf of the Builder, for all integration and compatibility issues between the different sub-systems that are contained within a major system.

Measurement Unit and Language

Unless otherwise specified, the SI system shall be adopted for design and construction of hull, machinery and equipment including: length in meters (m), mass in kilograms (kg), time in seconds (s) and hours (h), weight in metric tons (t), pressure in bars (bar), capacity in t/h, kg/h, m3/h or Nm3/h, velocity in m/s, speed in knots, heat transfer and power in kW, specific fuel consumption in g/kW/h, temperature in degrees centigrade unless otherwise specified in the Specifications and agreed by the Buyer.

Spare Gear

Spare gear shall be provided for two years continuous operations.

Commonality of equipment is to be considered to ease the spares purchase.

GENERAL DESCRIPTION OF THE VESSEL

The Vessel's fitted equipment shall have an operational life of at least 30 years. The hull and cargo containment systems shall have an operational life of 40 years based on world-wide trading.

The Vessel shall be able to use cargo vapour (methane), HFO with a sulphur content of 3.5% or DMA with a sulphur content of less than 0.1% as fuel. Vessel shall be capable of continuous operation on any of these fuels or mixtures of methane and HFO.

Boil off rate is to be less than or equal to 0.10%. In case there is a PRS fitted on board, the BOR should be 0.075% or less. of cargo volume per day. The cargo handling equipment shall allow the ship to be operated between 15 knots up to the Service Speed without burning gas (excess BOG) in the GCU.

In addition to the loaded and ballast passage, the vessel shall be capable of utilising cargo vapour as fuel during loading and discharging operations. The gas management system is to be capable of 100% gas-burning operations during loading and discharge. The ESD system shall be designed so that this is achieved in a safe manner complying with all rules and regulations.

The vessel shall comply with any expected retrospective IMO regulations and all relevant IMO regulations in effect at contract signing, keel laying or on the date of delivery of the vessel whichever is applicable.

The vessel shall comply with IMO's EEDI (Energy Efficiency Design Index) & SEEMP (Ship Energy Efficiency Management Plan) requirements.

The overall efficiency of the fuel and consumption shall be optimised and guaranteed by the Builder.

The Builder is to optimise the shaft horse power requirements by model testing to provide the most economical fuel efficiency as it is reasonably practical to do so. Initial ship speed / power curves shall be provided for design loaded draft and ballast conditions as part of tender package. Model tests to be repeated and witnessed by the buyer for optimisation purposes (at least three iterations).

General Arrangement

An under trunk deck, subject to containment system, passageway shall be provided port and starboard for access over the cargo tank length of the Vessel. These passageways shall also be large enough for all pipe and cable passages. FO transfer lines shall be situated within one of the passageways – i.e. not on the outside of the sloping trunk deck or main deck.

A duct keel passageway shall be provided (mainly for the ballast piping, and eductors for the insulation space) in the double bottom area. All main ballast tank valves are to be contained within this passageway. Access to this duct keel shall be via separate vertical access trunking at the forward and aft ends of the cargo length. The trunkings shall be such that emergency rescue is possible of a person on a stretcher via a direct lift. The duct keel will contain a grated walk way and a railed trolley.

FO tanks and DO tanks shall not be incorporated in the double bottom area.

The location of FO or DO tanks to be in accordance with MARPOL requirements but in no case shall be under the accommodation block or in the double bottom structure. Tanks shall

be fitted longitudinally where possible, but wherever transverse tanks are required, specific anti-sloshing structures and vents shall be fitted to ensure that FO or DO cannot be accidentally vented during excessive ship motions when tanks are near or at capacity

The Vessel shall have minimum flat of side above the ballast waterline, extending at least from 80 m aft to 60 m forward of the centre of the vapour return line.

Cargo tanks to be situated in accordance with specific rules relating to the proposed design.

For membrane type containment system, the trunk deck void spaces in the cargo area are to remain segregated from passageway areas by watertight boundaries with separate access manholes and services.

The wing ballast tanks shall be J-shaped tanks extending from the bottom shell to the uppermost continuous WT deck (main deck or 2nd deck) protecting the cargo tanks (or cargo tank void spaces) and engine room fuel tanks running from the collision bulkhead (aft bulkhead in Fore Peak void) to the after-most transverse bulkhead of the engine room fuel tanks.

A Fore Peak Void Tank, an Aft Peak WB Tank and Fore Deep P & S WB Tanks shall also be provided.

Domestic Fresh Water tanks shall not be arranged so that they share a common bulkhead with any other tanks.

Emergency Fire Pump Suction (if aft) and other miscellaneous suctions / ICCP equipment shall be positioned to allow for vessel operation with a bow trim of 2 m in the ballast condition.

Miscellaneous Tanks

Distilled Water, 2 tanks to be provided. Domestic Fresh Water, 2 tanks to be provided.

Intended Cargo

Liquefied Natural Gas (LNG; temperature: -163ºC, density: 460 kg/m3)

LNG cargo specific gravity of 0.47 shall be used for determining trim and stability criteria and maximum specific gravity of 0.50 shall be applied to the design of hull scantlings, cargo containment system and cargo pumps.

Dimensions and Capacities

Cargo Capacity to be approx. 180,000 Cubic metres LNG at 98.5% fill at 30 °C ambient conditions (two size options). Cargo specific gravity to be 0.47 kg/m3

The Builder to clearly define any filling restrictions for the cargo containment system.

Design Mean Draught Moulded - maximum 11.6 m (with aft Trim not exceeding 0.5 m)

All load conditions to allow for 170 tonnes residual ballast during loaded voyages.

Maximum LOA to be 300 m.

Maximum breadth to be 49.0 m.

Maximum air draught 53.0m.

The height of manifold from design loaded water line shall be 21m.

LNG capacity to be the maximum that can be carried within the above constraints in draught and displacement.

Deadweight

Will be defined by the builder for each design iteration offered.

Trading Area and Ship-Shore Compatibility

The Vessel shall be designed for world-wide trading. The vessel shall be designed to operate through expanded Panama Canal (to be operational from 2015) in both loaded and ballast conditions and will meet all the present Panama Canal requirements with the exception of size.

The vessel shall meet all of the requirements in the terminal compatibility list supplied.

The Vessel shall meet as far as practicable the requirements for all existing operational terminals particularly, Dahej, Gate, Grain, Huelva, Barcelona, Sakai, Hazira, Fujian, Guangdong, Bahia Blanca, Montoir, Cove Point, Chesapeake Bay, Elba Island Georgia, OLT Italy & Freeport, USA.

The propulsion plant and vessel hull form shall be designed to provide a service speed of 19.5 knots in the design draft condition with a sea margin of 21%. Builders shall indicate the most efficient speed whilst consuming only natural boil off gas (NBOG).

Vessel shall be capable of an operating range of 13,000 nautical miles at the service speed at the design draft based on HFO fuel having an S.G. of 0.95 and a tank fill of 95%.

The cargo tank filling restrictions, if any, shall allow sufficient heel capacity in the ballast condition to provide fuel for at least 13,000 nautical miles steaming at the service speed with a three day margin.

If distillate fuels are required for emissions control area (ECA) compliance the vessel shall be able to run continuously on MGO with an SG of 0.90 for six days at MCR.

Marine Diesel Oil with an S.G. of 0.90 shall be accommodated in one bunker tank. One each of fuel settling tank and one service tank shall be provided.

Light oil (DMA @ 0.1% Sulphur) storage shall be sufficient to supply the inert gas generator to inert the entire vessel twice, or have sufficient capacity to enable the vessel to complete 1.5 discharges, whichever is the greater. Two aft bunker tanks and one service tank shall be provided.

POWERING AND SPEED

Main Engine

The Builder shall provide XDF dual fuel diesel engines.

Propulsion System

The propulsion system, line shafting, etc. will be defined by the builder for the proposed propulsion system offered of twin skeg design.

Speed

Service speed will be 19.5 knots on the design draft with 21% sea margin.

The propulsion system design shall be such that the vessel can operate safely and efficiently at speeds as low as at which maximum natural boil off gas (NBOG) is consumed for extended periods. Builders shall indicate the speed.

The vessel will be designed to operate utilising gas as primary fuel for extended periods and in all conditions.

Specific Fuel Oil Consumption

Builders will define and quote Specific Fuel Consumption for the XDF propulsion option.

Daily Fuel Oil Consumption

Builders will define and quote on total daily fuel consumption of main engines and generators when on oil and when on gas.

Cruising Range

Cruising range will be 13,000 nautical miles at design draft operating at design speed burning heavy oil.

CLASSIFICATION, RULES AND REGULATIONS

Classification Society

The Vessel shall be built as an ocean-going gas carrier suitable for the transportation of LNG at a temperature of -163 °C, classed in accordance with the rules and regulations of BV (Bureau Veritas), or the equivalent from ABS (The American Bureau of Shipping) or DNV or LRS being in force as of the date of signing of the Contract or known to come into force before, on or after the date of delivery:

Class Bureau Veritas

Notations

BV1, +HULL, +MACH, Liquid Natural Gas/LNG, Ship Type 2G(Methane(LNG) + Builder to insert Containment System Notation, Vapour Pressure as per containment system, Minimum Temperature -163°C), Unrestricted Navigation, +VeriSTAR-HULL DFL 40 years, CPS(NBT), In Water Survey, +AUT-IMS, MON-SHAFT, CLEANSHIP, BWT, GREEN PASSPORT, LI-HG-S3, ERS-S.

A review is to be carried out by the Builder, the class society's structural specialists and the Buyer of all initial scantling plans before any numerical analysis is carried out.

Rules and Regulations

The vessel is to Comply with all relevant / applicable national and international statutory regulations, guidelines and recommendations. The vessel shall comply with those rules, regulations and requirements of the Authorities, having been published and ratified or known to come into effect prior to, on or after the date of the delivery as compulsory requirements:

- Maritime laws, regulations and requirements of Country of Registry.
- International Convention on Load Lines, 1966 with the Protocol of 1988 and amendments to date.
- International Convention for Safety of Life at Sea (SOLAS), 1974 with the Protocol of 1978/1988 and amendments to date including ISPS code
- International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code)
- International Convention for the Prevention of Pollution from Ships (MARPOL), 1973/78 (Annex I, IV, V & VI, as modified by the Protocol of 1978/1997 and amendments to date)
- International Convention for the Prevention of Collisions at Sea, 1972 with amendments to date (including IMO resolution A464 [XII]).
- USCG rules regarding oil pollution, sanitation and navigation safety for foreign flag vessels (33 CFR 155, 156, 159, 164)
- USCG rules for foreign flag liquefied gas carriers intended to call at US ports except Alaska area (46 CFR 154) and public law 95-474 OCT 17, 1978 "Port and tanker safety act of 1978".
- US EPA (Environmental Protection Agency) rules applicable to foreign flag vessel calling US ports.
- Maritime Labour Convention 2006.

- ILO Convention No 152: Concerning Occupational Safety and Heath in Dock work (1979).
- International Convention on Standards of Training, Certification and Watchkeeping (STCW) 1995 and amendments to date
- International convention for the Control and Management of Ships Ballast Water and Sediments, 2004 and amendments to date.
- International Telecommunications Union (ITU) Radio Regulations (2008 edition)
- Maritime Rules and Regulations of National Governments for ships entering into their ports.
- International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 and amendments to date.
- International Tonnage Measurement of Ships 1969 as amended by IMO resolution A493(xii) and A494(xii).
- Suez Canal Authority "Rules of Navigation" including Regulations for the Measurement of Tonnage.
- IMO Publication No.978. Performance Standards for Navigational Equipment (2011 Edition).
- IMO Resolution A.330 (IX) Safe Access to and Working in Large Ballast Spaces
- IMO Resolution A.601 (15) Provision and Display of Manoeuvring Information on Board Ships.
- IMO Resolution A708 Navigating bridge visibility and functions.
- IMO Resolution A.719 (17) Prevention of air pollution on ships
- IMO Resolution A.830 (19) Code on Alarms and Indicators
- IMO Resolution A.868 (20) Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogen (except Ballast Water Management Plan).
- IMO MEPC.1/Circ.511 Integrated Bilge Water Treatment Systems
- IMO Resolution MSC.137 (76) Standards for Ship Manoeuvrability.
- IMO MSC Circular 1053 Explanatory Notes to the Standards for Ship Manoeuvrability.
- IMO MSC Circular 982 Principles relating to Bridge Design
- IMO MSC Circular 1091 Issues to be Considered when Introducing New Technology on board Ship.
- IMO MSC Circular 1097 Guidance relating to the Implementation of SOLAS Chapter XI-2 and the ISPS Code
- DNV F-A, F-M, F-C, requirements (without certification).
- ILO Maritime Labour Convention (MLC 2006).
- Panama Canal Authority- Maritime Regulations applicable for vessel using Panama Canal including Notice to Shipping No. N-1-2012; Advisory to Shipping No. A-28-2012 (New Panamax Vessel requirements) and amendments to date.

Guidelines and Recommendations

- SIGTTO Manifold Recommendations for Liquefied Gas Carriers first edition 2011.
- OCIMF Guidelines and Recommendations for the safe mooring of Large Ships at Piers and Sea Islands. (incorporated in MEG3)
- OCIMF Mooring Equipment Guidelines (MEG3), (3rd edition)2008
- OCIMF Ship to Ship Transfer Guide (Liquefied Gases), [2nd edition].1995

- OCIMF Recommendations for Ships' Fittings for Use with Tugs, 2002. (incorporated in MEG3)
- OCIMF Recommendations on Equipment for the Towing of Disabled Tankers, 1981. (Incorporated in MEG3).
- SIGGTO Port Information for LNG Export and Import Terminals
- SIGTTO Guidelines for the Alleviation of Excessive Surge Pressures on ESD, 1987.
- SIGTTO ESD Arrangements and Linked Ship/Shore Systems for Gas Carriers (2009)
- SIGTTO Recommendations for the Installation of Cargo Strainers, 1992.
- ICS Guide to Helicopter/Ship Operations, (4th edition). 2008.
- International Electro-technical Commission (IEC) publication 60533 "Electrical and Electronic Installation on Ships – Electromagnetic Compatibility" (1999).
- International Electro-technical Commission (IEC) publication 60092. "Electrical Installations in Ships" (2002).
- IMPA recommendation for Pilot Ladders.
- EEDI formulas and methodology proposed by SIGGTO applicable for this vessel.
- ISO 14276-1 Ships and Marine Technology - Identification colours for the content of piping systems - Part 1: Main colours and media
- ISO 14276-1 Ships and Marine Technology - Identification colours for the content of piping systems - Part 2: Additional colours for different media and/or functions

Engineering, Noise and Vibration Standards to be applied

- IMO Resolution A343 (IX) Recommendations on the method of measuring noise levels at listening posts.
- IMO Resolution A468 (XII) Code of Noise levels on Board Ships
- ISO 2923:1996 Acoustics – Measurement of noise onboard vessels.
- ISO 6954: 2000(E) Mechanical vibration – Guidelines for the Measurement, Reporting and Evaluation of Vibration with Regard to Habitability on Passenger and Merchant Ships.
- ISO 10816-1:1995 Mechanical Vibration - Evaluation of Machine Vibration by Measurements on Rotating Parts - Part 1: General Guidelines.
- ISO 10816-3: 2000.Mechanical Vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 3: Industrial machines with nominal power above 15 kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ.
- ISO 10816-6: 1995 Mechanical Vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 6: Reciprocating machines with power ratings above 100 kW.
- ISO 17894: 2005. Ships and Marine Technology – Computer Applications – General Principals for the Development and use of Programmable Electronic Systems in Marine Applications.
- .ISO 4406:1999 Hydraulic Fluid Power Fluids Method for Coding Level of Contamination by Solid Particles
- ISO/ICE 15288: 2008. System lifecycle processes.
- BS 1807-1981 Surface Finish Requirements for Reduction Gears.
- ISO 484-1:1981 Shipbuilding – Ship screw propellers – Manufacturing tolerances – Part 1: Propellers of diameter greater than 2.5 m.

- ISO 8573-1: 2001 Compressed Air for General Use – Part 1: Contaminant and Purity Classes.
- ISO 8861: 1998 Shipbuilding – Engine-room ventilation in diesel engined ships – Design requirements and basis of calculation.
- ISO 7547:2002(E) Accommodation ventilation & air conditioning. (Design conditions and basis of calculation)
- ISO 18132-1:2006 Refrigerated light hydrocarbon fluids – General requirements for automatic level gauges.
- LRS Guidance Notes for Gas Combustion Units (Thermal Oxidizers), Rev.3, 2004.
- SNAME Technical & Research Bulletin 3-39. "Guide for Shop and Installation Tests".
- SNAME Technical & Research Bulletin 3-47 "Guide for Sea Trials".
- SNAME Technical & Research Bulletin 5-2 "Gas Trials Guide for LNG Vessels".

Certificates

The vessel shall be delivered with a full set of certificates as required by Regulatory Authorities and as agreed with the Buyer. Certificates shall include, but not be limited to:

- Builder's Certificate issued by the Builder.
- Classification Certificate issued by the Classification Society.
- Cargo Ship Safety Radio certificate issued by the Classification Society or other assigned Authority.
- Cargo Ship Safety Construction Certificate issued by the Classification Society or other assigned Authority.
- Cargo Ship Safety Equipment Certificate issued by the Classification Society or the assigned Authority.
- International Load Line Certificate issued by the Classification Society.
- International Tonnage Certificate issued by the Classification Society or other assigned Authority.
- International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk issued by the Classification Society or other assigned Authority.
- International Oil Pollution Prevention Certificate issued by the Classification Society or other assigned Authority.
- International Air Pollution Prevention Certificate issued by the Classification Society or other assigned Authority.
- International Sewage Pollution Prevention Certificate issued by the Classification Society or other assigned Authority.
- U.S. Vessel General Permit 2013
- Deadweight Certificate issued by Builder.
- Lightship Certificate issued by Builder.
- Certificate of International Convention on the Control of Harmful AFS on Ships issued by the Classification Society or other assigned Authority.
- Suez Canal special Tonnage Certificate issued by the Classification Society or other assigned Authority.
- Statement of compliance with USCG Rules and Regulations for Foreign Vessels carrying liquefied gases in bulk issued by the Classification Society.

- Cargo gear Certificate corresponding to ILO forms issued by the Classification Society for Provision Cranes and Deck Cranes.
- Test Certificates of anchors, chain cable and mooring lines issued by the Classification Society.
- Elevator Certificate issued by the Classification Society or other assigned Authority.
- Load Certificate for all lifting gear and strong points issued by the Builder.
- EIAPP Certificate for auxiliary diesel engine (Letter of compliance issued by assigned Authority).
- Certificate for Pressure Vessels (air receivers and boilers). (Issued by Class).
- Certificates for Auxiliary Pump Motors (Issued by Class) (for motors above 100 kW).
- Adjustment Certificates for Magnetic Compass issued by the Builder.
- Navigation Lights Certificate issued by assigned Authority.
- Crew Accommodation Certificate corresponding to ILO Maritime Labour Convention 2006.
- Certificates for all Custody Transfer Instruments and Cargo Tank Calibration Tables issued by Independent Society.
- Letters of Compliance for Notations Requested from an IACS member not classing the Vessel.
- Statement of Fact (SoF) of EEDI, issued by the classification society, based on SIGTTO latest recommended methodology including following notes:
    - ISO 15016 speed correction result calculated by Builder and confirmed by Buyer to be considered for ship speed variation.
    - Sea condition and procedure of speed trial to be followed based on building specification.

Registration

As decided by the owner.

PROPERTIES OF THE VESSEL

Deadweight and Lightweight

Trim and Stability

The vessel shall have positive stability in all conditions, including the simultaneous handling of cargo and ballast during loading and discharging. All combinations of full / empty cargo tanks during loading or discharging operations shall be considered for trim and stability assessments.

Compliance is required with IACS UR L2 and L5

Ballast tanks shall be sufficient to attain even keel draught, at each listed LNG terminal, to suit cargo arm envelopes and gangway working ranges. This capacity shall not include the use of the aft peak tank. All conditions shall be for even keel departure and arrival with 98.5% cargo and full bunkers and minimum ballast, heel and fuel.

If required, ballast exchange shall also be able to be carried out by sequential filling and emptying of WB Tanks using a combination of gravity and ballast pumps. There shall be minimal restrictions on operation in any sea-states during ballast exchanges. Exchange condition to be based on 100% bunkers and 100% consumables. Strengthening of bottom shell forward to be based upon resulting forward drafts during ballast exchange conditions - assumption for strengthening calculations shall also be based upon tanks being empty (i.e. no equalising pressure from within the tank).

Loading software shall be installed on the loading computer providing audible and visual alarms when excessive bending moments or shear forces are experienced based on an automated tank gauging system for cargo, ballast, FO, lubricating oil and FW tanks. Both on and offline operation is required.

Noise and Vibration

Noise levels in the accommodation spaces shall be in accordance with the IMO Resolution A468 (xii) “Code on Noise levels on Board Ships”. Measurements to verify compliance are to take place on sea trials during the endurance trial.

An inter cabin noise level reduction of 45 dB (A) shall be provided for between each cabin and between cabins and public spaces.

External noise levels and those not included HAB+ should be as per the amended IMO Res A.468 (XII).

On sea trials the vibration levels in accommodation and working spaces normally occupied during normal operating condition including engine room and steering gear platforms shall be within the range “adverse comments not probable” given by the lower guideline in the ISO 6954-2000(E), “Mechanical vibration - Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships”, and shall be reported in accordance with ISO standard 4867. Measurements are to be taken in ballast conditions at the service speed during the endurance test.

All major cargo and propulsion related piping systems shall be analysed for vibration, and this analysis is to cover the full operation propeller rpm/ship speed range especially between maximum speed using boil off alone (14 / 15 knots) to 19.5 knots.

The Classification Society shall carry out a confirmatory vibration analysis before any structural design and details are finalised. Builder shall incorporate any finding into the vessel design.

Design Studies

For Structural Design and Fatigue Strength Assessment - see Hull Part.

A cargo tank sloshing analysis is to be performed to demonstrate the adequacy of the cargo containment system / tanks for the dynamic forces resulting from loading of the tanks, including the pipe tower and associated fittings.

All ship motion responses and accelerations are to be determined through sea-keeping analysis based upon 'North Atlantic' wave data according to IACS Recommendation No. 34 definitions.

Vibration Analysis - a free and forced vibration analysis of the whole structure using 3-D finite element model shall be carried out by the class society of the entire structure including the superstructure to quantify vibration levels for vertical, horizontal and longitudinal vibration modes. The full load, normal ballast and trim-optimised ballast conditions shall be analysed. Recommendations proposed by the class society as a result of these studies shall be taken into account by the builder in order to limit noise and vibration

A vibration analysis of cargo tank pump towers shall also be carried out.

All strength and fatigue analyses carried out by the class society and any discussions relating to these studies between the designer and the class society are to be informed to the buyer.

FMEA, HAZID and HAZOPs are to be carried out for the cargo system, mooring system, navigation system, ballast system, IG system, propulsion system, steering system, electrical systems, control systems, general services by an independent contractor agreed by the buyer.

Model Ship Tank Test

The Builder shall be responsible, in conjunction with an agreed Ship Model Testing Facility, for the determination of the vessel hull form and hydrodynamic design. CFD method shall be used to confirm the performance of the final hull form prior to model testing. Model tests shall include, but not necessarily be limited to the following - All tests shall be at design and normal ballast conditions:

- Flow line tests to determine the line of the bilge keel and that flow separation does not occur at the propeller aperture
- A three dimensional wake survey is to be used to determine the final propeller design, and the aft body hull form.
- Open water tests of the final propeller design.
- Self-propulsion tests using the final propeller design. This test shall also be carried out for the sea trial condition

- Self-propulsion tests in wave to determine the speed loss and ship motions. Tests shall be carried out at 3 speeds in 3 irregular head sea states using recognised sea spectra.
- Manoeuvring tests are to be carried out to determine the steering and course keeping characteristics of the vessel. The manoeuvrability of the vessel shall be assessed in accordance with the IMO Standards for Ship Manoeuvrability.
- Comprehensive propeller cavitation tests, including modelling of the complete aft body. During the tests, pressure fluctuation measurements shall be made for the estimation of the hull vibration excitation forces.
- Wind Tunnel Tests to study the Funnel Design and optimisation of smoke plume dispersal.

Wind force estimation for manoeuvring shall be estimated using the accumulated data of the wind tunnel tests for this type of vessel.

The hull shall be designed such that the ballast power/speed curve is below the loaded power/speed curve

DOCUMENTATION

Drawings

A Quality Plan shall be submitted, by the Builder, with the tender and agreed between the Buyer and Builder at the contract stage. A separate cargo containment specific quality plan shall similarly be submitted to the buyer, to class and to the cargo containment system licensor for approval.

The Builder shall ensure that the quality assurance systems of sub-contractors, vendors and equipment manufacturers meet the requirements of the Builder's quality plan.

Free access for inspection of all work and materials shall be allowed for the representatives of the Buyer, who shall reserve the right to reject any work or material that does not reasonably meet mutually agreed standards of construction.

Plan Approval

A list of drawings, documents and equipment specifications ("the Plans") including their scheduled submission dates, which are required for the Buyer's examination/approval, shall be agreed within three months of the contract start date.

Four (4) hard copies, as a minimum, which number shall be agreed, of each of the Plans are to be forwarded to the Buyer for approval before any material is ordered or work put in hand. Should this not be possible the buyer must be consulted and approval given, this will not be unreasonably denied. In addition, all drawings are to be submitted in an Adobe pdf electronic format (files not locked for editing) for reference purposes only (i.e. all plan approval to be carried out using hard copy drawings only).

The Buyer shall be allowed 21 working days from receipt of the Plans for examination and approval.

All drawings are to be in English.

All comments by the Buyer or Classification society on the following principal drawings must be agreed by all parties and before construction commences as far as is practicable:

- Mid-ship Section
- Shell Expansion
- Construction profile and deck plan.
- Painting Specification

Finished Shipyard Plans

The list of required finished plans is to be submitted for the Buyers approval.

A list of drawings to be framed and mounted on board the Vessel shall be also to be agreed.

The Builder shall supply five complete hard copy sets of 'as fitted' drawings and vendor instruction manuals of all equipment.

Five sets of 'as-fitted' drawings in Adobe acrobat .pdf format (with facility for cut-and-paste sampling for future maintenance and repair work).

A fully editable General Arrangement, Mooring Plan, Fire and Safety Plan to be supplied drawn in AutoCad .Dwg format.

Instruction manuals, which shall cover installation, operating, maintenance, repair and trouble-shooting instruction, such that service engineers require no further information, shall be included in the 'as-fitted' drawings. Part copies of manufacturer's documentation or photocopies of manuals will not be acceptable.

Copies of all the technical correspondence between all parties (Buyer, Builder, Classification Society, etc) is to be provided in an electronic format.

An electronic database of all machinery and spare parts supplied by the Builder including all equipment name plate information (photograph) is to be supplied at least three months prior to delivery.

The Builder is to supply a final copy of the specification incorporating all updated design information upon vessel delivery.

All plans to be in English only.

Operations Manuals

The Builder shall arrange a major vendor with specialist proven experience to provide comprehensive 'Operations Manuals' for the safe operation of the ship.

The 'Operations Manuals' shall include two volumes to cover cargo operations, machinery operations and one "SOLAS Training" manual.

Draft Operations Manuals shall be submitted at least six (6) months before delivery of the Vessel.

Operating manuals and system descriptions are to be in English. All critical on-board signage including but not limited to mandatory flag state signage and all signage required for SIRE inspections shall be in English.

SUPERVISION, TESTS AND TRIALS

General

The Builder is to prepare a comprehensive installation, setting to work, testing and commissioning program and detailed schedule which shall be agreed between the Builder and the Buyer.

Vibration and noise measurement of all rotating machinery shall be carried out during shop and shipboard trials. Records of the results shall be submitted to the Buyer to facilitate maintenance of machinery.

Shop Tests

All machineries, equipment and fittings shall be tested or inspected before installation on board ships in accordance with the requirements of classification society and all applicable rules and regulations at Builder's and manufacturer's facilities.

Inclining Experiment and Lightweight Measurement

Inclining experiment and lightweight measurement shall be carried out in accordance with the classification and all applicable rules and regulation.

Sea Trial and Dry Docking

Dry Docking

The Vessel shall be dry docked no longer than 10 days before the start of the sea trials for cleaning the underwater hull and propeller. At this time the final coat of anti-fouling paint shall be applied. The propeller and the bow thruster shall also be polished (or scrubbed in the case of a painted propeller) at this time.

The vessel shall be re-docked if the period between sea trials and delivery exceeds 3 months for re-cleaning.

For both of the above requirements, the dry-docking shall take place in the same building yard at which the vessel is constructed. A vessel 'docking plan' shall be approved by the owner and the Classification Society prior to any dry-docking (with regards to global stresses and block loading).

Sea Trials

Sea trial shall be carried out according to recognised internationally recognised standards to be agreed by the Buyer.

The Builder shall not schedule sea trials until agreement is reached between Builder and Buyer that the vessel is substantially complete.

Speed trials consisting of double runs shall be carried out at the ballast draught. The consecutive runs shall be in opposite directions on the same course and carried out immediately after each other.

The speed trials shall be conducted in deep water of minimum 100 m depth with weather conditions not exceeding Beaufort 4 with wave height of less than 2 m.

The progressive speed test shall be carried out at 50%, 70%, 90% and 100% of propulsive shaft power.

An endurance trial of at least 8 hours duration at a steady main propulsion plant output of 100% propulsion power. During this trial a UMS trial of at least 6 hours duration shall be carried out.

A 2 hour fuel consumption trial will take place during the endurance test.

Manoeuvring trials at 90% propulsion power and at harbour speed shall include the following:

- Stopping trials
- Astern running at full-astern power
- Turning circles including Williamson turn and pullouts
- Kempf and Bech manoeuvres
- Torsional vibration measurement of propeller shafting, vibration measurement of hull, accommodation and rotating machinery

Gas Trials

Builder to secure and provide facilities for carrying out the gas trials.

Gas trials to be conducted at the Builder's expense (including the supply of LNG and terminal facilities) to confirm the operation of the cargo system under cryogenic conditions

and to demonstrate the performance of the gas burning systems, in accordance with the Builders test procedure approved by the Buyer.

Cold tests and gas trials shall be carried out by the Builder before delivery of each vessel to prove that the complete cargo system complies with the requirements set out in the specifications. The S.N.A.M.E. Technical Research Bulletin No.5-2 "Gas Trials for LNG Vessels" shall be used for guidance while conducting the gas trials.

Any cryogenic equipment that has failed during these trials shall be retested in the cryogenic condition.

DELIVERY

Guarantees

The performance of the Vessel, its systems and components shall be guaranteed for two (2) years from date of delivery of the Vessel. This shall include warranty against trading restrictions due to non-compliance with legislation.

Builder shall provide a guarantee for the cargo containment system for five (5) years.

Builder shall provide a guarantee for three years for external hull coatings, five years for ballast tank coatings and five years for void spaces coatings. The coating failure criteria shall be defined at the contract stage, but percentage breakdown shall be according to IACS Recommendation 87 referring to 'areas under consideration'. Percentage breakdown shall refer to inter-coat detachment and detachment at the substrate. The anti-fouling guarantee terms shall be defined at the contract stage.

The coating manufacturer, subject to conditions, shall provide an anti-fouling guarantee for five years from delivery. Note: it is not intended for the vessel to dry dock before the 1st special survey.

HULL PART

GENERAL

The Builder's Quality Plan shall specify construction standards and alignment standards for approval by the Buyer and the Classification Society prior to contract.

Structural Design

All analysis to be carried out by the Class Society

All combinations of full / empty cargo tanks shall be considered for strength and fatigue assessments. The details of strength assessments shall be agreed in a meeting between the Builder, Buyer and the Class Society.

The maximum design SWBM (hogging and sagging) to be calculated according to the following parameters:

Full load with 98.5% cargo, 98% bunkers and 100% consumables.

Deep ballast with 99% ballast in cargo length tanks, Fore WB Tanks, ER WB Tanks and Aft Peak at 99%, Fuel tanks at 98%, other consumables at 100%.

The details of the fatigue assessments are to be agreed in a meeting between the Builder, Buyer and the Class Society.

Fatigue life shall be assessed using a full spectral analysis using fine mesh FEA and is not to be less than 40 years based North Atlantic conditions.

Structural design will allow for operating in the following conditions:-

i) Fully Loaded, all cargo tanks 98.5% full

ii) Part Loaded, No. 1 Cargo tank empty

iii) Part Loaded, No. 2 or 3 Cargo tank empty.

In cases ii) and iii) above ballast may be issued to achieve acceptable trim and stability, bending moment, hull stress etc.

Structural Arrangement

The Hull shall be of double bottom, double hull construction, and in accordance with the cargo containment system licensor's standard arrangement.

In the case of a membrane vessel use of high tensile steel shall be limited to the deck and bottom structures. Only HT 32 grades (Yield stress of 32 kg/mm2) may be permitted. A maximum of 5% HT steel by weight shall be allowed and this shall be only applied in the cargo length (percentage steel-weight refers to total hull steel-weight). No thickness reduction is allowed when using HT steel over mild steel as a corrosion allowance.

In the case of a moss vessel the builder should provide a detailed description of the areas of inclusion and the types of HTS involved and a midship section.

The supplier and location of the TMCP steel in the hull shall be approved by the buyer; approval will not be unreasonably withheld.

The inner bottom is to be continuous from the engine room to the Fore Peak void.

Total of 5 areas of the side shell (each side) to be marked for tug pushing and shall be reinforced. The reinforcement design shall be based on a force of 60 tonnes over an area of 1 square metre.

No lapped structures are to be permitted in the hull – all butt welds shall be full penetration with back gouging or by using one-sided welding process with backing strips.

Forward bottom structure reinforcement is to be added where required by the agreed slamming study. The assumption of empty ballast tanks to be made for all such calculations.

Widened longitudinal stiffeners are to be utilised as access walkways in ballast spaces where possible.

All external deck areas are to have a suitable drainage camber and the external accommodation scupper system is not to be of the "cascade" type.

Hull stress monitoring equipment is to be fitted and will consist of the following, four strain gauges on deck, a bow pressure transducer and a bow accelerometer.

Scupper pipes shall not pass through any switchboard rooms or fuel tanks wherever possible.

Alignment

Buyer and Class to attend all alignment fit-ups of CM locations and to inspect back-gouging and final welding after all the post-weld dressing and NDT has been completed. All NDT failures shall be specially notified to the Buyer before rectification work is carried out. The resultant QA/QC alignment records must be signed by the buyer and copies kept by the yard and the buyer's site office.

Hull Appendages

Neutrally buoyant Hull Aperture Blanks to be provided for all hull openings and sea chests for fitting by divers to enable valve overhaul afloat.

The non-continuous bilge keels shall be of a rolled section and aligned with streamline flow and shall be fitted along the parallel mid-body length amidships, as determined by the model tests

Deckhouses

A separate cargo machinery room shall be provided on deck. The deckhouse shall contain a cargo compressor room and motor room separated by a gas-tight bulkhead. External access is to be at upper grating level.

Dry-powder fire-fighting installations shall be sited within passageways wherever possible to minimise items on external decks.

A deck store shall be provided on the upper most deck for manifold spares and equipment.

Bridge wings shall extend to the maximum width of the Vessel. The underside of bridge wings shall be enclosed. Wind deflectors shall be fitted at the forward end of the bridge wings.

The design of the superstructure shall incorporate vertical alignment of internal structural bulkheads to minimise vibration and to form fire boundaries. In general, not more than three cabins shall be contained between steel bulkheads.

The boundaries of the deckhouses on the upper deck shall be aligned with the transverse and longitudinal bulkheads in way of the machinery spaces to minimise vibration. Internal bulkheads in the deckhouses shall be supported by girders under the upper deck.

An unheated salt water swimming pool larger than 5 m x 3.0 m x 2.5 m deep shall be provided and a 10 m x 5 m recreational court enclosed by mesh fencing arranged as close as is practicable.

Materials and Scantling

Upon removal of the lifting lugs used during the block lifting the plating shall be inspected by UT for laminations.

The yard is to have a system to ensure traceability of all the grades of steel being used.

MAIN HULL

General

Hull shall be of welded steel structure and shall be designed and constructed in accordance with the requirements of the Class and the Builder's practice.

Structural details shall be in accordance with the Builder's practice approved by Class.

Slots, air holes, drain holes, scallops and lightening holes shall be provided in accordance with the Builder's practice.

Slots, air holes, drain holes, scallops and lightening holes shall be provided.

Steps and handgrips shall be provided for access openings with sill height over 600mm.

Lightening holes in horizontal stringers shall be protected by steel bars to prevent personnel falling through.

Frames, beams and stiffeners shall be either of flat bar, rolled section or built-up section.

Gunwale connection between upper deck plate and sheer strake shall be of directly welded type.

150 mm high gutter bar with extension of sheer strake and 75 mm high gutter bar with extension of trunk deck side shall be fitted.

The main hull shall be longitudinally framed; ends of the hull may be transversely framed.

Shell and deck plates will be gradually tapered in thickness from midship to the ends in accordance with the requirements of the Class.

Plating subject to heavy concentrated load shall be reinforced by extra thickness plating or with stiffeners where necessary.

After Body Construction

Stern shall be designed to obtain sufficient clearance for the propeller(s) and to support the rudder(s).

Adequate structure such as web, girder or pillars shall be provided against vibration in aft body construction.

Aft peak bulkhead shall be of plain type.

Eye plates for lifting rudder(s), shafts and propeller(s) shall be provided.

Stern boss shall be of weldable cast steel.

Rudder and Assembly

Rudder(s) shall be of high lift type; balanced, semi-balanced or spade depending on propulsion type.

Rudder(s) design shall be based on working angle of 35^{o} each side at the design speed according to Class requirement.

Welded jumping stopper(s) shall be provided to prevent undue rudder lift.

The change of plate thickness shall occur internally.

Propeller and rudder stock shall be capable of removal without dismantling rudder.

Bottom clearance for the rudder and propeller shall be a minimum 100 mm for dry docking.

One (1) set of air plug shall be fitted at the top and two (2) set of drain plugs at the bottom of the rudder(s).

Rudder stock shall be of piece forged steel with shrunk-on stainless steel sleeve (SUS316L) in way of lower bearing.

The lower end of the rudder stock shall be connected to the rudder by cone type connection.

Gudgeon shall have synthetic resin or equivalent bush and no special lubricating device shall be fitted.

Welded mounting cover shall be provided for the rudder dismounting.

Wear down gauge for rudder carrier bearing shall be provided

Engine Room Construction

Double bottom in the engine room shall be built on transverse and/or longitudinal framing system, and solid floors shall be fitted if necessary.

Upper deck shall be longitudinally stiffened and side shell shall be transversely and/or longitudinally stiffened.

Deep beams and/or pillars shall be provided against vibration.

Bulkheads shall be of plain type.

L.O. sump tank shall be provided under main generator and main engines. Bilge wells shall be arranged at suitable places in the double bottom.

Platform decks shall be arranged in engine room. These decks shall be extended from side to side with opening around the main machinery.

Opening in the platform deck shall be fitted with steel coaming.

Sea chest shall be provided to side shell in way of engine room.

Cargo Area Construction

Cargo hold structure shall be designed to have double skin arrangement in way of bottom, sides and trunk deck for membrane containment system. In case of Moss containment system, special attention is to be paid to the design of the foundation deck and its corner brackets.

The structure of cargo holds shall be strengthened for partial loaded condition with restriction of the filling height in compliance with requirement of the Class and the containment system.

The double skin structure shall be constructed with longitudinal framing and these longitudinal frames shall be supported by floors or transverse frames.

All stiffeners of the double skin structure shall be contained within the double skin space. Transverse bulkheads forming cofferdams shall be arranged between cargo holds and

Transverse bulkheads shall be of plain type.

One (1) longitudinal bulkhead of plain type with longitudinal stiffeners shall be arranged on port and starboard in way of cargo area to form the boundary of wing tanks.

Stiffeners on the longitudinal bulkheads shall be fitted on opposite faces to the cargo holds.

One (1) longitudinal access platform by enlargement of side shell longitudinal shall be provided for the close-up inspection at the upper part of hopper tanks in water ballast tanks.

Passageway under trunk deck shall be provided port and starboard side to access from after to forward hold and shall be also utilized as pipe & cable way.

Fore Body Construction

The structure of fore body shall be transversely and/or longitudinally framed and supported with solid floors, stringers and webs.

Forepeak bulkhead shall be of plain type

Stem shall be of fair formed welded steel plate construction with bulbous bow under water line and raked forward with round face above water line.

Stem shall be provided with breast hooks and connected to shell and keel plating by welding.

Forward flat bottom shall be reinforced against slamming load based on the draft in the normal ballast condition according to the requirements of the Class.

Shell plating in the vicinity of anchor hawse pipes shall be increased by 2 mm thick

Chain Lockers, Hawse Pipes and Chain Pipes

Two (2) self-stowing chain lockers shall be of box type construction with perforated steel plate grating at a level Approx. 800 mm above bottom of locker to make a bilge space underneath.

Access from the boson store shall be arranged into chain locker by hatch with Jacob ladder for inspection of locker and chain.

One (1) pair of hawse pipe with cast steel bellmouth shall be provided at the bow and shall allow acceptable housing of the anchor and easy lead of chain to the gypsy wheel.

Chain guide pipe shall be fitted centrally in each chain locker.

DECKHOUSE AND FUNNEL

Deckhouse and Funnel

Deckhouse shall be of welded steel construction.

Deckhouse steel plate thickness shall not be less than the following;

Exposed decks	: 8 mm
External walls	: 7 mm
Other areas	: 6 mm

External walls of deckhouse shall be of flat plate type with vertical stiffeners, and internal walls shall be of corrugated type and/or flat plate type.

Structural continuity between the deckhouse construction and the structure below upper deck shall be maintained.

Decks shall be transversely and/or longitudinally stiffened with beams, transverses and girders.

Wet spaces and spaces that are frequently hosed down shall be continuously welded if not covered with deck composition or cement.

The edge of deck plating shall be extended from the outside boundary walls by approx.

10 mm and ground smooth.

Knuckled wind-deflector shall be provided on the front bulwarks of the navigation bridge wings.

Bridge wings shall be extended to full beam of the Vessel and be suitably supported with closed type construction.

Manhole and lugs shall be provided for maintenance underneath bridge wing.

A camber shall be provided to the bridge wing deck for drainage.

Wheelhouse front wall shall be inclined outward from navigation bridge deck.

Cargo machinery room and electric motor room shall be arranged on the trunk deck in case of membrane containment system or main deck for Moss containment system.

MISCELLANEOUS

Foundation

Main machinery foundation structure shall be of welded steel construction with bedplates, floors and girders, which are integrated into double bottom structure and shall have adequate strength and rigidity.

Foundation of main machinery shall be designed according to the manufacturer's recommendation.

Foundation of auxiliary machinery, deck machinery, etc. shall be of welded steel construction and shall be reinforced with girders or carlings underneath.

Steel coaming of 75mm high shall be fitted around the foundation of machinery containing liquid.

Bulwark

Steel bulwark of approx. 1.0 m high shall be fitted at forward navigation bridge wing and steel bulwark of approx. 1.3 m high at the forward deck of the vessel.

Bilge Keel

Bilge keel shall be fitted on both sides midship for Approx. 25% LBP of the Vessel.

Bilge keel shall be non-continuously fabricated at block butt joints with rolled profile on the ground bar and tapered at fore and aft ends.

Bottom Plugs

Bottom plug of M52 stainless steel (SUS 316L) with steel socket shall be fitted in water ballast tanks as far as practicable. Bottom plugs shall not be fitted for oil tanks such as fuel oil tank, lubricating oil tank and etc. to avoid oil leakage into the sea.

Bottom plug shall be fitted as close as possible to the lowest point of each tank and shall be kept clear of points where keel block are laid beneath in dry dock.

Two (2) spanner wrenches shall be supplied for opening/closing of drain plugs

Hull and House Marking

Paint line between side bottom and topside shall be marked by approx. 50mm long welding bead, spaced at every web frame. Underwater hull marking shall be in accordance with class requirements for in water survey.

Name plates, marks, etc. shall be fitted.

The Buyer shall provide the information of Ship’s name, funnel mark and port of registry to the Builder for hull marking not later than two (2) month prior to the expected date of Steel Cutting.

MATERIAL PROTECTION

GENERAL

General

IMO PSPC Notes and Miscellaneous Requirements

All coatings are to be applied in accordance with IMO PSPC and paint supplier's requirements for the areas concerned.

Stripe coating (2 coats) in the ballast tanks is to take place between the first and second coats, the first stripe coat in the second coat colour the second stripe coat in the first coat colour.

Edges of structures including slots, drain holes, scallops and irregular weld beads in the WB Tanks, FW and DW Tanks and engine room tank containing oil/water mixes shall be rounded by 3-pass grinding to 2 mm radius minimum. All such edges in water ballast and fresh water tanks shall receive two stripe coats.

Edges of exposed structures in all other spaces including deckhouses shall be rounded by 1-pass grinding to 1 mm radius (chamfer) minimum. Edges of accommodation decks penetrating the vertical boundaries shall be ground back to a rounded profile.

Edges of exposed structures shall be rounded by 1-pass grinding to 1 mm radius (chamfer) minimum and shall receive at least one stripe coat.

Maximum DFTs may not exceed three times the specified DFT in local areas and twice the specified DFT in general. In such cases where these limits are exceeded, the Builder is to sand back the coating to an acceptable DFT and apply a thin touch-up coat where required.

DFT reading to be taken in accordance with PSPC Annex 3. However, there shall be no limits to the number of readings taken in way of block erection joint repairs and where excessive DFTs are discovered through DFTs taken in accordance with Annex 3 and by obvious visual indicators (runs, sags etc.).

Coatings in ER WB Tanks adjacent to heated tanks shall be specified according to anticipated temperatures on the inner hull.

Coating in bilge tanks to be satisfactory for heated service and to resist fresh water separated from oily emulsions.

DFT readings and other coating application QC marks are allowed to remain in all confined spaces upon completion of coatings except in the Passageways, Bow Thruster Room and Fore Pump Room.

Where galvanizing is to be specified for items of outfit, an etch primer shall be applied before over-coating with any other product. A full anti-corrosive system is to be applied in accordance with the paintings scheme in that location (i.e. confined spaces, external deck, etc).

Coatings

All coatings are to be applied in accordance with the paint manufacturer's requirements.

Any deviations from such procedure shall be approved by the Buyer.

All yard personnel involved in supervision of surface preparation, coating application and QA/QC work shall be suitably experienced, formally qualified where required and the said qualifications made available to the buyers site office.

Wet Film Thicknesses shall be continuously monitored by all personnel involved in applying coatings.

No change in formulation of any products shall be allowed after the commencement of the contract without full agreement by the Buyer. A full technical and chemical explanation and justification of the changes are to be presented by the Builder and the paint supplier for the Buyer's approval. All coating guarantees shall refer to any formulation changes.

All blocks transported by barge shall be fully HP (250 bar) FW washed then tested for chlorides before any further surface preparation or coating work is carried out.

Coatings are to be applied by airless spray wherever possible according to the manufacturer's recommendations.

The paint manufacturer and the Buyer's representatives are to be satisfied with the material and condition of the material to be coated.

In general, coating Dry Film Thickness (DFT), shall not be less than specified in more than 90% of measured points. No measured point shall be less than 90% of the specified DFT or 300% of the specified DFT. DFT sampling points shall be in accordance with IMO PSPC where applicable.

Completed cosmetic finishes shall be protected during the out-fitting period from damage by ferrous grinding inclusions.

All stainless steel fittings are to be protected from contamination by ferrous particles during the fitting out stage of the vessel the surface in general being covered with plastic bags and sheeting. Painting of stainless steel e.g. the accommodation weather doors is also an acceptable barrier.

All structural steel shall be shot-blasted according to Sa 2.5 standard (according to ISO 8501) and shop primed by airless spray application. Both processes will be fully automated.

All adherent and non-adherent weld spatter shall be removed in tanks to contain sea water. This should take place after block completion and prior to painting.

Rectification of damaged areas shall be based on the following procedures:

- Shell, weather deck (plating and tank covers), ballast tanks and FW tanks to be blasted to SA 2.5 standard at block stage and repaired by power tool to ST3 standard at block erection stage.
- All other areas to be treated to power tool ST3 standard except internal accommodation which shall be to ST2 standard at both block and erection stages.

All welding on the inner hull shall be finished (apart from erection welds) prior to blasting and coating of blocks for WB tanks and void spaces. Any exceptions must be reported to the buyer for approval, this will not be unreasonably withheld.

If scattered damage in WBTs or Void Spaces exceeds 2% in the area under consideration, that area shall be repaired by dry grit blasting and reapplication of the specified full coating system.

Climate control equipment in blasting and painting sheds in the yard and at sub-contractors facilities shall run continuously when surface preparation and coating work is being carried out on material related to these vessels, including during all curing periods.

Surface Preparation

Primary surface preparation / shop priming

Surface of structural steel plates and sections passing through the Builder's workshop shall be shot blasted to Sa 2.5 grade and immediately primed with inorganic zinc silicate type shop primer according to the Builder's standard.

Shop primer shall be compatible with the subsequent paints.

Dry film thickness of the shop primer shall be of approx. 15 microns.

The steel surface of fittings such as structural use pipes, pipe supports, grating supports, auxiliary machinery seats, etc., shall be blasted, pickling treated or power cleaned with wire brush or disc sander.

Secondary surface preparation in block stage.

Prior to the first coat, damaged area on shop primed steel due to burning and welding during fabrication shall be treated according to "Table of surface treatments for damaged areas," however intact shop primed area shall be untouched.

Location	Block Stage	Pre-Erection, Dock And Quay Stage
Flat bottom, Side bottom	Sa 2.5 (*)	St 3
Topside	Sa 2.5 (*)	St 3
Weather deck	Sa 2.5	St 3
Deck house external	St 3	St 3
Cargo hold	St 3	St 3
Accommodation, engine room and store	St 2	St 2
Water ballast tanks	Sa 2.5 (*)	St 3
Void space and cofferdam	St 3	St 3
F.O. tanks and L.O. tanks (**)	Dry and clean	Dry and clean
F.W. tank	Sa 2.5	St 3

Visible zinc salts on intact shop primed surface shall be removed by wire brush, power tool cleaning or sweeping according to the paint manufacturer's recommendation.
Flame cut edges of structural members in water ballast tanks and fresh water tanks shall be ground off to '3C' - three (3) pass grinding or equivalent prior to the first main coat.

Secondary Surface Preparation in Pre-Erection, Dock and Quay Stage

During and after the main coats, damaged areas of coating shall be treated according to the table above.

Painting Work and Inspection

Water ballast tanks, painting work and inspection shall be carried out "Painting and inspection standards for water ballast tanks" in accordance with IMO PSPC.

A stripe coat shall be applied to cut edges of structural members and the edges of holes such as slots, scallops, drain holes and air holes.

Stripe coats for water ballast tanks shall be applied in accordance with IMO PSPC.

Inspection and Measurement of Dry Film Thickness

Painting inspection and surface preparation inspection shall be carried out according to the manufacturer's recommendation.

Dry film thickness of painted surfaces shall be measured by electronic dry film gauges such as elcometer, micro test, or their equivalent.

Coating DFT measurement will comply with a 90/10 requirement and will require a minimum of five (5) readings for each 10 sq.m. Of ballast tank coated area. All other regions will comply with a 90/10 requirement with five (5) readings of each 20 sq.m. Of coated area.

PAINTING SCHEDULE

Hull Coating

The underwater hull areas, including appendages, shall be coated with a 2 coats of an anti-corrosive paint system with a minimum total dry film thickness (DFT) of 300 microns.

A 60 month anti-fouling coating to the underwater areas.

Polyester Glass Flake anti-abrasive coatings shall be applied in way of typical bow chain damage and tug contact areas.

Hull topsides (above summer draught) shall be coated with a 2 coat anti-corrosive system to a total DFT of 300 microns and 1 coat of polyurethane or water-borne acrylic cosmetic paint at 75 microns DFT.

The Buyer to specially approve the application procedure for hull coatings.

The inside of the rudder shall be protected by a proprietary corrosion inhibitor.

Exposed Deck Coating

Exposed decks shall be coated with a 2 coat anti-abrasive system to a minimum DFT of 300 microns with a polyurethane or water-borne acrylic topcoat to a minimum DFT of 75 microns.

The builder is to provide an option for applying Inorganic Zinc Silicate as the anti-corrosive on the exposed sunken, main & trunk decks.

Other Tanks and Void Space Coatings

Cargo hold boundary coatings shall be applied in accordance with the cargo containment system licensor's requirements in the case of membrane systems.

Fresh water tanks shall be coated with two coats of anti-corrosive solvent-free paint, certified for potable water.

All other tanks, cofferdams, void and double bottom spaces including all fittings shall be coated with a 2-coat anti-corrosive epoxy paint system with a minimum dry film thickness of 320 microns.

Engine Room steam condensate tanks including header tanks and observation tanks operating at high temperatures shall be coated with coating systems that are able to resist chemicals dissolved in distilled water at temperatures of up to 100 degrees centigrade where applicable.

Superstructures and Other External Area Coating

Superstructures with white cosmetic finishes and tank covers, if fitted, shall be coated with a 2 coat anti-abrasive system to a minimum DFT of 320 microns. All edges and fittings shall be coated with one 50 microns stripe/touch-up coat before applying a full polyurethane or water-borne acrylic topcoat to a minimum DFT of 75 microns to ensure a good opacity in all areas.

The protruding edges of the internal decks in the accommodation block through the accommodation block front, sides and back, must be ground to a semi-circle in order to obtain the full DFT of the external coating system.

Deck fittings, pipework, masts, machinery and miscellaneous attachments, shall be coated with a similar system, allowing for two stripe coats between full coats for the anti-corrosive system.

Internal Area Coating

The Builder shall submit a schedule of all internal spaces showing the proposed paint systems for Buyer's approval.

The inside of ventilation trunking using ship’s structure as part of the boundary shall be coated according to the paint scheme for the WB tanks.

Engine room double bottom and other tank top areas in machinery spaces and cargo machinery room shall be coated with 2 coats of anti-corrosive paint to a DFT of 320 microns.

Machinery and all consoles to have uniform standard colour scheme and pipe identification colour coding scheme to be agreed with Buyer where not otherwise specified by ISO 14726-1.

No QC marks to be visible on any coating applied in usually habitable spaces including but not limited to machinery spaces, external surfaces, Bosun’s Store and Pipe Passageways.

Miscellaneous

All external outfitting shall be painted according to the paint scheme for the exposed decks.

Builder to ensure that the equipment from the main suppliers adheres to this and that they do not apply inferior coatings

The compression bar around the top of coamings for WB Tank entries, for the access hatches for the ropes to the Lazarette and focsle stores and for the escape hatches are to be 316L stainless.

CATHODIC PROTECTION

Underwater hull and appendages shall be protected by an automatically controlled Impressed Current Cathodic Protection (ICCP) system designed with the following current densities:

Underwater Hull:	35mA/m2
Propeller:	600mA/m2
Rudder:	120mA/m2

The ICCP system shall be automatically controlled to keep the hull potential between -1050 mV and -850 mV at all ship speeds.

All ballast water tanks shall be protected by sacrificial zinc anodes, these will be cast on a flat mild steel bar which will be bolted to brackets welded to the ballast tank stringers. Additional "pit guard" type anodes (mounted in a similar fashion) are to be installed to protect areas close to ballast tank suctions)

Design life of 85% depletion:	10 years
Mean current density	5.0mA/m2
Ballast ratio:	50%

Sea chests shall also be protected by sacrificial aluminium anodes:

Design life:	5 years
Mean current density:	40mA/m2

Temporary Sacrificial Anodes for the External Hull Area shall be provided after the Vessels Launch during the Afloat Outfitting period.

CARGO SYSTEM

GENERAL

Main Design Conditions

Membrane

Cargo	Value
LNG Temperature	-163°C
Cargo Density	500kg/m^3
Tank operating pressure	-0.01 – 0.35 bar G
Tank Filling Limit	98.5%
Boil Off Rate (BOR)	Guaranteed Maximum 0.1% per day
Loading Time (bulk)	13 hours
Discharge Rate (bulk)	13 hours
Inerting Time	20 hours
Aeration Time	20 hours
Warm up	48 hours
Cool down	12 hours
Vapour Purge	12 hours

Ambient Conditions	Value
Air Temperature	45°C
Sea Water Temperature	32°C
Pressure Variation	0.95 – 1.05 bar A

Moss

Cargo	Value
LNG Temperature	-163°C
Max. Cargo Density	500kg/m^3
Design Vapour pressure of Cargo Tank (Relief Valve Set Pressure)	0.25/1.07/2.13 bar G
Tank operating pressure	-0.01 to +0.25 bar G
Tank Filling Limit	98.5%
Boil Off Rate (BOR)	Guaranteed Maximum 0.08% per day
Loading Time (bulk)	13 hours
Discharge Rate (bulk)	13 hours
Inerting Time	20 hours
Aeration Time	20 hours
Warm up	65 hours
Cool down	20 hours
Vapour Purge	12 hours

Note 1: For normal operating condition, the cargo tank relief valve setting shall be 250mbar. For emergency discharge by means of cargo tank pressure build up, the Moss design shall permit increased tank pressure by the fitting of additional setters to the tank relief valves.'

Ambient Conditions	Value
Air Temperature Max	45°C
Air Temperature Min	-18^{0}C
Sea Water Temperature Max	32°C
Sea Water Temperature Min	0^{o}C

Cargo composition

Composition	Range (Mole %)	Design standard (Mole %)
Nitrogen	0.006 – 1.2	0.09
Methane	86.7 – 98.0	96.0
Ethane	3.0 – 8.2	3.2
Propane	0.3 – 3.0	0.6
Butane	0.05 – 1.5	0.1
Pentanes & heavier	0.00 – 0.03	0.01

OPERATIONAL REQUIREMENTS

In addition to those characteristics previously defined the vessel will also be designed to be capable of:-

- Isolation of each cargo tank to allow ingress while other tanks remain under vapour and cold.
- Carrying out STS (Ship to Ship Transfer) in accordance with OCIMF, "Ship to Ship Transfer Guide (Liquefied gases)".
- The vessel will be provided with emergency cargo pumping arrangements to allow discharge of any and all cargo tanks.

CARGO CONTAINMENT SYSTEM

General

Builders will have the option of applying:-

- **GTT Membrane Systems NO.96 or MK III** - Iterations are to be of the most robust, well proven design, track records are to be stipulated.
- **Moss Rosenberg**

CARGO MACHINERY

Cargo Machinery Room and Electric Motor Room

A cargo compressor room and an electric motor room shall be arranged on the trunk deck (Membrane containment) or upper deck (Moss Containment).

The cargo compressor room shall be separated from the electric motor room by a gastight steel bulkhead.

The electric motor room shall be designed as a gas safe space.

Cargo compressors, fuel gas compressors (if required) LNG vaporiser(s), and gas heater(s) shall be arranged in cargo compressor room.

Particular consideration shall be given to emergency escape ways in the cargo compressor room and electric motor room. As to the small hatch for compressor room and electric motor room, Section 532.1 of the Specifications shall be referred to.

Cargo handling equipment such as LNG vaporiser shall be provided with drain line which will be led to the bilge well in the cargo compressor room.

Any steam condensate drains will be lead to a degassing tank fitted with vent to a safe location and gas detector before being lead to the engine room. The gas detector element shall be suitable for continuous operation in a hot steamy atmosphere.

Cargo compressor room and electric motor room shall be fitted with lifting eyes to facilitate the overhaul and moving of all heavy equipment and spare parts near the landing area in their rooms.

A fixed davit for removing equipment from cargo compressor/motor room shall be provided.

Cargo Pumps

Each cargo tank shall be equipped with two (2) independent submerged cargo pumps.

Cargo Pump Characteristics	
Pump Type	Vertical, Centrifugal, Single Stage, submerged
Material - Casing, Inducer and impeller	Aluminium
Material - Shaft	Stainless Steel
Drive	Electric, direct drive built in

The pump impeller shafts shall be of single piece construction and manufactured from cryogenically stable stainless steel.

Pumps shall be designed to be fully hydraulically balanced in normal service.

Bearing lubrication and motor coolant flows shall be generated by the pump impeller.

An inducer shall be fitted on the pump suction of each cargo pumps to reduce the required NPSH.

A suction screen shall be fitted on the pump suction.

The non-return valve fitted on discharge side of cargo pumps shall be installed in the cargo tanks immediately above the pump.

The cargo pumps shall be located close to the tank bottom for effective stripping of the tank.

The cargo pumps and pump motors shall be designed to operate continuously from 40% to 120 % of design capacity.

Cargo stripping/spray pump

Each cargo tank shall be equipped with one (1) cargo stripping/spray pump.

Cargo stripping/spray pumps shall be used:

- To supply LNG to LNG vapouriser for the purging during one(1) tank operation
- To supply LNG to the cargo tanks during the ballast voyage in order to cool down of cargo tank with temperature of approx. -130℃.
- To strip the cargo tanks
- To supply LNG for pre-cooling of liquid lines, if appropriate

Stripping/Spray Pump Characteristics	
Pump Type	Vertical, Centrifugal, Single Stage, submerged
Material - Casing, Inducer and impeller	Aluminium
Material - Shaft	Stainless Steel
Drive	Electric, direct drive built in

Fuel Gas Supply (FG) pump

Fuel gas pumps shall be used to supply LNG forcing vapouriser a single pump must be able to supply the maximum main engine, diesel generator, boiler and hotel demand.

There shall be one Fuel Gas Supply Pump in tanks 3 & 4.

FG Pump Characteristics	
Pump Type	Vertical, Centrifugal, Single Stage, submerged
Material - Casing, Inducer and impeller	Aluminium
Material - Shaft	Stainless Steel
Drive	Electric, direct drive built in

Emergency cargo pump

An emergency cargo pump (For Membrane) of portable, retractable type shall be provided for emergency conditions.

Otherwise the tank shall be designed to be pressurised for emergency discharge (For Moss).

Emergency Cargo Pump Characteristics	
Pump Type	Vertical, Centrifugal, Single Stage, submerged, retractable
Material - Casing, Inducer and impeller	Aluminium
Material - Shaft	Stainless Steel
Drive	Electric, direct drive built in

Vaporiser

One (1) direct steam heated LNG vaporiser of horizontal and shell & tube type shall be arranged in cargo compressor room for the following purposes:

To supply cargo vapour to the cargo tanks when the cargo pumps are discharging at the designed flow rate without the availability of vapour supply from shore (cargo vapour in tank assumed to be kept at -130℃).

To purge inert gas from cargo tank during the gassing up process.

To act as the stand by unit in case of failure of the forcing vaporiser.

Forcing Vaporiser

One (1) direct steam heated LNG vaporiser of horizontal and shell & tube type shall be arranged in cargo compressor room for the following purposes:

To supply cargo vapour at the maximum engine demand.

Cargo Compressors

HD compressors

The HD compressors shall be used:

- To transfer the generated vapour to the shore during loading.
- To transfer the generated vapour to the shore during initial cooling down.
- To re-circulate the hot cargo vapour (max. 80^{o}C) for tank warm-up.
- To insure the cargo vapour purging of cargo tank.

Two (2) equally sized HD compressors shall be provided in the cargo compressor room and their motors shall be located in the electric motor room.

Each compressor shall be designed to handle 60 % of the maximum vapour generation rate under design loading condition (temperature of cargo tank assumed to be -130 ^{o}C when loading starts) or based on warming-up condition of cargo tanks as specified in the Specifications.

HD compressors can be operated independently or in parallel. Both compressors shall be operated in parallel during warming-up procedure and for vapour return to shore during loading.

The HD compressors shall be used for circulation or transferring of cargo vapour, inert gas or/and their mixtures during the cargo operations for docking/after docking and cargo loading.

Each HD compressor unit shall be equipped with an automatic anti-surge control system, a speed-up gear box, a gas tight bulkhead shaft seal, LO system, etc.

Each HD compressor shall be driven via gear and shaft through a gas tight bulkhead seal by an electric motor located in the electric motor room.

Each HD compressor unit with electric motor shall be arranged on a common bed.

The shaft seals on the gas-tight bulkhead shall be packed with nitrogen gas, and the shaft seals on the rotor labyrinth or floating carbon rings between speed-up gear box and impeller shall be sealed by nitrogen gas from nitrogen generation plant.

The LO system shall have a fresh water cooler.

One (1) suction filter of conical in-line type shall be fitted at the suction side of each cargo compressor.

Cooling of compressor motors shall be done by air or FW.

L.D. Compressors General

The BOG compressors (also called Fuel Gas Compressors) shall be used for:

- Maintain constant tank pressure.
- Transfer the natural boil off gas (NBOG) to the main engines.
- Transfer the NBOG to the generator engines and auxiliary boilers.
- To transfer the NBOG to the GCU, if fitted.
- BOG compressors will have a by-pass for free flow to the GCU or boilers.
- Transfer NBOG to BOG Booster Compressor (were fitted)

Use of BOG units shall be integrated fully into the fuel gas system such that they will each supply full fuel requirements, plus 5%, they will integrate into the gas fuel supply from the forced boil of system.

Each LD compressor shall be driven by an electric motor located in the electric motor room. Alternatively, if the LD (Fuel gas) compressors are supplied as single skid units so that the electric motors are located inside the cargo compressor room, then the electric motors are to be of Ex type and approved by the class society.

Each LD compressor unit with electric motor shall be arranged on a common bed.

The shaft seals on the gas-tight bulkhead shall be packed with nitrogen gas, or as per Makers approved design.

The LO system shall have a fresh water cooler.

Cooling of compressor motors shall be done by air or FW.

Gas Combustion Unit

One GCU is to be supplied the capacity based on the boil off rate for the full cargo volume. It should not require pilot fuel to ignite gas whilst purging or gassing up.
The total capacity of all the air supply & dilution fans should be such that with one fan unavailable the GCU has 100% capacity.

Gas Heaters

HD heater

The HD heater shall be provided for the following purposes:

- To heat the BOG to the GCU, if fitted, under free flow mode.
- To heat the BOG vented to atmosphere
- To heat the LNG vapour sent by both HD compressors in order to warm-up cargo tank.
- To heat the inert gas during inerting operation

Heaters shall be shell and tube type and shall be direct steam heated.

Fuel Gas heaters

Independent Fuel Gas Heaters shall be fitted; each unit will be capable of providing 105% of full load fuel gas requirements.

Builder shall investigate the most efficient method for heating the fuel gas.

BOG Booster Compressor

A reciprocating BOG Booster compressor shall be installed in the cargo compressor room to provide high pressure LNG gas to the Partial Reliquefaction System.

Partial Reliquefaction System (PRS)

A PRS system using LNG gas at high pressure and reliquefaction process using the Joule-Thomson expansion valve process shall be installed to return excess BOG as a liquid back to the cargo tanks.

CARGO PIPING SYSTEM

General System

The piping arrangement for the cargo handling system shall be arranged as stipulated as follows:-

Cargo pumping system

A main liquid main line connected with liquid crossovers shall be arranged on the trunk deck or at the level of the flying catwalk and shall be branched off to each cargo tank liquid dome.

Two (2) cargo discharge lines, one (1) cargo stripping/spray discharge line, one (1) FG pump discharge line for tanks 3 & 4, one (1) cargo loading line and one (1) emergency pump column, for Membrane containment system, shall be arranged in each cargo tank liquid dome and shall be connected with the liquid branch line.

The vapour main line connected to vapour crossover shall be fitted on the trunk deck or at the level of the flying catwalk and shall branch off to each cargo tank vapour dome.

The inlet of LNG vaporiser shall be connected with the liquid line and stripping/spray line and the outlet shall be connected with the vapour main line.

Expansion bellows are not to be used on liquid lines. However, it is realised that there will have to be certain exceptions to this i.e. for the Moss vessel.

BOG treatment system

The system shall consist of BOG compressors, gas heater, tank pressure control valves and FG master valve(s).

The BOG from the cargo tanks shall be compressed, heated and fed to propulsion system in ER as FG through separate FG lines.

The surplus BOG from the cargo tanks will be directed to the GCU.

GCU, if fitted, shall be capable of taking gas direct from the cargo tanks via vapour main line in free flow operation and flow rate of free flow shall be approx. 15 % of GCU's capacity.

Given the lower boil off rates specified a partial reliquefaction plant would be considered a valuable asset to include in the BOG treatment system, it should be capable of liquefying excess BOG in the 14.5 to 17knot speed range.

Cargo tank spray system

The cargo tank spray system shall be provided for cooling down of the cargo tanks before cargo loading or during ballast voyage, and line cooling down before cargo loading or unloading as necessary.

One (1) stripping/spray main line connected with the discharge line of each cargo stripping/spray pump shall be branched off to each cargo tank liquid dome and each liquid manifold (P&S).

One (1) strainer and one (1) isolating valve shall be arranged on the branch line to each cargo tank liquid dome. The isolating valve shall be controlled via the VDUs of IAS in CCR.

Two (2) spray branch lines with spray nozzles shall be arranged at lower part of each cargo tank vapour dome or as required by the containment system to achieve the required cool down rate.

Cooling down rates of each cargo tank can be adjusted by throttling the valve on spray branch header line.

During initial cooling down, liquid shall be fed from shore to the stripping/spray main line through the liquid manifold.

During ballast voyage, liquid shall be fed by one (1) of the cargo stripping/spray pumps or one(1) of the FG pumps and the cooling down rate of each cargo tank shall be controlled according to the required FG amount from propulsion system.

Piping

Tank domes, insulation and hold spaces shall be connected by branch lines to their respective longitudinal header lines. Drain lines shall be arranged to permit remaining liquid in lines to flow into cargo tanks or to the shore connection.
Piping joints shall be kept to a minimum and where possible, shall be joined by butt welds.
Comprehensive sampling points, fitted with double shut-off valves and test connection for pressure gauge, shall be provided on the liquid lines, vapour lines, cargo tanks, associated spaces and equipment throughout the cargo system.
Provisions shall be made for adequate Nitrogen purging.
Cargo pipelines on deck to be stainless steel 316L, pipelines in tank to be stainless steel 304L, including spray lines.
Fastenings for cargo lines outside tanks shall be stainless steel 316 (ASTM A320 GR.B8M Class 2) for bolt and stainless steel 316 (ASTM A194 GR. 8M) for nut.
Cargo system pipelines are to be designed for:

- Design liquid flow rate of 7 metres/second with three liquid arms and a design max flow rate of 11m/sec when utilising 2 liquid arms
- Maximum vapour flow rate of 40 metres/second

Cargo Manifold

The cargo manifolds, consisting of 4 liquid lines and 1 vapour line shall be provided port and starboard on platforms above the upper deck and be in compliance with SIGTTO / OCIMF standards with presentation flanges of 400 mm for both liquid and vapour manifolds.
Double shut off valves shall be provided on each manifold liquid line.
Load bearing and pressure relief in case of ESD II activation shall be taken into consideration.
Eight manifold adaptor pieces for use with camlock type loading arm flanges shall be provided (four each port and starboard side), together with a simple handling method to mount and stow the adaptors.
A portable nozzle for cargo jettison shall be supplied, capable of being connected to any cargo liquid manifold, port or starboard.
Portable spool pieces shall be provided for temporary connections between liquid and vapour manifolds and vapour manifold to inert gas line in accordance with CCS licensor's recommendations
Gratings on manifold deck shall be FRP with stainless steel grating inserts in load arm bearing areas. Adjacent to the cargo manifold shall be connections for loading marine diesel/gas oil, fuel oil and fresh water.

Vent Masts

A stainless steel (SUS 316) vent mast shall be provided for each cargo tank. The mast is to have a drain and a nitrogen purging connection.
The vapour header and pressure build-up line (where fitted) shall be led into the forward vent mast which shall be fitted with a pressure control valve, and a trip closing arrangement operated from the wheelhouse, with manual override.

Piping Ancillaries

Piping Insulation

System pipelines operating at temperatures below 0 °C shall be insulated and sealed with a watertight vapour barrier.
Provision shall be made to avoid damage to outer layers of insulation during normal expansion / contraction of pipelines. Mechanical protection covers shall be FRP. The LOGSTOR system is the type envisaged. Alternative equivalent systems would also be considered acceptable.

Pipe Supports

Sliding supports shall be provided with PTFE type pads. Any metal to metal contact shall be avoided. 'U' bolt bands shall be of stainless steel SUS 316.

Expansion Loops / Bellows

Bellows shall only be provided where it is impractical to employ an expansion loop. Such cases shall be approved on a case by case basis.

Filters

Removable conical strainers shall be installed in each liquid manifold, designed in accordance with SIGTTO recommendations.
Six loading strainers and six discharge strainers shall be provided and stowed in a water tight box on loading platform.
Strainers shall be located in the manifolds immediately inboard of the presentation flanges.
Supply lines to the spray nozzles shall be provided with removable mesh strainers.
Test and Work Practices
100% NDT shall be carried out for cargo pipeline welds. All butt welds of cargo liquid and vapour lines shall be radiographed. Mitred joints shall not be used.
An internal TV inspection of all the major liquid and vapour lines is to be carried out in a cogent manner. The standard of cleanliness for inert gas and N2 lines shall be to the same degree as the cargo piping system.
Piping systems cool-down test with LN2 shall be carried out prior to gas trials.

Ship to Ship Transfer

Mooring equipment details and arrangement shall include provision for ship to ship transfer. The Builder is not required to provide cargo hoses, fenders and electric cables etc. for ship to ship transfer.

Cargo System Valves

The main cargo system valves, for liquid and vapour lines shall, in general, be of welded type, triple eccentric butterfly design with an extended bonnet and stem.
The valve seals shall be of metallic or Teflon/stainless steel and designed for bi-directional flow and be fire safe

The valves shall be so designed as to allow the replacement of the seat ring in a timely and efficient manner.
All valves shall be of fire safe type according to Oil Companies Materials Association (OCMA) or equivalent.
All other control valves and small-bore valves shall be of the globe type.
Cast valve casings and small valves to be stainless steel 316L or equivalent.

Safety Valves

Cargo Tank Safety Valves are to be to Rule and Class requirements.
Insulation spaces shall each be provided with at least two equally sized, pilot operated, relief valves of sufficient combined capacity to relieve the total required capacity.
The valves may also act as vacuum breaker valves.
Provision shall be made with pipeline system relief valve arrangement to allow for safe access to any one cargo tank after aeration.

Remote Control Valves

All valves to be operated during normal operations such as cool-down, loading and unloading shall be operated from the CCR.
Remote operated valves shall have local and remote indication, including where practicable flag indication.
All cargo system remotely operated valves and emergency shutdown valves shall be capable of being operated locally.
The operating characteristics of all remote control valves shall be such as to avoid harmful pressure surges on closing.
Valve actuators shall be supplied and fitted by the valve manufacturer.
Constant, accurate and reliable valve position indicators for cargo and ballast system valves shall be provided.

Gas Detection System

A comprehensive gas detection and alarm systems shall be provided to continuously monitor appropriate spaces, e.g. Cargo area, engine room, GVU (gas valve unit) rooms and GCU area) and accommodation space.
The main system shall be of the infra-red analyser type (0-100% LEL Type); all other systems shall be of the catalytic combustion type or individual infra-red analyser type.
Duplicate gas detectors to be installed in the generator engine rooms and GVU rooms. Initiation of two gas detectors in the same space shall trip the generator engines in that space.
A mimic representation of all sample zones together with meters shall be provided in the CACC with repeater panels mounted in the wheelhouse.
The gas detection panels and systems shall be interfaced with the IAS to give visual indication of which sensor has detected gas
CO gas monitoring to be provided for IGG room.
The IGG Room, CMR and EMR shall have oxygen detection systems.

Nitrogen & Inert Gas Systems

Nitrogen System

A nitrogen gas system shall be installed to provide nitrogen gas to insulation spaces, purging of fuel gas line in engine room, purging of cargo liquid lines, vapour lines and vent masts, and sealing of gas compressors.
A low pressure type, of maximum 10 bar shall be supplied.

Nitrogen system pipelines are to be stainless steel (SUS 316L), throughout.

Nitrogen Generation Plant

Two membrane type nitrogen generation plants and two 100% air compressors shall be provided.
Each unit shall be of sufficient capacity to supply at least 2.0 times the maximum "at sea" daily nitrogen demand.
In parallel, both units shall be of sufficient capacity to supply at least 1.0 times the maximum demand during cool-down and loading after refit etc.
Produced nitrogen is to be stored in a buffer tank suitably sized to ensure that the plant does not start more than twice per hour under normal sea going conditions.
The produced nitrogen shall conform to the following specification:

- Purity: Not less than 97% at 100% rated throughput
- Dew Point: -70 °C at atmospheric pressure

An oxygen monitoring and control system shall prevent the flow of nitrogen to the buffer tank upon a content of greater than 3% O2 being detected.

Inert Gas/Dry Air Plant

The inert gas / dry air plant shall be located in a separate compartment in the engine room.
Preparation, starting and adjustment of the inert gas generator shall be carried out locally; tripping of the plant shall be possible from the CCR.

The independent inert gas generator shall supply inert gas within the following specification:

- O2 content- max 1% by volume
- CO content- max 100 ppm
- SO2- max 10 ppm
- NOX- max 100 ppm
- Soot- 0 Bacharach
- HC- 0
- Dew point- -45 °C

If the O2 content is above 3% by volume or any HC content detected, the discharge shall be vented automatically and a visual/audible alarm shall indicate such situation locally and in the CCR & ECR.
Seawater for the inert gas generator scrubber shall be provided by independent sea water pump with backup from a ballast pump with appropriate interlocks.
Inert gas/air drying plant shall be provided. The drying process shall not use steam heating.
Any water-cooled heat exchangers shall use fresh water.
Materials in contact with humid inert gas or seawater shall be corrosion resistant materials and blowers shall also be suitably protected as to prevent corrosion.
Inert gas system pipelines are to be stainless steel (SUS 316L) throughout.

SHIP'S EQUIPMENT AND OUTFIT

MANOEUVRING EQUIPMENT

Steering Gear

One or two sets of electro-hydraulic, two ram four cylinder or rotary vane type steering gears shall be provided.

The steering gear shall be provided with two (2) completely independent, each 100% power hydraulic circuits. Each steering gear shall have two 100% power, electric motor driven pumps (total of two), with independent piping, valve boxes (stop valve, by-pass valve, relief valve), etc.

Each steering gear shall be capable of turning its rudder (at full speed of the ship at maximum loaded draught) from 35º port to 35º to starboard and from 35º on one side to 30º to the opposite side in 28 seconds with only one hydraulic circuit with two pumps in use in use.

The steering gear system shall be designed to provide for full flexibility for split rudder operations, where a twin skeg arrangement is chosen. The Builder is to specify any limitations and operating parameters when utilising this function.

Where twin skegs are fitted, the steering gear shall be capable of turning the rudder to 45 degrees when the rudders are in split mode.

ANCHORING AND MOORING EQUIPMENT

Anchoring and Mooring on General

The mooring arrangement shall be confirmed by mooring calculations including prediction of wind and current loads in accordance with both IMO and OCIMF Guidelines and Recommendations. The following shall be considered as a minimum. 3 x Headlines, 3 x Forward Spring Lines, 4 x Forward Breast Lines, 3 x Aft Spring Lines, 4 x Aft Breast Lines and 3 x Stern lines. In the case of the 3rd spring lines forward and aft they should be configured so that it may be deployed as a breast or spring line. i.e. the aft spring will come from a winch on the sunken deck that is on the same side as the berth."

In addition the aft main deck spring winches by means of pedestal rollers and additional chocks should be capable of putting 4 lines out on the port side.

In addition, arrangements shall be provided to receive six additional wires from shore, three forward and three aft (one forward and one aft must be springs). Arrangement shall include bitts, chock, etc. aligned with existing winches for hauling the wires aboard.

Winch drum direction of rotation, speed and brake shall be controlled locally and remotely from ship's side port and starboard.

Windlass

Two sets of windlasses, each combined with a mooring winch shall be installed on the upper deck forward. Each unit shall be driven by low pressure hydraulic motors.

Each windlass shall have a clutch, reversing control, friction band brake, chain counter and a dynamic fluid brake type speed limiter or disc brake.

Each windlass shall be capable of lifting the bow anchor and full lengths of chain (110 m) using one hydraulic pump.

In addition, Windlass and Mooring arrangements shall meet all the requirements of enlarged Panama Canal.

Mooring Winch

Mooring winch drums shall have a means of being disengaged from the main drive shaft with a split drum configuration; the storage drum having sufficient capacity for the full 275 meters of rope. The winches shall be driven by a reversible hydraulic motor through totally enclosed gears and be fitted with one or two warping guides depending upon location.

The winches shall be capable of retrieving 275 m length and 42 mm diameter of HMPE mooring rope with a 30 ton pull at 15 m/minute.

Brake capacity of drum shall be about 80% of mooring rope MBL in design and a means of setting the brake by means of spring mechanism at 60% of the mooring rope MBL at first layer in accordance with the recommendation of OCIMF.

The brake drum face will be of stainless steel.

The builder shall supply one brake test kit and deck stiffening if required to allow for the 6 monthly OCIMF brake testing.

Power Pack for Windlasses and Mooring Winches

If a hydraulic system is used, two separate electro hydraulic power systems shall be provided for deck machinery, one forward and one aft, and are to be of the low pressure type . Each hydraulic power system is to be provided with 3 (or 4) x 50% motors/pumps. The winch motors will be of the vane type and capable of walking the anchor out to 90% water depth without recourse to the brake.

The forward system shall drive the anchor windlasses and forward mooring winches. It shall be capable of driving simultaneously two windlasses at rated load or two mooring winches at rated load.

The after system shall drive the aft mooring winches. It shall be capable of driving simultaneously two mooring winches at rated load.

Each hydraulic power plant shall be provided with a stop switch in the vicinity of the windlass/winch operation.

The motors and pumps are to be interchangeable between the forward and aft systems.

Alarms shall be provided locally and to the IAS. As a minimum, low oil level alarm and high temperature alarm shall be provided.

The power packs forward and aft will have coolers fed from the fire main of sufficient size to cope with the hot oil in the deck pipes that return to the unit on start up when trading in the gulf in summer

Anchor, Anchor Chain, etc.

The vessel shall be provided with 2 anchors, high holding power, stockless, AC-14 type.

Anchor cables shall be U3, flush butt welded stud link cable in 27.5 m lengths joined by cast steel "Kenter" type shackles. Anchor chain shall be one size higher than the class requirement.

Fixed Mooring Fittings

Towing Equipment

Eighteen sunken bitts recessed into the hull shall be provided and they will have a safe working load of 100 tonnes with a test loading of 150 tonnes. The towing chock shall be arranged in pairs, one above the other, 4 pairs along each side and one pair in the transom.

One (1) set of quick acting emergency towing bracket (200 tonnes SWL; 400 tonnes MBL) to be fitted forward with Panama fairlead, with stowage and deployment facilities for foredeck chaffing chain.

One (1) set of (aft) emergency towing system complying with latest IMO requirements to be installed below deck (steering flat).

3 bollards and fairleads (SWL 200 tonnes MBL 400 tonnes) are to be fitted for escort tug duty and pull back, two forward and one aft. There must be means provided for pulling the tugs tow line on board.

Harbour tug towing (sufficient for at least five tugs) should be provided utilising the mooring winches, bitts and panama fairleads in accordance with MEG 3rd edition.

Capstans for Tug Ropes

Four locally controlled capstans with a capacity of 1,000 kg x 25 m/min shall be provided on the upper deck cargo tank part for handling tug ropes.

Fire Wire Rope

Two fire wires; galvanized steel core wires (6 strands x 24 wires) 38 mm diameter and 90 m long shall be provided, one forward and one aft. Each wire shall be stored on a reel driven by an air motor.

Mooring Rope

Builder shall supply all required mooring ropes stored on the winch drums. Mooring ropes shall be 275 m long, of HMPE (High Modulus Polyethylene). The actual number and sizes of ropes shall be confirmed by the mooring calculations required above.

Polyamide tails of 11 meters long with a strength of 125% MBL of the rope are to be attached to the mooring lines with suitable shackles.

Mooring lines and tails should be supplied pre-stretched.

All the mooring bitt fairleads shall be of the Panama type and shall be supplied with nylon inserts.

DECK OUTFITTING

Access Arrangements for Tanks and Engine Room

The upper course of safety railings and hand railings anywhere on the vessel shall not be lower than 1100 mm from the deck level. An intermediate railing shall always be provided. The height of railings on inclined stairways in any area should be increased to provide adequate safety against falling for a person of 1.9 m height. Railings around intermediate platforms on inclined stairways in the engine room shall be increased to provide enhanced safety.

Provided hatches must be large enough for the removal of the largest piece of equipment in the tank.

Special attention shall be paid to the design of access and egress facilities in tanks and enclosed spaces. Ladders, doors, access openings, rails, lifting lugs, foot rungs, hand grabs, etc. shall be arranged for easy movement of personnel with breathing apparatus, equipment and removal of an injured person by stretcher.

Guardrails are to be provided around edges of horizontal members, e.g. stringers and vertical lift openings. Welded grids are to be provided over ventilation and lightening openings.

Ladders are to be arranged in a fore and aft direction as far as is practical and shall be sloping (less than 50 degrees from the horizontal) for safe tank access. Stair height shall be in accordance with European standard.

Should vertical ladders be necessary they shall be provided with safety hoops up to 4 m height and with protective cages over 4 m height. Ladders to be staggered with a landing spaced a maximum of 5 m apart.

Two stairway routes are to be provided in each ballast tank.

Two ladder routes are to be provided in each void space and cofferdam.

All main water ballast tanks accesses on the main deck to have watertight hinged hatches. These are also to have 316L compression bar welded on top of the tank hatch coaming.

Each Water Ballast Tank and cargo hold cofferdam is to have a Clear Lift Rescue Area with an enlarged manhole and lightening holes aligned vertically beneath. This access is to be of sufficient size to permit an injured person on a stretcher to pass through. The manhole should be marked to clearly state ‘no ladder below’.

All walkway gratings in exposed areas or in confined spaces shall be Phenolic resin type with stainless steel clips.

Manifold Service Crane

The manifold cranes shall be provided with sufficient length of wire rope to allow the hook to be lowered to the waterline level when the ship is in the light ship condition with remaining length of minimum three turns on the winch drum.

Two hydraulic manifold cranes shall be provided to reach over the ship’s side 4 m in way of the cargo manifold or 2 m over the full length of the cargo, bunkering and service manifold whichever is greater. Lifting capacity to be 5 tonnes, slewing speed to be 0.33revs/min maximum.

Provision should be made for stowage of Suez mooring boats.

Provision and Equipment Handling Crane

Stores cranes and cargo machinery davit shall be provided with sufficient length of wire rope to allow the hook to be lowered to the waterline level when the ship is in the light ship condition with remaining length of minimum three turns on the winch drum.

Two hydraulic stores cranes to be provided adjacent to the deckhouse for storing aft with the ability to plumb the ship's centre line as well as stores hatches and engine room hatch. Portable remote control operation is required. The stores cranes shall be capable of reaching the aft mooring deck.

The lifting capacity at maximum outreach to be 5 tonnes port and 10 tonnes starboard at 12 m/min at full load.

The maximum outreach is to be suitable for all berths in Japan as well as barges alongside.

A davit approximately 5 tonnes SWL is to be provided in way of the cargo machinery room with a capacity to suit the largest item of equipment and outreach to enable transfer to a barge alongside. Hatches shall be provided in the house to enable withdrawal of equipment via this davit. The position of the cargo machinery room davit shall not adversely interfere with navigating bridge visibility.

Ship Access

Two aft facing accommodation ladders shall be provided, one port and one starboard, of one-section self-stowing type of aluminium construction with curved non-slip type treads of a minimum width of 600 mm. Each ladder is to be capable of being operated by one man with the bottom platform not more than 1.0 m above light ballast waterline at maximum inclination of 45 degrees.

Two self-contained rope pilot ladders, one man operated, shall be provided, port and starboard. The ladders shall be stored on drums driven by air motors.

The accommodation ladder/pilot ladder arrangement shall meet IMPA requirements.

A shore gangway of aluminium alloy shall be provided.

LIFE SAVING APPLIANCES

Lifeboat and Davit

Two gravity launched lifeboats are to be provided and shall be totally enclosed, gas and fire protected and of FRP construction capable of accommodating 45 persons (of 90 kgs each). There should be one set of heavy weather recovery gear provided.

Life rafts with launching davits shall be provided as follows: 2 x 25 man port and starboard aft and 1 x 6 man fwd.

LSA lights to be suitable for use in gas hazardous zones as defined by the vessel gas hazardous zone drawing and in accordance with amendments to SOLAS chapter II-1: regulation 45 regarding LSA / lifebuoys provided with self-igniting lights.

FIRE EXTINGUISHING SYSTEM

General

Firefighting arrangements shall be installed in accordance with Regulatory Requirements and shall be of a standard qualifying for an enhanced Safety Notation, e.g. DNV F-AMC.

A fire hydrant and general service system (fire and deck wash system) shall be installed to cover all external and internal areas of the vessel. The fire main shall be a ring main, located in the fore and aft underdeck passageways and shall be permanently pressurized. An approved B.S.336 instantaneous coupling shall be used on all hydrants. Hydrant valves shall be stainless steel ball valves.

The fire main serving the accommodations shall be fitted exterior to the structure.

The fire and general service main shall be served by:

Fire Pumps (self-priming),

Fire, bilge and general service pumps (self-priming),

Emergency fire pump (self-priming),

A fixed water spray system, in accordance with the IGC code, supplied from dedicated (self-priming) pump(s) shall protect the cargo tank domes, cargo manifold valves, deck compressor room, lifeboat embarkation areas and all front and side bulkheads of the accommodation block. Water spray system nozzles shall be brass; pipes shall be non-ferrous or polythene lined steel.

In addition, an independent water curtain system shall cover the shell plating in way of the cargo manifold area. Provision shall be made for fresh water flushing all sea water spray systems.

Water based alternative fire extinguishing systems shall not be used in switchboard rooms, electrical rooms or ECR, a suppressant such as NOVEC 1230 should be offered.

Protected spaces shall include the engine room, including all spaces contained in the engine room envelope, such as IG generator room, Purifier/FO treatment room, compressor and compressor motor rooms, etc. Stand-alone firefighting systems with automatic and manual release shall be provided for the individual spaces in the engine room above IG generator room, FO treatment room, plus the boiler flat, emergency generator room, steering gear room, forecastle stores, hydraulic power pack rooms, incinerator room, paint stores, chemical stores and the cargo switch board room.

The cargo deck area shall be protected by a dry powder system fitted at intervals along the deck. Four individual tank units shall be used. Each tank shall have a capacity of at least 750 kg of powder with the required number of hoses to reach any part of the cargo deck. Hose stations shall be protected from the weather by suitable housings. For Moss containment system, hose stations shall be suitably housed on the catwalk in way of the cargo domes.

A fire control station shall be provided on the main deck level with access both from the deck and the accommodation. The fire control station shall contain fire detection repeater panel, and remote controls and indications of all fire extinguishing and safety equipment, including shut offs for flammable liquids and fuel oil pump, stops for ventilation fans, controls for dampers, etc. Communications to other control positions shall be provided.

BALLAST SYSTEM

General

Ballast Pumps

	Details
Number of Units	3
Type	Vertical, Centrifugal, single stage
Prime mover	Electric Motor
Rating	To meet loading/discharge rates

Ballast pumps will be arranged in the engine room such that any two (2) units can operate in parallel to meet stipulated loading and discharge criteria and operating in parallel with these operations.

One of these Pumps will be arranged, and interlocked, such that it can be used for inert gas plant cooling needs.

Pumps will be started and stopped from the IAS, suction and discharge pressures will be transferred to the IAS as well electrical load readings.

Ballast Piping System

Ballast main system shall of "ring main" design, in normal operation the ring main will be operated as port and starboard mains with the forward crossover closed.

The system will be equipped with two (2) sea chest, one port one starboard and a separate ballast overboard above the normal ballast waterline.

The system will allow free flooding of ballast tanks.

Port and starboard mains will be equipped with a pressure and vacuum monitoring system with read outs transmitted to the IAS. The system will be equipped with vacuum cut out units.

Ballast stripping shall be carried out by two (2) ballast eductors one port one starboard. Eductor nozzles will be SUS 316L, eductor bodies will be nickel aluminium bronze.

Valves and Valve Control

Ballast valves will be concentric wafer butterfly valves operated by double acting hydraulic actuators controlled from the IAS.

Valve will be cast steel with nickel aluminium bronze discs and stainless steel (SUS 316L) shafts

Ballast Tank Pressurization

General service airline shall be used for this purpose and the main line shall be arranged in inner deck and branched to each ballast tank with blank flange adjacent to one (1) of air vent pipes of each ballast tank on the upper deck.

Two (2) sets of flexible air hose, 15A valve fitted to slip-on flange and two (2) sets of blind flange shall also be provided. The builder should propose arrangement for a class approved ballast water treatment system.

HULL PIPING

General

PTFE type material sliding pads shall be applied for exposed deck piping supports (similar to ‘stop-rust type’ for example to avoid crevice corrosion issues). All pipe hoops for metallic pipes to be stainless type with UV resistant PE sleeves. Those for insulated pipes or stainless pipes may be stainless type without sleeves.

Waste pipes, scuppers and drains shall not pass through, or under the deck-heads of, spaces used for the storage and preparation of food, or electrical equipment.

Bilge systems for cofferdams, voids, under deck pipe passageways, double bottom pipe duct, bosun's store, chain locker, store rooms and emergency fire pump room shall be provided.

Separate bilge systems shall be provided for the cargo hold void spaces and the cargo machinery room.

All fresh water piping in the accommodation to be copper and PVC for the toilet space sewage and grey water drains.

Liquid Fuel / Lube Oil Filling, Transfer and Heating System

A fuel oil filling and transfer line, if necessary, shall be arranged with one branch line provided to each fuel oil tank. All fuel grades to have their own dedicated loading lines.

Fuel oil and diesel/gas oil, shore connections fitted with locally operated butterfly valves and blank flanges shall be provided on the main deck, port and starboard, near the cargo manifold. Inline fuel samplers shall be provided. Pressure gauge tapping and thermometer pockets shall be provided at each fuel loading connection.

It would be preferable to store all HFO in the after end of the vessel. Where design precludes this, the fore-deep bunker tanks are to be provided with remote level gauging, tank heating, two transfer pumps and trace heating.

Fresh Water Service System

A domestic fresh water system with an approved silver ion steriliser, remineralisation system and duplicated pumps fitted in the engine room shall be provided. Hose connections shall be provided at intervals along the main deck and flying passage (where fitted), at cargo manifolds, and external to the accommodation on every deck and casing.

A domestic hot water circulating system shall be provided with steam and electric heaters.

One cooled water drinking fountain shall be provided on each deck, the Wheelhouse and in the Engine Room.

Compressed Working Air System

Compressed air from the engine room shall be supplied on deck for air-operated machinery and tools.

Quick acting, self-sealing, stainless steel couplings shall be located throughout the length of the vessel at about 25 m spacing, and external to the accommodation on every deck and casing. The air supply line shall be sized to minimize pressure drops.

ACCOMMODATION

GENERAL

General

The accommodation, office and recreational facilities shall be designed in accordance with recognised international ergonomic standards (i.e. MLC 2006).

European style accommodation, complying with the IMO (ISPS) 'International Ship and Port Facility Security Code', of a high standard shall be provided for the vessel's complement. The layout of the accommodation, individual rooms, door access and passageway arrangements, shall be submitted with the G.A. at the tender stage

Soft furnishings (carpet, chair & sofa cover, mattresses and curtains) shall be fire retardant (low flame spread characteristic) low toxic smoke emitting to meet European Union standards with certificates for the Buyer's retention.

The accommodation shall comply with DNV F(AMC) notation for fire fighting

Wool carpets are to be provided in all cabins and lounge spaces, vinyl flooring to be used in passageways, offices, messes and control rooms.

Free height in the accommodation shall be not less than 2,200 mm including all fittings, ventilation outlets, light fixtures, etc.

Main passageways shall be no less than 1,300 mm clear opening. Obstructions such as fire hydrants, drinking fountains, etc. shall be recessed.

Steel boundary bulkheads with non-combustible lining material shall be provided around the wheelhouse, electronics room, changing room, hospital, laundry rooms, stores, galley and air conditioning room, etc.

A covered stores handling area is to be provided between the accommodation deckhouse and the engine casing. Double access doors shall be provided. Provisions shall not be transported to the handling area by any ladders or stairs. If the stores are not at deck level a gravity roller conveyor system must be provided.

Access for engine room stores is to be via a hinged hatch cover on the first deck level. A bolted hatch is to be provided for the largest lifts and use during docking.

A hygienic and also automated, if on different decks, way of transporting galley and accommodation waste to the incinerator room, waste handling space and compactor room should be provided. The rooms should be constructed so as to be easily hosed out and cleaned. The bulkhead to deck join should be radiused and the floor cambered to gutterways as per the galley.

Comprehensive storing facilities including deck stores, paint and chemicals are to be provided at the sides of the engine casing on the upper deck. A Bosun's store is to be provided forward. A safety equipment store is to be provided on aft end of deckhouse at upper deck level.

Complement and Cabins

The following classes of cabins shall be provided:

Class of Cabin:	Number of Cabins:
Captain Class - Day Room, Bedroom and adjoining office.	2
Senior Officer Class - Day Room, Bedroom	2
Junior Officer Class - single cabins	12
Pilot Cabin - cabin with double bunk	1
Petty Officer Class - single cabins	2
Rating Class - single cabins	13
Worker Class (Suez) - cabin (external access) with six berths	1
Worker Class (riding squad) - cabins with double bunks	3
Total cabins/complement	39 + Suez

All cabins shall have private toilets and shower. Shower heads shall be at least 2 metres above the tray. Drainage arrangements in the accommodation are to be suitable for bow and stern trim operations.

All the officer's cabins are to have double beds.

The hospital & dispensary shall be provided with an additional access direct to the open deck. The bath must be accessible from both the longest sides so that the patient can be rendered assistance by two persons.

A Cargo control room with an adjoining cargo office should be located such as to give good visibility and access to the deck. The conference room (10 persons) and the general office (6 work stations) should be located on the same deck. Noise and traffic emanating from these work places must not impact on any designated sleeping quarters.

Messing and recreational areas shall consist of separate officers' and crew's mess, a separate officer and crew duty mess, separate recreation and separate TV rooms. One games room, gymnasium, training room (for 10 persons) and one library are to be provided.

The Galley shall be located on the first deck level above but adjacent to the provision stores and adjacent to mess rooms port and starboard. Provision stores to have large doors at aft end for loading.

There shall be a total of five pantries: One for the officers and one for crew (generally located between the galley and the respective mess rooms), three night pantries; one for officers, one for crew and one in the vicinity of the CCR. Limited pantry facilities shall be provided in or adjacent to the wheelhouse.

Two laundries shall be provided. One for the officers' and one for the crew, each with a drying room, and furnished with domestic type washing machines and dryers (two of each for the officers and three of each for the crew).

Two changing rooms shall be provided, one for the officers and one for the ratings on the upper deck. These shall each also have one washing machine and dryer of industrial standard (12kg).

A ship's laundry facility, having a central laundry room and drying room with two industrial standard washers, two driers and one roller iron sized for all the ship's linen and work clothes requirements. Dirty and clean linen lockers are to be provided in close proximity.

Electronics and electrical workshop to be provided close to electronics equipment rooms. Adequate storage areas and lockers shall be provided.

Adequate storage areas and lockers shall be provided within the accommodation block to include but not be limited to a stationery locker, baggage lockers, bonded stores, cleaning gear lockers (one on each deck), radio/radar stores, oilskin lockers, etc.

GALLEY, PANTRY AND LAUNDRY EQUIPMENT

Waste Management System

The vessel shall operate an integrated waste disposal plan, the waste management room shall be provided with ready access from the galley and machinery space. The following equipment shall be provided: Incinerator for generated oil sludge, solid waste (500,000 kcals/min) and certified for burning plastics, Shredder, Compactor, Storage area for 10 drums of 205 litres.

The food waste macerator is to be located in the galley with a dedicated discharge overboard pipe.

PROVISION STORES AND REFRIGERATING PLANT

Dry Provision Stores

Refrigerated Provision Stores

Refrigerated stores spaces shall be provided as follows:

Space	Temperature	Volume m^3
Meat Room	-20 °C	30
Fish Room	-20 °C	15
Lobby	+2 °C	
Dairy Room	+2 °C or -20 °C	25
Vegetable Room	+4 °C	30

Refrigerating System for Refrigerated Provision Stores

Two sets of refrigeration plant shall be provided, with each unit able to automatically maintain the specified cold room temperatures under the following conditions:

Cooling fresh water temperature	38 °C
Ambient air temperature	35 °C
Duty cycle	12 hrs. /day

Each refrigeration unit shall be fully duplicated.

The freezer rooms will have split curtains and door seal heaters.

Hot fresh water connection and ozone generator to be provided in vegetable room.

SANITARY EQUIPMENT AND ACCOMMODATION PIPING

General

Toilets shall be freshwater flushing with soil removed via a gravity system to the sewage treatment tank and the sewage holding tank.

A sewage treatment unit in compliance with the latest MARPOL requirements capable of handling more than the maximum persons on board shall be fitted.

Public toilets shall be provided on each deck where there are public rooms or working spaces, including one accessible from the upper deck outside. One toilet shall be provided in the Wheelhouse, in the Engine Room and between the Master and Chief Engineers' offices.

A free standing sewage holding tank of at least 10 m3 is to be provided.

AIR CONDITIONING AND VENTILATION SYSTEM

General

Air conditioning system is to be provided in the accommodation block. The system shall consist of two 100%, centrally located, cross-connected units supplying conditioned air through low velocity, single duct pre-insulated piping and shall provide up to 9 air changes/hour for cabins and, generally, 12 air changes/hour for public rooms.

Each unit shall be capable of maintaining an internal temperature as specified below. In extreme conditions of 45 °C with a relative humidity of 80% the two units shall be capable of operating together to produce the required internal conditions.

Air temperature in each cabin shall be controlled by re-heaters, controlled by thermostats, in each room.

The ventilation, heating and air conditioning system shall be designed for the following conditions (to be confirmed with the above):

For Cooling

Ambient Temperature:	Outside 45 °C, Inside 23 °C
Relative Humidity:	Outside 80%, Inside 50%
Fresh air ratio:	Approx. 50%

For Heating

Ambient Temperature:	Outside -25 °C, Inside 20 °C
Relative Humidity:	Outside 20%, Inside 50%
Fresh air ratio:	Approx. 50%

Packaged air conditioning units shall be provided as well as spot cooling from the main system for the Wheel house and galley. Further package units will be provided in the ECR, switchboard rooms, engineers work shop, and electronics room. Alternatively central engine room AC plant with duplicated systems shall be provided. Air flow from the packaged air conditioning units shall be distributed through a local ducting system (where ‘stand-alone’ package A/C units are installed, these are to be 2 x 100% for ECR, main/cargo switchboard rooms).

Package units for wheel house and galley to be ‘air-cooled’ split type.

Cargo Machinery Room Ventilation

Two supply fans (one running, one standby) providing sufficient air changes to be provided for the (cargo machinery) motor room. Change over to standby unit to be automatic in the event of running unit failure

Two exhaust fans (one running, one standby) providing sufficient air changes to be provided for the boil off gas duct.

Ventilation manifold / boxes shall have manhole access for maintenance purposes.

LIFT AND ACCOMMODATION EQUIPMENT

Lift

Combined personnel and cargo lift - 500 kg capacity – shall be capable of going from deck below navigation bridge deck to lowest possible platform in engine room (selective/collective operation shall be provided).

PIRACY PREVENTION & MITIGATION

The sunken deck should be fitted with an over the side high pressure water spray system, consisting of 316L spray piping. The system should be flushable and capable of being supplied from the emergency fire pump without compromising the "pressurised" fire main concept of the vessel.

A method of detecting a breaching of the water spray (wire or optical) by persons and sounding the general alarm shall be provided.

The accommodation block and engine casing shall be secured as citadels. However, security measures necessary for restricting access must not compromise escape routes.

The steering flat security, fitted equipment (communications, first aid) and provisions (food & water) should be such that the space will serve as the final safe sanctuary for the crew in the event of an incident.

MAIN MACHINERY AND EQUIPMENT

GENERAL

Builders will submit proposals XDF System.

Builders will submit designs for twin skeg arrangement.

Propulsion system will be capable of consuming:-

- Gas as primary fuel
- Low Sulphur Marine Diesel Oil 0.1% sulphur
- Heavy Fuel Oil (700 cst) 3.5% sulphur

Shaft locking device to be provided to ensure that on twin engine operated vessels one engine can be separated due to damage or maintenance reasons a so-called shaft locking device must be installed on each propeller shaft. This device protects the stopped engine against turning during sailing by the wind milling effect.

The auxiliary systems (e.g. cooling water, lubrication oil supply, fuel supply) of each XDF engine shall be independent of each other.

For installation on board vessels, GVU-OD™ (Open Design) to be provided.

Gas detectors have to be installed at following locations:

- In GVU venting blower air outlet line, for detecting any leakage of the gas pipes and gas equipment in the double-wall installation and GVU respectively
- On the engine for piston underside gas detection

Builders will supply an Electric Load Balance for all operating conditions.

Builders will supply a full safety case for the XDF fuel gas system.

Builders will undertake a full FMEA of propulsion fuel systems.

Builders will carry out a full RAM (Reliability, Availability and Maintainability) study for the XDF duel fuel diesel propulsion system.

Builders will carry out a short circuit study of the generating power plant and submit to the client for approval.
Builder should indicate the most efficient speed using natural boil off avoiding use of the GCU or steam dumping

Engine Arrangement

With regards the Machinery space, Auxiliary machinery spaces and switchboard rooms each space will be self-sufficient in terms of ventilation and air supply, fuel supply, fire and safety systems.

ELECTRIC POWER GENERATING PLANT

General

Auxiliary dual fuel diesel, electric generating plant shall be arranged in the engine room.

One (1) emergency diesel generator shall be arranged in the emergency generator room which located outside the engine room.

Each diesel generator except emergency generator shall be capable of parallel running.

Generator Engines

Dual Fuel Diesel engines will be four (4) stroke, turbocharged unidirectional, dry sump units outfitted as below:-

- Turbocharger with manufacturer's standard cleaning provision
- Air cooler
- Flywheel
- L.O. pump (engine driven)
- L.O. priming pump (electric motor driven)
- Engine driven HT-cooling water pump
- Engine driven LT-cooling water pump
- Engine driven pilot fuel pump
- Exhaust gas waste gate
- Engine control system
- Turning device
- F.O. injection pump

Diesel engines will be directly and flexibly coupled to generators

Safety Concept for Gas Burning Engine Installation

All dual fuel generator engines shall be provided with double-wall gas piping on each engine in accordance with manufacturer's standard design.

Followings shall be considered for gas burning.

- Gas valve units (GVU), port and starboard sides, shall be provided for each main XDF engine and each DF generator installed in the gas valve rooms.
- The ventilation system of gas valve rooms and double-wall pipes shall be independent of other ventilation systems onboard to ensure under-pressure in the gas valve room and double-wall pipe. Should this ventilation system be failed, the safety system shall automatically initiate the changeover to MGO.
- Two (2) exhaust fans of each 100% capacity shall be provided; each fan capacity shall be based on the 30 times air change per hour for total volume of gas valve room and double-wall pipes for DF engines.
- The exhaust fan shall take the suction from the top of gas valve room and double- wall pipe, and shall discharge to weather deck.

- The gas valve room shall be considered "gas safe" in normal operation. A gas detection system shall cover all areas where gas is likely to accumulate. In the event of a "gas hazardous" situation developing in the gas valve room, the gas detection shall initiate an alarm and the engines shall automatically changeover to MGO.
- A fire detection alarm in any gas valve room shall cause all engines to automatically trip from gas to MGO and close the master gas valve.
- A fire detection alarm in the engine room shall cause all engines to automatically trip from gas to MGO and close the master gas valve.
- Gas shut off valves to the individual engines shall employ a double block and vent valve arrangement, to permit automatic purge with nitrogen of the gas supply lines to the units following an engine stoppage after gas burning. The block valve arrangement shall be as close to the engine as possible and the vent line shall be led to atmosphere where there is no possibility of spark ignition. The vent outlet shall be designated a "gas dangerous" zone of radius 3m. Ventilation and exhaust piping shall slope upwards to prevent any accumulation of light gas.
- In the event of an engine trip, the gas shall be shut off to that engine and a ventilation sequence performed. During the deceleration period, all gas still remaining in the engine shall be vented out so that the subsequent start is safe.
- The ventilation system of gas valve rooms should be operative even during engine room ventilation shut down. Electric source of a ventilation fan shall be supplied from emergency switchboard. Ventilation fan motors shall be installed outside the ventilation ducting. The fans shall be manufactured of spark free materials. Ventilation system shall be provided according to Class requirements.
- In the event of a cargo emergency shutdown (ESD), the master gas valves shall close and all engines shall changeover to MGO.
- Each individual exhaust system shall be fitted with a ventilation system to purge the exhaust system after the engine has been stopped in gas mode.
- Gas piping from the cargo area to the engine room through enclosed spaces shall be fitted inside an enclosed duct.

Emergency Diesel Generator Engine

Number of set	One (1)
Type	Vertical, 4-stroke, direct injection, trunk piston
Revolution	1,800 RPM
Starting	Primary Automatic electric battery starting Secondary manual hydraulic starting
Cooling	Radiator cooled
Applicable fuel	MGO

Emergency generator set shall be installed in emergency generator room with emergency switchboard.

The engine shall be directly coupled to the generator.

An electric jacket F.W. preheating unit shall be provided with temperature control.

POWER TRANSMISSION

Shafting

Line shafting shall be machined all over and finished "journal smooth (surface roughness N6)" in way of the journal bearing. Bearing journal of the intermediate shaft shall be increased by approx. 5 mm in diameter. Diameter of Line shaft, Stern Tube shaft and Tail Shaft should be at least 2 mm more than the minimum diameter required by the Class Society.

The shafting shall be coupled by conventional reamer bolts of forged steel Coupling flange of shafting shall be provided with protection cover.

The aft part of propeller shaft shall be machined 1/20 taper and threaded at the end for fitting the propeller with a hydraulic nut.

The shaft grounding device consisting of silver graphite brush, silver alloy band and milli-voltmeter shall be fitted. One (1) spare set of silver graphite brush shall be provided.

Intermediate Shaft Bearing

The intermediate shaft bearing, if required, shall consist of two (2) sections, a lower half of cast iron construction with white metal lining and an upper half of cast iron or steel plate.

An opening with a cover shall be provided on the upper section for inspection and oil filling.

The lower section shall be provided with an oil receiver, oil drain plug, cooling water connection and dip stick gauge.- and low level alarm.

The bearing shall be securely fastened up to the seat, and chock liner shall be fitted for adjusting the shaft centre height

Stern Tube and Bush

The stern tube shall be of cast steel with welded steel plate which shall be welded to the ship's stern frame boss forming of hull structure.

The stern tube bush shall be of cast iron with a lining of white metal having a length consistent with permissible bearing load.

An independent lubricating oil system of forced circulation shall be provided for the stern tube.

A replaceable thermo sensor shall be provided for monitoring the bush temperature and one (1) set of spare sensor element shall be fitted in place.

A distance piece with thickness of half the distance between two Stern Tube aft seal rings to be fitted in way of the Chrome Liner.

Stern Tube Seal

Air seal for aft sealing and compact oil lip seal for forward sealing (two (2) rings) shall be provided. The seal shall be of the non-polluting (IACS) air type and compatible with the U.S. General Vessel Permit 2013.

Aft seal casing shall be designed to allow replacement of the sealing rings without removal of the shafts or propeller.

Wear down measuring apparatus shall be provided to measure the wear down of aft bush.

Propeller

The propeller diameter and number of blades shall be finalized considering the propulsion efficiency and hull vibration.

The propeller blades shall be smoothly finished in accordance with ISO484/1 Class I and the propeller shall be statically balanced.

The propeller shall be of solid nickel aluminium bronze and shall be turned right hand, seen from aft (in case of single skeg design only) when going ahead and shall comply with the requirements of ISO 484/1 Class 1. For twin screw installations the choice of propeller rotation shall be to ensure greatest efficiency. Either rotating inward or outward.

STEAM GENERATING PLANT

General

Auxiliary boiler shall be of suitable type to burn HFO and gas. Starting of auxiliary boilers shall be carried out with MGO.

Boiler

Number of set	Two (2)
Type	Dual fuel fired, vertical, forced draft, marine boiler
Evaporation	8,000 kg/h
Steam condition	10 bar saturated steam
Applicable fuel oil	HFO (up to 700 cSt at 50°C), BOG (as fuel gas), MGO (ISO8217:2010 DMA, max. 1.0 mass% sulphur)
Feed water temperature	80°C
Forced draft fan	Single speed

Exhaust Gas Economizer

Number	One (1) per Main Engine (two)
Type	Forced circulating, vertical gas flow, smoke tube type
Evaporation	About 1,200 kg/h
Steam condition	7 bar saturated steam
Feed water temperature	80°C

Exhaust gas economizer shall be so designed that the saturated steam of rated capacity and condition can be produced with each engine developing at 90% MCR in the Gas mode under ISO condition ie. @ 19.5 knot speed, without firing the Auxiliary Boilers, the total steam produced by the combined economisers should be sufficient to supply steam to the usual consumers on the Deck, Engine Room and Accommodation.

Exhaust gas economizer shall be arranged in engine room or E.R. casing to recover the waste heat from XDF main engine exhaust.

Exhaust gas economizer shall be designed to allow for dry running in HFO mode in an emergency.

AUTOMATIC AND CENTRALIZED WATCHING SYSTEM

GENERAL

Automatic and centralized watching system shall comply with ISO 17894 ‘’General Principles for the development and use of programmable electronic systems in marine applications.’’

Unattended engine room shall be applied for the Vessel, and the automation and instrumentation shall comply with the requirement of the Class and concerned Authority.

Control and automation system shall be a ship wide IAS (Integrated Automation System) covering all aspects of vessel operations, cargo and monitoring systems.

Ship’s cargo emergency shutdown system shall be independent from the IAS.

Microprocessor systems shall be designed for easy troubleshooting and shall initiate an alarm giving both the nature and position of the fault.

In general, the electronic equipment, which is not specifically required by the Classification Society and these Specifications, shall comply with the recommendation of IEC publication No. 60092.

CONTROL STATION AND EQUIP. ROOM LAYOUT

Control Station

Major Control Stations (areas) are as follows:-

Cargo Control Room: Main control centre for cargo and ballast system operation
Engine Control Room: Main control centre for engine room machinery operation
Wheelhouse: Navigation, communication and main propulsion motor remote control centre

Console

Consoles shall be of strong and rigid construction with hinged front and/or rear doors.

Internal wiring and incoming field wiring shall be terminated using solderless lugs.

Terminals with dangerous voltages (AC220V or higher) connected to them shall be protected and suitably identified.

Intrinsically safe terminals shall be identified and all intrinsically safe cables shall be blue in colour and run separately from all other cabling.

A power socket (AC220V) shall be installed inside each compartment of the console for working light.

Water, air and oil pipes will not fitted in or in way of consoles, electric switchboards or control spaces. Failure of normal power supplies shall cause automatic transfer to an emergency supply and initiate an alarm.

Control Spaces and Equipment

Control Station - Wheelhouse

The wheelhouse shall be fitted with the necessary equipment and controls to permit the safe navigation of the ship.

The propulsion system shall normally be operated from the wheelhouse automatically via a single lever control.

Following equipment shall be provided in the wheelhouse

- Wheelhouse console
- Chart table
- Radio operating desk
- Overhead instrument panel
- CCTV monitor (W/H Front ceiling)

Bridge Console

One (1) central bridge console shall be provided and the following equipment shall be provided:

- Propulsion system control panel
- One (1) IAS VDU and a keyboard including extension alarm panel with watch responsibility switch and duty engineer indication
- Emergency general alarm push button
- Fire alarm push button

- Emergency stop push button for accommodation fans
- Start/stop push button with running lamp for main fire pump
- Steering gear alarm panel with start/stop button and running lamps
- Adaptive heading control panel with steering mode selection and take-over device
- Steering override unit
- Steering control position indicator
- Control panel for whistle
- Automatic telephone
- Sound powered telephone
- Public address control panel
- Display units for navigations
- Control panel for CCTV
- CCTV monitors and control panel
- DGPS navigator (No.2)
- AIS
- VHF Radio telephones
- Controller for window wipers and heated glass
- Dimmer switch for instrument lights
- Lamp/buzzer test switch
- Buzzer stop switch
- Joystick for search lights

Engine Control Room (ECR)

Engine Control Room (ECR) shall be arranged in engine room.

Following equipment shall be provided in the ECR for centralized control and monitoring of machinery systems.

- ECR console
- Printers for IAS
- Cabinet (Unit control panel) for DF engine control system
- Desk and chair according to details in chapter 5
- Other specified in this specification

ECR Console

Following equipment shall be provided on the ECR console.

- Four (4) IAS VDUs and two (2) keyboards
- Propulsion control panel (Refer to Sec. 7.3.1-1) in detail.)
- Steam Generating Plant control panel.
- CCTV Monitor and control panel
- Maneuvering table
- Emergency stop switches for propulsion system, generator engines, boilers and ESDS
- Signal light column
- Inmarsat FB-500 remote telephone
- Electric slave clock
- Automatic telephone

- Sound powered telephone

Cargo Control Room (CCR)

Cargo Control Room (CCR) shall be arranged in the accommodation.

Following equipment shall be provided in the CCR for centralized control and monitoring of cargo/ballast systems.

- CCR console
- Workstation for mooring tension monitoring system on desk
- Printers for IAS
- Ship / shore communication system main cabinet
- Desk and chair according to details in chapter 5.
- Other specified in this specification

CCR Console

Following equipment shall be provided on the CCR console.

- Four (4) IAS VDUs and two (2) keyboards
- CTS workstation
- Loading computer
- Ship / shore telephones (PABX, Hot and public)
- CCTV monitor and control panel
- ESDS reset switch
- Electric slave clock
- Auto telephone
- Sound powered telephone
- Public address remote controller
- Push button for fire alarm and general alarm

CENTRALIZED MONITORING AND SUPERVISION

Centralized Automation System

Integrated Automation System (IAS)

General

The intent of the IAS is to provide safe and efficient control, monitoring and alarm of the following Vessel functions from the CCR and ECR.

- Propulsion machinery and auxiliaries as specified
- Electrical generating plant and distribution (PMS)
- General vessel services
- Cargo and ballast systems

The IAS shall be interfaced to:

- Propulsion control system
- DF engine control system
- Custody Transfer System (CTS)
- Loading computer
- Gas compressor control system
- SMS (Buyer supply)

The IAS design shall be redundant microprocessor based integrated control/monitoring and alarm system having redundant communication and high-speed local area networks.

Dual communication buses shall be provided between process stations for automatic changeover between buses in the case of failure in running bus to achieve system bus redundant, and the buses are to be separately routed. The topology of communication buses are as per selected manufacturer standard.

All process stations for control and monitoring function shall be equipped with dual CPU card for automatic changeover to back-up CPU card in case of failure in running CPU card.

A UPS system shall be provided for the supply of electric power to the IAS. The system shall be capable of supplying power to connected consumers for a minimum 30 minutes. The UPS system shall be powered from the distribution board which have power supplies from both main and emergency power sources.

Alarm and Monitoring Function

Alarms shall be inhibited on systems intentionally shut down and shall remain inhibited in the event of a ‘blackout’.

Monitoring Function - Analogue

Specified analogue parameters, such as temperature and pressure, shall be monitored. When any input of them deviates from the pre-set value, an alarm shall be issued with visible and audible signal together with flickering asterisk marker or equivalent IAS VDU.

The following data shall be indicated for each channel on the monitor in alpha-numeric forms:

- Channel number

- Text of monitoring point
- Measuring data
- Alarm pre-set value
- Unit

Monitoring Function - Binary (ON/OFF Input)

Specified alarm points detected by pressure switches, level switches, thermal switches, flow switches etc. shall be monitored and shall be issued when the alarm contacts open.

The following data shall be indicated for each channel on the IAS VDU in alpha-numeric forms:

- Channel number
- Text of monitoring point
- States of monitoring point (failure, high, low etc.)

Machinery alarms shall initiate audible/visual alarm in the machinery spaces through Signal Light Column.

IAS Layout

Workstation (W/S)

The IAS workstation shall be provided as follows:

- W/H: One (1) workstation, comprising single VDU (23" TFT LCD) and a keyboard/pointer for monitoring purpose
- CCR: Two (2) workstations, comprising double VDU (23" TFT LCD) and a keyboard/pointer for cargo system control and monitoring
- ECR: Two (2) workstations, comprising double VDU (23" TFT LCD) and a keyboard/pointer for cargo system control and monitoring

* Each workstation above can be able to configure machinery or cargo duty via multi-level password or key-switch control according to the manufacturer's standard.

- Ship's conference room: Two (2) workstations, comprising double VDU (21" TFT LCD) and a keyboard/pointer for Cadet training.

Printers

The IAS Printer shall be provided as follows;

- W/H: No printer
- CCR: One (1) alarm/log printer and one (1) colour printer for screen dump
- ECR : One (1) alarm/log printer and one (1) colour printer for screen dump

I/O Units

I/O unit arrangement shall be such that remote I/O and/or centralized I/O unit shall be provided and distributed throughout the hull.

The communication buses for remote I/O shall be provided according to manufacturer standard.

The enclosure grades of I/O units shall be as follows:

- I/O units in the process station room & electronic equipment room : IP22
- I/O units in main and cargo switchboard room: IP22
- I/O units in machinery spaces: IP44
- I/O units in main deck side passageway (P&S): IP44

System design shall be based on 3,000 hardware I/Os including 5% spares.

Man-Machine Interface (MMI)

The IAS shall be designed so that operator may take easy action in abnormal condition and operator may get sufficient / clean information from the VDU by simple operation of keyboard.

Consequently IAS shall be provided with function keys and trackball for operation.

Graphic Display

The graphic display shall show an overview of system, as well as status of measurements, pump/valve, etc.

The graphics shall be so designed as simple as possible to give clear view / information to the operator. Overview shall be so designed as to give the required display to the operator when desired. Approx. 120 graphic displays shall be provided.

Trend Displays

Trend displays shall provide historical information of process data or analogue measurement in curve format.

Alarm Display

Alarm display shall show list of alarms in chronological order, indicating date & time, system code, instrument code and indication of alarm group.

Manual blocking of alarm will be possible.

Extension Alarm System

An extension alarm system shall be provided as a part of IAS.

The system shall be comprised of two (2) extension alarm groups as follows:

- Machinery
- Cargo

The emergency engineer calling system shall be provided as a part of the extension alarm system.

Master panel in engine control room shall be provided with an emergency calling pushbutton and each cabin and public space alarm panels shall be provided with an emergency calling alarm.

When the emergency calling pushbutton is pressed, the emergency calling alarm shall be extended to the extension alarm panels in the cabin.

Extension Alarm

During unmanned machinery space operation, alarms occurring in IAS for machinery group shall be transferred to the duty engineer’s cabin and public spaces.

If the alarm is not acknowledged within the predetermined period or the emergency calling push button is activated from master panel in the ECR, the alarm shall be extended to the engineer's cabin and public spaces.

Cargo Extension Alarm

During cargo control room is in unmanned; alarms occurring in IAS for cargo group shall be transferred to the duty officer's cabin and public spaces.

If the alarm is not acknowledged within predetermined period or the emergency calling push button is activated from master panel in the CCR, the alarm shall be extended to the officer's cabin and public spaces.

Cargo and Ballast Monitoring System

IAS For Cargo/Ballast System

Following cargo and ballast system shall be controlled and/or monitored from the IAS:

- Cargo pumps, spray pumps and valves
- Cargo high duty compressors, heaters and vapourisers (Interface with stand-alone control system)
- BOG compressor and heater system monitoring (Interface with stand-alone control system)
- Vapour header pressure control
- Ballast pumps, eductors, valves and tank levels
- Nitrogen system monitoring (Interface with stand-alone control system)
- Compressor and motor room ventilation
- Inert gas system monitoring (Interface with stand-alone control system)

Control system for Gas compressors, N2 generators and IGG shall be interfaced to the IAS so that above mentioned formation can be done from IAS via relevant stand-alone control system.

Custody transfer system shall be interface to the IAS for monitoring of cargo tank level, pressure and temperature.

In addition to above, following system shall be provided as a part of cargo system.

Cargo Tank and Containment Temperature Monitoring System (membrane)

The system shall be provided as follows;

Inner Hull Temperature Monitoring

The temperature of inner hull of each cargo tank shall be measured by the IAS as follows:

Each five (5) sensors at cofferdam for:

- No.1 cargo tank forward bulkhead
- No.4 cargo tank after bulkhead

Each three (3) sensors at cofferdam for:

- No. 1 cargo tank after bulkhead

- No. 2/3 cargo tank forward and after bulkhead
- No. 4 cargo tank forward bulkhead

Each two (2) sensors at duct keel or trunk deck side for each cargo tank as follows:

- Tank top hull centre line
- Tank bottom hull longitudinal centre line

The temperature sensors shall be located in cofferdam, duct keel and trunk deck to monitor the temperature of the inner hull steel structure.

Reading scale of temperature monitoring shall be from – 50deg.C to +50deg.C and accuracy shall be +/- 3deg.C.

Cofferdam temperature sensors shall be used to provide the average cofferdam temperature for glycol heating system.

Cargo Tank Barrier Space Temperature

The temperature of cargo tank barrier space shall be monitored by the IAS as follows:

Each One (1) pair of sensors for following position at each cargo tank:

- Bottom inner barrier space adjacent to pump column
- Bottom inner barrier space corner port, adjacent to after bulkhead
- Bottom inner barrier space corner stbd, adjacent to after bulkhead
- Bottom insulation space center
- Lower chamfer insulation space center
- Port side insulation space center
- Port side insulation space fixed on the hull center
- Upper chamfer insulation space center
- Top insulation space center
- After bulkhead insulation space center
- Fwd bulkhead insulation space center

Cargo Tank and Containment Temperature, Pressure Gas Monitoring Systems (Moss)

The system shall be provided as follows;

- High pressure in cargo tanks
- Low pressure in cargo tanks
- High pressure in hold space
- Low pressure in hold space
- Differential pressure between cargo tank and hold
- Equator ring temperature sensors 3 port, starboard & for'd
- Hold space temperature sensors 1 on the aft transverse bulkhead all tanks
- Hold space temperature sensor 1 on the fwd transverse bulkhead No1 hold.
- Drip pan temperature sensor
- Gas detection for hold space
- Gas detection for insulation space
- Support for the small leak detection system.

Automatic/Sequential Controls

The systems shall be so designed that ship shall be operated with minimum manpower and kept optimum conditions at any ships mode.

Consequently automatic and/or sequential control of various systems / equipment shall be provided as far as practicable.

Automatic Logging of Various Measurements

All-important measurements and cargo equipment conditions shall be automatically logged by IAS log printer at every predetermined time.

Automatic Sequential Control Cargo Pump

Each cargo pump shall be interfaced with associated cargo valves and shall be sequentially started / stopped with valves.

Automatic Control of Auxiliaries for Cargo System

Auxiliaries for cargo system shall be so designed to keep optimum running condition at all time and fail safe design shall be required.

Gas Combustion Unit (GCU)

The GCU control system shall be a stand-alone system performing control sequence, with a local control panel.

Followings shall be performed from the IAS:

- Information display with graphical display
- Select operating mode
- Initiate a fully automatic start/stop sequence.

Emergency stop facilities shall be provided locally and in the Fire control station, CCR and ECR.

Ballast and draught monitoring system

Electro-pneumatic type level measuring system shall be provided for the following tanks and draught, and the level and draught shall be indicated on the IAS workstation.

- Water ballast tanks
- Ship's draught (forward, aft, mid-port and mid-starboard)
- Refer to Sec. 6.5.1 in machinery part for E/R tank

The system shall also be connected on line to the loading computer through IAS.

The fuel oil storage tanks shall have level indication and high alarm at the IAS

Custody Transfer System (CTS)

The CTS shall provide measurements and data logging of the above and calculation of total LNG cargo loaded or discharged.

The data will be converted to volumetric corrected for ships trim and list. The density data shall be manually input.

Machinery and Hull Monitoring System

IAS For Machinery System

Following machinery systems shall be controlled and/or monitored from the IAS:

- Propulsion Engine control system monitoring (Interface with stand-alone control system)
- Switchboards and generators control (Power management system)
- Propulsion system control (Interface with stand-alone control system)

Power Generation and Distribution System

The ship's main generating equipment shall produce AC 6,600V, 60Hz, 3 phase electrical power.

Power Management System (PMS)

The following main functions shall be available in the IAS.

- Automatic synchronizing
- Frequency control
- Automatic load sharing
- Balanced load sharing
- Load dependent start/stop
- Black-out automation
- Blocking of heavy consumers
- Generator standby selection

The manual start/stop of generator engine shall be available from the IAS:

With a generator in standby mode it shall automatically start under the following conditions:

i. Black out
ii. Low voltage on main bus bar
iii. High voltage on main bus bar
iv. Low frequency on main bus bar

For condition i) the generator shall start and connect to the main busbar.

For conditions ii) or iii) the generator shall start and connect to the main bus bar after the generator in service CB has been tripped.

Mooring Tension Monitoring System

A mooring tension monitoring system shall be fitted for all mooring wires to meet the requirements of loading and unloading terminals.

Data shall be transferred using the ship/shore link provided on the vessel.

Cylinder Pressure Monitoring System

A cylinder pressure monitoring system is to be fitted. Readings are to be transferred to the IAS and shall be trendable.

Ship Performance Monitoring System

The vessel will be provided with a system for monitoring of, and optimisation of, vessel performance.

The system will be based around a thermodynamic model of the power plant in its entirety and will take data from the IAS.

Integrated into the system will be the output from the shaft power measurement system (minimum accuracy requirement +/- 0.5%)

Also input to the system will be:-

- Total and daily distance made good from vessels speed log(s)
- Rudder angle
- Water depth
- Vessel Heading
- Course made good
- Ambient atmospheric pressure
- Ambient air temperature
- Trim, Draft, list.
- Vessel speed over ground
- Slip
- Fuel and gas flow to power plant and auxiliary equipment (separate readings and input for each piece of equipment in operation)
- Calorific values of each fuel as applied above.

Output from the system shall be output to IAS and shall be viewable on separate, independent screens in:-

- ECR
- CCR
- Wheelhouse

Data from the system shall be recorded such that it can be transferred as a non-editable data file by internet link to the Owner/Charters office.

MANEOUVRING CONTROL AND MONITORING

Propulsion Control and Monitoring System

General

The propulsion system shall be remotely controlled from the control panel in the wheelhouse and ECR.

The system shall be connected to the IAS for indicating the condition and status of equipment associated with the propulsion system.

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ELECTRIC SYSTEMS

GENERAL

In design and developing Builders are to propose designs based the following philosophy:-

a) Main electrical power generation units will generate 6.6kV, 3phase, 60Hz, AC

b) Emergency Generator will generate 450V, 3phase, 60Hz, AC

Power Distribution System shall be as shown below:

Equipment	**Voltage & phase**
Main alternator	AC 6,600V, 60 Hz, 3 phase
Heavy consumers including propulsion motors (if fitted) cargo pumps, HD compressors, BOG compressors, ballast pumps and bow thruster	AC 6,600V, 60 Hz, 3 phase
General power supply	AC 440 V, three phase
Large Heaters	AC 440 V, three phase
Small consumer	AC 220 V, three or single phase
Galley equipment, lighting and hotel loads	AC 440 V, three phase AC 220 V, three or single phase
Control and monitoring system	AC 220 V, three or single phase DC 24V
Navigation and Communication Equipment	AC 440 V, three phase AC 220 V, three or single phase DC 24V

ELECTRIC CABLE AND INSTALLATION

Cable Application

Cables installed throughout the Vessel shall be constructed in compliance with the requirements of the Classification Society and IEC recommendations.

Flame retardant characteristic of cable shall be in accordance with IEC publication No.60332-3 category A.

Cables shall be halogen free (halogen content 0.5%) material in accordance with IEC 60754-1, low smoke emission in accordance with IEC 61034 and flame retardant characteristic in accordance with IEC 60332-3 category A.

The cables for emergency services and their emergency power supplies shall be fire resistant in accordance with the requirements of the Classification Society.

Cable for supplying one (1) load shall have a continuous current carrying capacity of the connected load except for intermittent loads such as steering gear, deck machinery, cranes, thruster, etc.

Voltage drop on the power and lighting circuits at the final point shall be satisfied with the requirement of the Classification Society.

All intrinsically safe cable shall be light blue in colour.

Where cables are exposed to temperatures in excess of 70℃ they shall be defined as to their specific operating temperature.

Electric Power Systems

Main Generator

Main Generators will have the following characteristics:-

Fuel of engine (where applicable)		Gas and liquid fuels (see previous definitions)
Voltage	:	AC 6.6 kV
Frequency	:	60 Hz
No. of phase	:	Three (3)
Power factor	:	0.8 (lagging)
Duty	:	Full load continuous
Revolution	:	720, rpm
Type	:	Self-excited, brushless
Insulation	:	Class "F" with temperature rise class "F"
Enclosure	:	Totally enclosed (IP44)
Cooling system	:	Air cooling via fresh water cooled double wall tube type air cooler
Number of bearing	:	Two, one at each end
Type of bearing	:	End bracket type sleeve bearing
Lubricating	:	Self-lubrication
Space heater	:	AC 220V, 1 phase
Stator winding temp.	:	Two (2) embedded temp. Sensors (one working, the other for stand-by) for each phase, alarm connected to the IAS
Water leakage detector	:	To be fitted, and connected to the IAS
Cooling air temp. Sensor	:	To be fitted and connected to the IAS
Bearing temp. Sensor.	:	One (1) for each bearing, and connected to the IAS

At least one of the auxiliary generators shall be large enough to take full sea load when gas burning

Emergency Generator

Voltage	AC 450V
Frequency	60Hz
Phases	3
Power factor	0.8 (lagging)
Excitation	Self-excited, brushless
Insulation	Class "F" with temperature rise class "F"
Enclosure	Drip-proof
Space Heaters	AC 220V, single phase

POWER DISTRIBUTION

General

The electric distribution system shall be composed of the following switchboards:

2 - High voltage (AC 6.6 kV) main switchboard (HVMSBD)
2 - Low voltage (AC 440 V) main switchboard (LVMSBD)
2 - High voltage (AC 6.6 kV) cargo switchboard (HVCSBD)
2 - Low voltage (AC 440 V) cargo switchboard (LVCSBD)
1 - Emergency switchboard (ESBD)

Steam, water or oil lines shall not be passed through any switchboard.

Air from ventilation ducts shall not be discharged directly on the switchboards.

Switchboards and internal components shall be designed to withstand shipboard vibration without damage or faulty operation.

Switchboard shall be properly illuminated and part of this lighting shall be fed from the emergency supply system.

Duplicated E.R machinery and cargo handling equipment shall be divided into two groups; each group shall be fed from the divided section of the switchboards to ensure the Vessels ability to operate, at reduced capacity, when any one section of switchboard is out of service.

Low voltage switchboards shall be provided with a device capable of monitoring the insulation level to the earth, continuously and giving an audible and visual alarm, interfaced with IAS, of a low insulation level indicating scale 0~20 MΩ).

Construction and Installation

Switchboards shall be of dead-front, drip-proof, box frame construction and shall have hinged front panels that can be opened without disturbing the meters, pilot lamps, etc. mounted on them.

HV switchboard shall be of IP32 and metal clad type in arc proof construction

Handrails and rubber mats shall be provided at front and rear of each section of switchboard and all doors should be grounded.

Each bus bar system including branch circuit shall be capable of withstanding a short circuit at any point.

The HV main and cargo switchboard room shall be arranged in two inter connected sections, each section located in separate air conditioned rooms.

High Voltage Switchboard

The HVMSBD (IP32) shall split into two (2) sections; each section, connects with half of alternators and HV consumers, shall be located in a separated main switchboard room and connected via the bus-tie breaker panel.

Each main alternator panel and synchronizing panel shall be provided with instruments necessary for manual synchronizing and load sharing device according to the requirement of the Classification Society.

HV Fault Levels

Each HV switchboard shall be capable of withstanding for one (1) second the thermal and mechanical effects of the maximum prospective short-circuit due to a symmetrical fault fed by all generators, plus the contribution from HV motors and possible fault contribution from equipment connected to the 450 system at the time of fault.

HV fault levels equipment should be capable of clearing fault in one (01) second. All equipment should be capable of withstanding the effects of short circuit currents and consequential voltages arising in the event of equipment or short circuit faults. Rating for internal arc containment and fault current withstand must exceed the fault clearing time.

HV System Earthing

The HV system shall be of an insulated neutral system. This may be negotiable to follow HV system manufacturer's standard.

Earth leakage detection equipment or equivalent shall be provided with alarm and test detection facilities. The detection equipment shall incorporate metering to enable the gravity of the fault to be determined and location of the earth fault without the need to isolate any circuitry.

Alternator panel

Each alternator panel shall be provided with the following instruments, which shall be regarded as guidance:

1 - Draw-out triple pole HCB with protection device
1 - Multi protection relay for reverse power, short circuit, over current, under voltage, differential protection, etc.
1 - Space heater "ON" indicating lamp
1 - Space heater ON/OFF switch
1 - Generator start push button (except shaft alternator)
1 - Generator stop push button (except shaft alternator)
1 - Ready to start indicating lamp (except shaft alternator)
1 - Generator running indicating lamp (green)
1 - Wattmeter
1 - Ammeter with a selector switch
1 - Voltmeter with a selector switch
1 - Power factor meter
1 - Test terminal for ammeter and voltmeter

Low Voltage Switchboard

The LVMSBD (IP22) shall be split into two (2) sections; each section shall be located in the separated room (same room with high voltage main switchboard) and connected via the bus-tie breaker panel which consists of a fixed air circuit breaker.

Each section shall consist of the followings:

1 - Incoming panel (from HVMSBD via 6.6kV/450V transformer)
1 - AC 440 V feeder panel
1 - AC 220 V feeder panel
1 - Group starter panel

1 - Bus-tie breaker panel (normal open)

The 220V feeder panel shall be fed from the 440V feeder panel via the 440V/230V transformer.

Emergency Switchboard (ESBD)

One (1) set of self-standing type ESBD (IP22) shall be located in the emergency generator room.

The ESBD shall be composed of an emergency alternator panel, an AC 440 V feeder panel, an AC 220 V feeder panel and a bus-tie panel.

In case of voltage failure of LVMSBD, the ESBD shall be automatically fed from the emergency generator.

The ESBD shall be connected to the LVMSBD for supplying shore power (440V) and short term parallel running.

Distribution Board

Distribution boards shall be provided at suitable positions to supply power to the various consumers of power, lighting, communication and navigation equipment throughout the Vessel.

Distribution boards shall be constructed from sheet steel with front opening door.

AC 440 V circuits, 3-pole MCCB will be fitted with thermal over current trip device and magnetic instantaneous trip.

AC 220 V circuits, 3-pole or 2-pole MCCB and miniature circuit breaker will be fitted with thermal or magnetic over current trip devices.

DC 24 V circuits shall have 2-pole MCCB and miniature circuit breaker or fuses fitted.

Galley and laundry equipment shall be supplied through residual current circuit breakers (RCCBs).

The distribution board's enclosure shall be drip proof type (IP22) or splash proof (IP44) dependent on location.

Each distribution board shall maintain 10% of total circuits as spare

Distribution boards fitted in accommodation shall be of flush mounted type.

Shore Power Supply

One (1) shore connection box shall be provided which is permanently wired to the shore supply air circuit breaker on the emergency switchboard.

Connections shall be provided at the bottom of the box for connecting temporary shore cable.

The connection box shall be outfitted as follows:

1 - 1,200 A moulded case circuit breaker
1 - Phase sequence indicating lamp
1 - "POWER ON" indicating lamp
1 - Kilowatt hour meter

The shore supply breaker shall be interlocked with the generator breakers.

A notice, in either stainless steel or plastic, shall be provided to give detailed information of the supply system and the procedure for carrying out connection and disconnection.

Test Equipment

One (1) wall mounted type test panel shall be provided.

This test panel shall be used for lamps, fuse and small electric appliance check and shall have the following instruments and devices.

1) 1 set - test terminals : 440V A.C. 3Ph, 60Hz, 10A
   220V A.C. 1Ph, 5A
   24V D.C. 5A
2) 1 set - A.C. Voltmeter with a selecting switch for A.C. 440V, A.C. 220V
3) 1 set - D.C. voltmeter for D.C. 24V
4) Various lamp holders for testing incandescent or fluorescent lamp bulbs
5) 1 - Fuse testing instrument
6) 4 - Moulded case circuit breaker (3 pole - 20A for AC 440V/220V, 2 pole - 10A for AC 220V/DC 24V)
7) 1 - Source pilot lamp
8) 2 - N.W.T./W.T Receptacle

ELECTRIC MOTOR STARTER AND DRIVE

Electric Motors

Motors shall be of squirrel cage induction type using IEC standard frame designed for AC 440 V, 3Ph, 60 Hz.

AC 6.6 kV motors shall generally be in accordance with standard IEC requirements , and have clear warning plate fitted to identify these motors as AC 6.6 kV on the machines themselves.

Motors shall be of totally enclosed fan cooled induction type.

With the exception of motors for bow thruster, deck machinery, turning gear, cranes and etc., motors shall be generally rated for continuous duty (service type S1).

Two-speed motors (if fitted) shall be equipped with a separate winding for each speed.

Motors for LD (Fuel gas) compressors and BOG boosting compressor installed in cargo machinery motor room shall be of "Exe or Exn" type.

Motors with a rated power equal or higher than 100 kW shall be fitted with PTC thermistor (one working and one spare) for winding temperature detection.

Enclosure

In general, enclosure of motors shall be in accordance with the following criteria, unless otherwise specified.

- Water-proof type (IP56) : Motors exposed to weather
- Totally enclosed type (IP44) : Motors other than above
- Submerged type : Motors for cargo pumps, fuel gas pumps and Stripping /spray pumps
- Certified safe type : Motors installed in the hazardous area

Insulation

Stator windings shall be treated with insulating varnish to resist oil and water.

Generally, motors shall be designed into class "F" insulation with class "B" temperature unless otherwise specified.

HV motors shall be designed into Class "F" insulation with temperature rise Class "F".

Space heater

In general all electric motors for main systems shall be provided with space heaters that are automatically activated when the motor is in the stand by condition, all SW pumps, all Feed system pumps etc. The space heater shall also be provided to the electric motors of the following equipment:

- Steering gear
- Emergency fire pump
- Hydraulic pump for deck machinery
- Bow thruster
- Compressor and fan for main & aux. air condition unit
- Motors exposed to weather of free ventilated area

- Fan motors for motor room, compressor room
- Ref. compressor for provision

Element type space heater shall be applied to high voltage motors

Electric Motor Starters

Starters shall be of electro magnetically operated type, except starters for non- essential motors of 0.4 kW and less which will be manually operated.

In general, starters shall be of direct-on-line starting type.

Where excessively high starting current of large motors cause voltage drop at the switchboard bus bars of more than 15%, starters for those motors shall be of reduced voltage starting type (auto transformer or star-to-delta starting).

Starter for each motor shall be built into a drip-proof enclosed steel cubicle with hinged door and shall be bulkhead or floor mounted.

Where the starter is located at a distance (out of sight of the motor), a local start and stop master switch with locking device on "off" position shall be provided near to the motor.

Starters installed in E/R fan room, steering gear room, bosun's store, emergency generator room, deck store and weather decks and service spaces shall have anti-condensation space heaters.

Starters for each lifeboat davit and each provision crane shall be fed from No.1 & No.2 feeder respectively via local group starter panel.

Low insulation protection for starters of motors shall be provided as below.

- all motors above 30kW
- all motors exposed to weather (except accommodation duct fan)
- all motors installed in spaces without heating arrangement (except engine room)

Insulation shall be monitored (with adjustable set point) during non-running periods. When alarm condition is reached, an interlocking function shall be activated to prevent start of motor. Alarm signal shall be interfaced with IAS.

Each starter controlled by IAS shall have a switch for selecting the control position. These will reflect local or remote control.

NAVIGATION AND COMMUNICATION SYSTEMS

Navigation and communication equipment shall comply with the appropriate IMO performance standards (Performance standards for Ship borne Radio Communications and Navigational Equipment).

Most wheelhouse equipment shall be fed from then AC230V wheelhouse power distribution panel which shall be fed from the main and emergency switchboards with automatic changeover.

Indicators shall generally have illumination with dimmers on the console for night vision.

ELECTRIC NAVIGATION EQUIPMENT

Compass and Steering Control System

Auto Pilot

One adaptive autopilot will be provided with the following modes of operation:

- Follow up
- Non follow up
- Automatic course keeping from gyro compasses
- Track keeping from INS.
- Rate of turn and radius turn capability.
- The autopilot will interface with the INS, speed log, gyro, and magnetic compasses.
- One back up adaptive autopilot shall also be provided.

Compass

Two gyro compasses with inter switching shall be fitted. Repeaters shall be self-aligning type. The gyro compasses shall interface with the speed log, and any other equipment requiring heading information. Azimuth circle and azimuth mirror shall be provided.

One transmitting magnetic compass with periscope and illumination heater shall be provided and it shall interface with the auto pilot. A spare magnetic compass bowl in wooden storage box will be supplied.

Navigation Equipment

The design of the wheelhouse shall maximise all round visibility and shall also provide for a navigation console, overhead instrument panel, steering stand, chart console and radio console. All navigation equipment will be type approved and will fully comply with SOLAS requirements. Navigation equipment will make use of uninterruptible power supplies; failure of main supplies shall not cause loss of data and full functionality shall be promptly restored with minimal operator intervention.

Radar Plant

The radar plant shall consist of inter-switched radars as follows:

One X-band (3 cm) radar with about 8~9’ scanner, down mast transceiver, ARPA, 23” display and performance monitor.

Two S-band (10 cm) radars, each with scanner, down mast transceiver, ARPA, 23” display and performance monitor.

Radars shall be from the same maker as the INS.

Integrated Navigation System

There shall be a primary ECDIS and a back-up ECDIS, each connected to an independent power supply and a separate GPS position input, so that the Vessel can use electronic charts without carrying paper charts. The Vessel shall be equipped for storage, correction and display of paper charts.

The system shall interface with Navtex, AIS, radars, auto pilot, gyro compasses, GPS receivers, speed log, echo sounder, anemometer and anemoscope, rudder angle indicator and propeller shaft power/RPM system, etc.

The INS shall provide two high resolution 23" colour chart displays capable of displaying ECDIS and ARCS chart data, conning display, colour display for route planning, printer and uninterruptible power supply.

Bridge Navigational Watch Alarm Systems (BNWAS) is to be provided.

Central bridge alarm system is to be provided.

One adaptive autopilot will be provided with the following modes of operation:

- Follow up
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- Automatic course keeping from gyro compasses
- Track keeping from INS.
- Rate of turn and radius turn capability.
- The autopilot will interface with the INS, speed log, gyro, and magnetic compasses.
- One back up adaptive autopilot shall also be provided.

Other Navigational Equipment

The following additional equipment shall be supplied:

- Two [2] differential GPS navigators with changeover switch and outputs to INS, gyrocompass, AIS, radars, Inmarsat FB, Inmarsat C, MF/HF DSC, VHF DSC, AIS, Navtex, weather facsimile, ship performance monitor, etc. DC24 V and AC230 V supply.
- Echo Sounder with transducers, forward and aft,
- Doppler docking (3 axis) speed log with gate valve
- Ships Whistle: Electric with heater forward, air driven aft.
- Electric fog bell and gong system
- Weather facsimile receiver
- Navtex receiver interfaced to INS
- Anenometer and anemoscope with indicators in the wheelhouse and CCR.
- Independent rudder angle indicator system with three face [visible over 270 deg] indicator on wheelhouse ceiling, and indicators on overhead instrument panel, each bridge wing, steering stand, ECR console, steering gear room and INS.
- Course and rudder angle recorder
- Main Engine Power/Tachometer
- Wind screen wipers, washing system and heaters[single panel operation]
- Clinometers
- Central clock system with clock signal for telegraph logger, INS, CTS and IAS
- Chronometer
- Infrared night vision camera system
- Three clear view screens
- Sun shields for all bridge windows
- Four pairs of binoculars
- Load hailer

- Sextant

One overhead instrument panel shall be provided at the upper part of wheelhouse front wall and following equipment shall be provided:

- Gyro repeater (digital type)
- RPM indicator for each propeller shaft
- Power indicator for each propulsion motor
- Clinometer (centre)
- Ship speed indicator
- Water depth indicator (digital)
- Wind speed and direction indicator
- Electric slave clock
- Rate of turn indicator
- Rudder angle indicator

The bridge wings shall be fitted with the following:

- Rudder angle indicator
- RPM indicator for each propeller shaft
- Power indicator for each propulsion motor
- Control panel with speed control lever for main propulsion
- Gyro bearing repeater
- Speed indicator (fore/aft, athwart ship's bow and stern)
- Whistle control push button
- Receptacle for public address microphone
- VHF radio telephone extension unit
- Morse/manoeuvring light key
- Public address speaker
- NFU steering tiller
- Telegraph transmitter/receiver with buzzer
- Manoeuvring responsibility selection button
- Emergency stop switch
- Bow thruster sub control panel with ammeter and pitch indicator
- 1 kW search light and switch
- Reset button for wheelhouse watchman alarm

The navigation and signal light control panel, with mimic identification is to be provided in the wheelhouse.

Lights shall be fitted in accordance with flag requirements and those of National authorities and include:

- Double type fore mast, radar mast, port, starboard and stern navigation lights
- Manoeuvring light
- Portable daylight signal light
- Suez canal signal lights (6-red, 5-white and 1-green) on radar mast
- Suez canal signal light (1 red light at the stern)
- Quarantine and Sampan calling lights (may use suitable Suez canal lights)
- Deep draught lights

- NUC lights, supplied from emergency AC supply and 24 V DC supply
- RAM (restricted ability to manoeuvre) lights
- Anchor lights
- Blue steering light on foremast with dimmer in wheelhouse
- Propeller notice lights (receptacles with switch shall be provided)
- Huge vessel light: green flashing light (with spare) approved by the Japanese Government
- Dangerous cargo light: red flashing light (with spare) approved by the Japanese Government
- Three green lights per Singapore MPA Port Marine Circular No 02 of 2011
- Receptacle and switch for Suez canal searchlight (230 V, 3 kW)
- Collision avoidance lights.

An outdoor light control panel shall be provided in the wheelhouse for deck floodlights, accommodation outer passage, name board and funnel mark lights.

Bridge illumination and status/running lights shall be controlled from the console to allow night vision on the bridge.

A voyage data recorder shall be provided.

COMMUNICATION EQUIPMENT

Internal Communication System

An 80 line automatic electronic programmable telephone exchange shall be provided for communication throughout the vessel. The electric source shall be AC 230 V and UPS or DC 24 V backup. Heavy-duty telephones shall be provided in machinery spaces. Provision shall be made for connection to the satellite communication system and the public address system.

A sound powered common battery telephone system shall be provided for communications between principal control and work stations.

A machinery talk back system shall be provided for communication between the ECR and the principal machinery space out-stations.

A “Hotline” telephone system shall be provided to allow communication between the CCR and the terminal jetty office. This is required to be compatible with worldwide terminal installations. Telephones shall be provided, using fibre optic and electric ship/shore links:

For Ship to Shore plant internal network.

For Ship to Public telephone network. This should be in a booth or small room

The ship to shore communication system shall be supplied by AC230 V with UPS or DC24 V backup.

A public address system with duplicate amplifiers, incorporating fire and general alarm systems and with control panels in the wheelhouse and CCR shall be provided. It shall be possible to make public address announcements from the control stations through selected groups. The system shall provide cover to all accommodation spaces, working areas, machinery spaces and all open deck spaces. AC power supply with UPS or DC24 V backup.

A talk back system shall be provided for communication between the wheelhouse, bridge wings, forward and aft mooring stations, steering gear room and fire control room (minimum 10 locations).

A loudhailer system shall be fitted to broadcast from the wheelhouse and CCR to the whole of the cargo deck area.

A UHF communication system shall be provided consisting of intrinsically safe portable transceivers and base stations in wheelhouse, CCR and ECR. An active aerial repeater system shall be provided covering the whole deck including fore/aft mooring space, engine room, steering gear room, electric motor room, bow thruster/forward pump room and bosun store.

A CCTV system should be provided to monitor the cargo manifolds these should have a zoom and wash wipe facility and enable the operater to read the manifold pressure gauges.

A comprehensive communal aerial system for all cabins and public rooms with distributed radio [AM/FM] and TV signals [satellite and terrestrial VHF/UHF] shall be provided. Audio, TV and DVD player equipment shall be provided for 3 public rooms and 2 senior officer cabins.

Table of internal communication system (for reference)

Location (To be updated in accordance with vessel design)	Sound powered telephone	Auto telephone	Public address speaker	Central clock	Fire detector
Wheelhouse	F	2F *4	A *3	3 hand *4	A
Chart space		D *1	A *3	Master	A
CCR, ECR	F	F	A *3	3 hand	A
Each main switchboard room		S *1	A		A
Each cargo switchboard room		S *1	A		A
E/R workshop		S HD *6	A *5		A
Emergency generator room	NB *6	NB HD *6	A *5		A
Steering gear room	NB *6	NB HD *6	A *5		A
Fire control station	S	S HD	A *5		A
Galley		S HD	A *5	2 hand *5	A
Hospital/dispensary		D	A *3	2 hand	A
Public rooms (Mess, TV & recreation, gym, games, training, library, smoker's, administration office and conference room)		A	A *3	2 hand	A
Captain & C/E cabin day rooms	D	D *1	A *3	2 hand *2	A
Senior class cabin day rooms		D *1	A *3	2 hand *2	A
Cabins & bed rooms		D	A *3	Quiet type	A
Toilet			A		
Accommodation inner passage			A		A
Accommodation outside			A *5		
AHU room, HPU room, garbage store			A *5		A
E/R	NB *6 (floor)	NB HD *6 (floor)	A *5		A
Each converter room		S HD	A		A
Diesel generator/Boiler rooms		NB HD *6	A *5		A
Electrical equipment rooms		A	A		A
Lift car		F	A		
Lift machinery room		S			A
IGG room		S HD *6	A *5		A
Electric motor room		NB HD *6 *7	A *5		A
Cargo machinery room		NB HD *6 *7	A *5		A
Bosun store		S HD	A *5		A
Main deck			A *5		
Ship's laundry		S	A *5	2 hand *5	A
Forward pump room/bow thruster room		S HD	A *5		A
Under deck side passage			A *5		
Life boat stations			A *5		A

Paint store, chemical store, drying room					A

Abbreviations	
A	Applied
F	Flush mounting type
S	Surface mounting type
D	Desk mounting type
N	Surface mounting with headset
B	Telephone booth (half)
HD	Heavy duty

Notes	
*1	Common line
*2	Installed in day room
*3	With volume control
*4	With illumination
*5	Waterproof type
*6	Extension acoustic and visual calling
*7	Sound powered or auto telephone

GMDSS Radio Equipment

External Communication System

The communications systems shall comply with the requirements of GMDSS (Global Maritime Distress and Safety System) for sea area A3 with duplication of equipment and shore based maintenance.

Equipment will be provided as follows:

- MF/HF radio telephone (400 W) and DSC system.
- Two Inmarsat C systems, each with EGC and printer.
- Two VHF radio telephones, each with DSC facilities.
- VHF radio telephone located in the CCR.
- Inmarsat FB500 satellite system with remote telephones (wheelhouse, CCR and master's office), fax and high speed data. AC230 V supply, with UPS or DC24 V battery backup for the FB500.
- Three GMDSS portable VHF radio transceivers.
- Satellite EPIRB
- Two 9 GHz SARTs
- External sound reception system
- Ships security alert system according to SOLAS requirements
- AIS according to SOLAS requirement interfaced to GPS receiver, gyrocompass, speed log, ECDIS and radars with AIS Pilot Plug and nearby 120 volt AC 3-prong receptacle
- LRIT (Long Range Identification and Tracking)

One set of very small aperture terminal (VSAT) shall be provided by the Buyer and installed by Builder. It shall be the responsibility of the Buyer for commissioning.

One set of data receiving system (ChartCo) shall be provided by the Buyer and installed by Builder. It shall be the responsibility of the Buyer for commissioning.