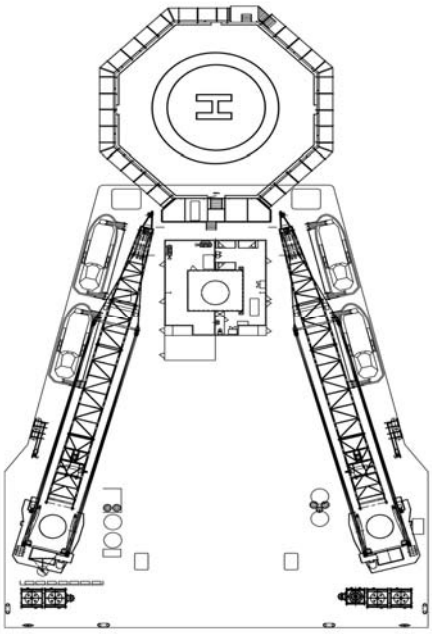

Levingston™
The World Class Liftboat

Technical Specifications
The Levingston 320EX Liftboat

Contact: Ronald E. Sanders
RonSanders@LevingstonOffshore.com
Website: www.LevingstonOffshore.com

TABLE OF CONTENTS

1. INTRODUCTION

This document is divided into the following:

1) General operational and construction data
2) General Vessel data
3) Hull
4) Deck Equipment
5) Marine equipment
6) Accommodation, Life Saving and Safety systems
7) Main Machinery
8) Auxiliary systems
9) Electrical systems
10) Legs and Jacking system

1.1. DEFINITIONS

As fitted plans	Drawings and documentation showing the Vessel as built.
Approved:	Means approved by the Class, Authority and/or Owner/Levingston, as indicated. If not specified, approved means approved by Owner/Levingston.
Authority:	National or International regulations to which the Vessel will be built.
Builder:	Company contracted to build the Vessel for the Owner/Levingston.
Owner:	Company ordering the Vessel from the Builder.

Class:	Classification Society responsible for approval of the Vessel according to a set of established construction rules.
Length (L):	As defined in the Load Line Convention.
Length (LOA):	Maximum length of the Vessel.
Load Line Convention:	The International Load Line Convention signed in London on 5th April 1966, and subsequent amendments.
Maker:	Name of company that manufactures equipment which can be installed in the Vessel
Maker's list:	List of alternative makers which will be requested to offer delivery of equipment to the Vessel.

1.2. ABBREVIATIONS

ABS:	American Bureau of Shipping
AC:	Alternating Current
AIS:	Automatic Identification System
ARPA:	Automatic Radar Plotting Device
BHAB:	British Helicopter Advisory Board
BS:	British Standard
CAA:	Civil Aviation Administration
CCTV:	Closed Circuit Television
COLREG:	Convention on International Regulation for Preventing Collision at Sea
CPU:	Central Processing Unit
D & ID:	Duct and Instrument Diagrams
DC:	Direct Current
DGPS:	Differential Global Positioning System
DIN:	Deutsche Industry Normen
DNV:	Det Norske Veritas Region Norge AS

DO:	Grade of Fuel (Diesel oil) Sp.gr. 0.83 for design purpose only
DP:	Dynamic Positioning
ECDIS:	Electronic Chart Display and Information System
ECR:	Engine Control Room
EMC:	Electro Magnetic Compatibility (the technology to minimize
EMI/RFI) EMI:	Electro Magnetic Interference
EPIRB:	Emergency Position Indication Radio Beacon
EX:	Explosion proof
FAT:	Factory Acceptance Test
FI-FI:	Fire Fighting
FMECA:	Failure Mode Effect Consequence Analysis
FO:	Fuel Oil
FPP:	Fixed pitch propeller
Fr. (fr.):	Frame nos. indicate position from aft perpendicular
FRC:	Fast Rescue Craft
FU:	Follow Up
FW:	Fresh Water
GA:	General Arrangement
GMDSS:	Global Maritime Distress and Safety System
GMS:	Global System for Mobile telecommunications
GP:	Refer to group number in the SFI system
GPS:	Global Positioning System
HF:	High Frequency
Hi PAP:	High Precision Acoustic Position (transducer)
HPR:	Hydro acoustic Positioning Reference
HSEQ:	Health, Safety, Environment and Quality
HT:	High Temperature
HVAC:	Heating, Ventilation and Air-Conditioning
I/O:	Input/ Output
IACS:	International Association of Classification Societies
ICS:	Integrated Computer system
IEC:	International Electro-Technical Commission
IMCA:	International Marine Contractors Association
IMO:	International Maritime Organization
INLS:	Refer to IMO resolution A.673 (16)
IOPP:	International Oil Pollution Prevention
IP rating:	Ingress Protection of enclosures
ITP:	Inspection and test plan
ISO:	International Organization for Standardization
LAN:	Local Area Network, Data Communication Network
LCD:	Liquid Crystal Display
LO:	Lubrication Oil
LT:	Low Temperature
MCC:	Motor Control Centre
MCR:	Max. Continues Rating

MCT:	Multi Cable Transit
MDO:	Marine Diesel Oil
MF:	Medium Frequency
MOU:	Mobile Offshore Unit
MRU:	Motion Reference Unit
NFU:	Non Follow UP
NMA:	National Maritime Administration
NOX :	Oxides of Nitrogen
NS:	Norwegian Standard
OFE:	Owner Furnished Equipment
P and ID:	Piping and Instrument Diagrams
PMS:	Power Management System
PLC:	Programmable Logic Controller
PPM:	Parts Per Million
PWM:	Pulse Width Modulator
QA:	Quality Assurance
QC:	Quality control
RAO:	Response Amplitude Operator
RB:	Regulatory Bodies
RH:	Relative Humidity
RFI:	Radio Frequency Interference
RMS:	Root Means Square
s.gp:	Refer to sub group number in the SFI system
SART:	Search and Rescue Radar Transponder
SFI:	SFI Group system, The Ship Research Institute of Norway
SOLAS:	Safety of Life at Sea
SOPEP:	Shipboard Oil Pollution Emergency Plan
SBM:	Special Bearing Monitoring
SSB:	Single Side Band radio telephone
THD:	Total Harmonic Distortion
UPS:	Uninterrupted Power Supply
USCG:	United States Coast Guard
VAS:	Vessel Automation System
VDR:	Voyage Data Recorder
VDU:	Video Display Unit

2. GENERAL OPERATIONAL AND CONSTRUCTION DATA

2.1. GENERAL

This specification together with General Arrangement Drawing No. OCD044-DW-NA-001-01 to 08 (see GA's) shows a 72m LOA – The Levingston 320 EX, Self-Elevating, Mobile Offshore Unit (hereafter referred to as '320 EX', 'MOU', 'Unit' or 'Vessel').

The intent of this 'Technical Specification' is to provide a detailed description of the 'Levingston 320EX' Vessel that the Owners of the unit intend to operate. The following documents are to be taken as mutually explanatory of one another. For the purposes of interpretation and in event of any conflict or ambiguity between these documents, the order of precedence of the documents shall be in accordance with the following sequence:

1) GLND Ref. OCD044 - Design Basis for Levingston 320 EX
2) GLND Ref. OCD021-RP-N-003- Technical Specification for Levingston 320 EX

2.1.1. General Description

The Vessel is a triangular shaped, three (3) legged, self propelled and self elevating lift boat designed to the requirements of American Bureau of Shipping (ABS).

The Vessel can elevate its hull out of the water using an electro-hydraulic rack and pinion jacking system on its three legs to provide a stable working platform for lift boat services to the oil and gas market like well intervention/hook-up, platform maintenance, additional accommodation, etc.

The Vessel has been provided with 320-foot (97.5 meters) long legs of cylindrical type and is capable of working in water depths of 20 feet (6 meters) to 65 m in such areas of the world as the Middle East, India, Africa, and South East Asia, Mexico, Central and South American Offshore regions subject to applicable operational limitations stated in the Operating Manual.

It is equipped with two Ram Cranes, a main crane (Leg Encircling Crane "LEC") of 300 short tons (272 MT) with a 42.7 meters (140 foot) boom encircling the starboard and port leg which allows for more usable deck space accessible by the main crane.

The Levingston 320 EX has approximately 12,916 sq. ft. (1,200 sq. meters) available deck space along with 405 MT of net deck load capacity and 400 MT of consumables for an endurance of 14 days for a total variable load capacity of 905 MT.

The Vessel is propelled with three (03) 1100 KW Schottel azimuth thrusters at the aft and one Schottel 570KW bow tunnel thruster for offshore maneuvering.

Accommodation is arranged for 160 persons total including 2 VIP cabins and crew accommodations. Two (2) 80 men lifeboats are arranged each side of the MOU according to the GA.

Workshops, stores etc. shall all be arranged according to the GA and in agreement with the Owner.

The Owners plan to certify the Vessel for the flag state of their option and have the hull, machinery and cranes classed by the American Bureau of Shipping (ABS) as “A1 AMS Self-Elevating Unit”.

2.2. VESSEL OPERATIONAL CAPABILITIES

This specification describes the requirements for the design, building and delivery of one (1) Vessel. The Vessel shall be capable of undertaking all aspects of repair, maintenance, modification and installation of facilities.

2.2.1. Positioning keeping DP1 Performance

The Vessel is DP 1 standard, supplied by Imtech/ Praxis Automation application, and is fitted with suitable forward tunnel thruster and three (03) PORT/CENTER/STARB azimuth thruster for offshore and harbor dockside maneuvering.

2.2.2. Sea keeping (Transit and positioning for Jack-Up)

To be established by a numerical motion characteristic study during basic design or model trials.

2.2.3. Design Conditions

The Vessel is sufficiently equipped to remain self-contained in a harsh offshore environment for a minimum period of 21 days with respect to fuel, lubes, water and power and 7 days in respect to food for a full complement of personnel.

The Vessel shall be suitable for worldwide operations, excluding arctic/ice areas.

Following conditions shall be taken into account in the design of cooling, ventilation systems and equipment selection:

Criteria	Temperature
Maximum ambient air temperature	+ 45° C
Minimum ambient air temperature	1° C
Maximum temperature of seawater intake	+ 32° C

Minimum temperature of seawater	+4° C
Maximum temperature in engine room	+50° C
Maximum permissible temperature for rooms containing electronic equipment	+50° C

Heating, ventilation, machinery and equipment shall be designed for following temperatures:

- Outside temperature: 1° C to 45° C with RH 70 %
- Sea water temperature: 4° C to +32° C
- Inside temperature 22 to 24 Deg C - Accommodation & ECR/Switchboard Room

During sailing the legs and associated structures are capable of withstanding a roll or pitch of:

- 6º at vessel natural period + 0.2g heave – spud can tip flush with hull bottom.
- 15º in 10 seconds + 0.2g heave – spud cans lowered 15.2m below hull bottom.

Max variable load, moving, jacking, operating 905 tons
Max elevated weight (pre-loading) Per ABS
Max elevated weight (jacking) Per ABS penetration
Pre load time: Variable (dependent on bottom conditions/penetration)

2.2.4. Environmental conditions for Main & Auxiliary Crane Operations

The main and auxiliary cranes shall be Ram Crane designed to operate safely; as per the limitations set by the crane suppliers and the Classification society (ABS).

Environmental Conditions for Structural Design

Description	Mon	Non
Water Depth (LAT)	65m	85m
Significant Wave Height, H_S	10m	8.2
Maximum Wave Height,	17.1	14.3
Associated Wave Period,	11.8	11.5
Peak Energy Period, Tp	13.7	12.5

Maximum Wind Speed, V_W (1-minute mean)	46 m/s	38 m/s
Surface Current Speed, V_C	0.8	0.8
Storm Surge and Tidal Rise	4m	3.6
Air Gap	18.3	18.3

2.2.5. Noise and Vibrations

Special attention should be paid in the design and construction to limit the vibration and noise levels within the Vessel and more particularly under the main deck.

The noise and vibration limits shall conform to the requirements of the IMO Resolution A468 (X11) “Code for noise levels on board ships”

2.2.5.1. Vibration limits for Machinery and Equipment

Special attention shall also be taken to avoid that machinery and equipment will have local vibrations causing risks for malfunction or damages when the Vessel is in service. The vibration levels of machinery, jacking system, equipment, radars, structure etc. shall be in accordance with the recommended limits as stated by the Classification Society (ABS).

2.2.5.2. Measurements

In accordance with the Class requirements, a detailed noise / vibration measuring program indicating the measuring positions, shall be submitted for approval in due time prior to trials. If the vibration or noise levels exceed the requirements given in the specification, corrective measures shall be carried out by the Vessel Builder and shall be to the Owner’s and Levingstons satisfaction.

2.3. MAIN DIMENSIONS

2.3.1. Overall

Length Overall including Helideck	57 m	187 ft
Breadth Moulded	44.2 m	145 ft
Depth Moulded	ab. 6.9	ab. 22.63 ft
Design Draft	ab. 3.657 m	ab. 12.00 ft

2.3.2. Legs and Spud Cans

Number of Legs	Three (3)	
Type of Legs	pipe / tube	
Length of Leg to bottom of can (including leg Protrusion)	97.5 m	319.8 ft
Distance from Bow to Forward Legs	13.0 m	42.6 ft
Longitudinal distance between Leg Centres	33.6 m	110.23 ft
Transverse distance between Leg Centres	36.7 m	120.4 ft
Diameter of Spud Can	15.00	44.0 ft
Height of Spud Can (including leg below spudcan bottom)	4.20 m	6.1 ft
Bearing Surface per can	176.62 m^2	1901.2 ft^2

2.3.3. Jacking System

Make / Model	EBI GB82
Type	Fixed, Rack & Pinion
Drive	Electro- hydraulic
Storm Holding Capacity (per leg)	2700 tonne
Jacking Capacity (per leg)	1658 tonne
Speeds	Vessel elevating + 1.2 m/min
	Legs elevating +/- 3.6 m/min

2.3.4. Propulsion system

Typical	Three (3) azimuth thrusters with FPP at stern.
	One (1) tunnel thruster with FPP at bow.
Size of thrusters	3 x 1,100 kW Z Drive Azimuth Thrusters
Transit speed	6 knots

2.3.5. Accommodations

Accommodations	For up to 160 persons, public facilities.
	Mess area below deck
Helicopter type	Sikorsky S92 (12.8 t) and S-61N or equivalent
Dimension – D Value	22.2 m diameter

2.3.6. Main Crane

Model	(2) RAM LEC250-120LR
Boom Length	120 ft
Main Block	272 tonnes (300 short tonnes) at 9.1 m
	99.79 tonnes at 47.85m
Intermediate Block	113 tonnes
Whip line	22.7 tonnes

2.4. VARIABLE LOAD

The total variable load can be composed of the following items:

- Fuel oil, potable water, waste water, dirty oil, lubricating oil, cooling water,
- Ballast water, seawater
- Fluid in piping systems
- Deck cargo
- Sea fastening equipment
- Anchor and anchor wire
- Mooring lines
- Stores, crew and their effects
- Consumables
- Spare parts
- Repair equipment
- Gangway
- Crane load
- Temporary deck equipment
- Well intervention equipment
- Extra accommodation/ office module(s)
- Helicopter

2.5. SPEED

The Vessel shall be designed for a trial speed of not less than 6 knots with the propulsion (thrusters) motors operating at 100% load.

Trial conditions

- Conducted in an approx. 3.8m draught condition. Pending the final assembled condition of the Vessel prior to transit and acceptance by the Classification society.
- Clean hull
- Calm sea
- Wind force max. Beaufort 2

2.6. DIMENSIONS IN ACCOMMODATION

The clear minimum ceiling height in the accommodation is required to be 2.2 m, or as indicated otherwise in the applicable drawings.

2.7. CAPACITIES

Fuel Oil …….....	Approximately 534 m³
Fresh water ……	Approximately 553 m³
Ballast water ……...	Approximately 1921 m³
Lube oil ……...	Approximately 5m³
Dirty oil …….	Approximately 19.2 m³
Fuel Oil Day Tanks (engine room) ……	2 x Approximately 12.3 m³
Deck Drains Tanks …….....	Approximately 180 m³
Sea Water Buffer Tank (double bottom) ……	Approximately 90 m³
Emergency Gen set (day tank) …….	Approximately 3 m³
Sewage holding tank …….....	Approximately 38 m³
Gross tonnage according to international conv. …...	As per ABS

2.8. ACCOMMODATIONS

Accommodation to be provided for one hundred and sixty (160) personnel and one medic room. This includes one hundred thirty two (132) persons in thirty three (33) x four (4) men cabins and twenty four (24) persons in twelve (12) two-men cabins, with five (5) x one (1) man including two VIP cabins and one medic.

2.9. TRIM AND STABILITY

The Builder will observe and apply all applicable rules and regulations as detailed in Section 2.10 of this specification with regard to the Trim and Stability. Final trim and stability calculations with necessary loading conditions shall be worked out after final inclining experiment.

2.10. CLASSIFICATION & RULES

The Vessel will be classed as ABS MOU (Mobile Offshore Unit - Self Elevating) as per MODU Rules or equivalent.

The Vessel is designed to meet the present requirements, as far as applicable, of the following International and National Bodies:

• ABS Rules for Building and Classing Offshore Mobile Drilling Units (MODU), 2012 with amendments.
• International Load Line Convention, 1966 (Edition 2005)
• International Convention for Safety at Life at Sea (SOLAS), 1974 including amendments of 1981 and 1991 (only applicable in case referred to by MODU code) and the latest amendments (in effect from July 2004)
• International Regulations for Preventing Collisions at Sea, 1972 including amendment of 2003.
• International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) including Annexes I (Oil), IV (Sewage), V (Garbage) and VI (Air pollution)
• International Regulations for Tonnage Measurement of Ships, 1969.
• IMO Code for Construction and Equipment of Mobile Offshore Drilling Units, IMO resolution A.649(16), adopted October 19, 1989 and including latest amendments (consolidated edition 2001).
• Applicable Flag State Rules and Regulations.
• API Specification for Offshore Cranes, API Spec 2C, 6th Edition.
• Offshore Helicopter Landing Areas – Guidance on Standards, UK Civil Aviation Authority CAP437, 6th Edition.
• ILO C92 Crew Accommodations.
• International Telecom and Radio Regulations, Geneva 1976.
• IMO A468 Noise & Vibration.
• IEEE Standard No. 45 “Recommended Practice for Electrical Installation” 2002.

These regulations shall be applied with all amendments in force or adopted by the relevant bodies at the date of signing the Vessel building contract. For the deliveries and work according to this specification, the Builder shall include, install and supply all necessary equipment, work and fees to satisfy the above mentioned rules.

All necessary certificates, including classification reports shall be delivered with the Vessel, without any remarks.

Certificates shall be final or provisional (according to standard from issuer) but the Builder is responsible for achieving the final certificate when applicable.

All fees for approval of calculations, drawings and inspection, by both Class and Authorities shall be included in the offer from the Builder. If the Owner has paid any of these fees due to, for example, requirement from authorities, then these expenses shall be reimbursed from the Builder to the Owner.

2.10.1. Certificates

Certificates for the Vessel's hull, machinery and equipment shall be delivered with the Vessel in one (1) original, one (1) copy to the Captain of the Vessel, and one (1) copy to the Owner. The Vessel shall fly the Flag of the preferred country of the Owner and shall be certified for unrestricted trade.

All certificates required by authorities shall be valid and delivered and include a minimum of:

- Aeronautical Non Directional Beacon License (Owner Supplied)
- Aeronautical Radio License (Owner Supplied)
- Anchor- and chain certificates, if required
- Appendix to Class Certificate
- Annual Flag State Inspection
- Air breathing app. Certificates
- Builders certificate
- Bollards (type certificate)
- CAA Air Navigation order
- Certificate of Registry
- MODU Certificate or MOU Certificate as required by Class
- Classification certificate
- Crane, derrick and lifting appliance certificates
- Crew Accommodation Certificate
- CO2 certificate
- El Plant
- EIAPP for engines
- Fairleads (type certificate)
- Fire appliance certificates
- Guide rollers (type certificate)
- Helicopter deck approval
- Hull and Machinery Insurance Certificate (Owner Supplied)

- International Antifouling Certificate
- International tonnage certificate
- International Load line Certificate
- International Load line Conditions of Assignment
- International Oil Pollution Prevention (IOPP) certificate
- International Ship and Port Security Certificate (Owner Supplied)
- Inmarsat Access Authorization (Owner Supplied)
- IMO certificate for carrying dangerous cargo in bulk and on deck IMO A 673 (16)
- Lifting eyes (shall be marked with SWL)
- Life rafts certificates
- Life boat certificates
- Machinery certificates
- Medical certificate
- Minimum Safe Manning (Owner Supplied)
- MOB boat certificate
- Navigational Equipment Conditions of Class
- Navigation Lights, Gongs, Bells and Whistles Certificate
- Record of Safety Equipment- Potable water tanks certificate
- Sewage Pollution Prevention
- Shipboard Management Certificate (ISM) (Owner Supplied)
- Suez Canal tonnage Certificate
- Ship Hygiene and Sanitation Survey (De rat)
- Ship Radio license certificate
- Windlass
- Hazardous area equipment list

2.10.2. Plans and Manuals

- Register Management Plan
- Operations Manual
- Ballast Water Management Plan
- Bilge Water Management Plan
- Fuel Oil Management Plan
- Fresh Water Management Plan
- Refrigerating Management Plan
- Sewage Management Plan
- DPVOA - IMCA Survey Report
- Tests and Trials Reports
- SOPEP Manual

In addition equipment certificates for all equipment installed.

Certificates issued by Class where required, elsewhere manufacturers certificates to be furnished.

2.11. DRAWINGS

The Builder will be responsible for the approval of detail drawings by the Classification Society and Legal Authorities.

Text on drawings framed on board, As-Built drawings and approval drawings shall be in English language. Preparation of drawings, instruction books and manuals shall be done in co-operation with the Owner and Levingston.

2.11.1. Drawings for Approval by Owner

2.11.1.1. List of Drawings for Approval

The Builder shall provide the Owner/Levingston with a list of drawings for approval by the Owner/Levingston within 120 days after contract award.

Approval Process:-

One (1) copy of all basic design plans and design drawings called for according to the agreed list shall be submitted by the Basic Designer/Builder to the Owner/Levingston for approval. It shall be the Basis Designer's responsibility to ensure that all such plans and drawings comply with Classification Society rules and any other regulations which form part of the Contract.

The plans and drawings shall be returned by the Owner/Levingston to the Builder with approval or remarks, if any, within fourteen (14) days after receipt by the Owner/Levingston. In case the plans and drawings or comments are not returned from the Owner/Levingston to the Builder within fourteen (14) days they shall be deemed to have been approved by the Owner/Levingston without any comment.

Work may only be started by Builder if the relevant plans and drawings are approved by the Owner/Levingston or deemed to have been approved as provided above.

Approval of a drawing by Owner/Levingston does not absolve Builder of their responsibility for compliance with the requirements of the specifications and all subject regulatory/ Class requirements.

2.11.2. Classification Society Approvals

Copies of all plans and drawings submitted by the Builder to the Classification Society and Regulatory Bodies shall be simultaneously sent to the Owner/Levingston.

2.11.3. Drawings to be provided upon Delivery

Three (3) sets of as-built drawings and instruction manuals covering the Vessel's equipment shall be furnished on the Vessel and to the Owner prior to delivery of the completed Vessel.

The drawings shall include system diagrams, logic diagrams, termination drawings, interconnection drawings. The following list is a guide only.

2.11.4. Drawings (As Built)

Three (3) hard copies plus one set electronic files in CAD format of the following drawings will be handed over at delivery of the ship. These drawings will include but not be limited to the following:-

- General arrangements
- Transverse frames and bulkheads
- Longitudinal Frames and Bulkheads
- Deck plans
- Structural arrangement fore and aft ship
- Foundations for engines and thrusters
- Thrusters
- Crane pedestal arrangement plans
- Accommodation plans
- Hydrostatic data
- Stability data
- Capacity plan with dead-weight scale
- Tank plan
- Docking plan
- Helideck plan
- Escape routes
- Hazardous areas
- Gas detection systems
- Arrangement of engine rooms, casings and funnels
- As built arrangement of engine rooms, thruster rooms
- Jacking system with associated equipment
- Leg arrangement and structural plans
- Compressed air system
- Engine Cooling system
- Fuel oil system
- Fresh water supply
- Exhaust system

- Ballast, bilge and fire-fighting systems
- Sanitary system
- Fire and safety plan
- Air and sounding pipes
- Ventilation plans for accommodation, engine rooms and cable trunks
- Air-conditioning
- Electric installation and distribution
- Schematic diagrams of switchboards
- Wiring diagrams
- List of spare parts
- Equipment list

2.11.5. Plans and Certificates Fitted Onboard

Following drawings shall be framed and fitted throughout the Vessel, as required:

- Capacity plan with loading scale
- Tank plan
- Export Services Plan
- GA Plan
- Bilge and Ballast diagram
- Fire and deck wash diagram
- Mustering plan. Muster Lists to be supplied by Owner
- Other plans required by Class/Authorities
- Maneuvering information (on bridge)
- Notice Board
- Leg arrangement and structural plans
- Compressed air system
- Engine Cooling system
- Fuel oil system
- Fresh water supply
- Exhaust system
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- Sanitary system
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- Other plans required by Class/Authorities
- Maneuvering information (on bridge)
- Notice Board

Two (2) CD-ROM versions of the manuals shall be supplied (scanned versions are acceptable). MS Word or CAD format shall be provided as far as practicable. Instruction books and manuals shall be in English language.

Instruction books and manuals are to be supplied prior to the delivery of the ship. As far as applicable for equipment concerned, following information to be given:

a) General information about the equipment, type etc.
b) Specification of the equipment.
c) Instructions for operation and maintenance together with block diagrams, drawings and other applicable facilities.
d) Instructions for installation of equipment.
e) List of spare parts, with reference numbers.
f) Data on service addresses etc.

2.11.7. Emergency Response Manual

Prior to delivery a good quality manual for emergency response shall be prepared by Owner with assistance, if necessary, of the Builder. The emergency manual shall contain data on safety, fire fighting and damage stability and shall cover the requirements for Vessel and environmental contingency plans according to IOPP, OPA 90 and MARPOL

2.12. MATERIALS, CONSTRUCTION, INSPECTION

All materials, equipment and components for use onboard shall be new, of good quality and suitable for a Vessel of this type and size working world-wide.

Upon delivery, the Vessel shall be completed in all respects and in a seaworthy condition, as per contract, and fully in accordance with the specifications. All painting, greasing and cleaning work shall be completed to Owners and Levingston satisfaction.

All tanks, cargo areas, bilge wells, engine room, accommodation, stores room and other areas shall be thoroughly cleaned before delivery. All machinery shall function perfectly under world-wide conditions under specified temperature and RH conditions. All equipment shall be selected and all construction shall be carried out, emphasizing easy access for cleaning, maintenance, repair, inspection and after sales service in remote areas.

2.12.1. Materials

All steel materials for the hull shall be of Marine quality with certificate from Class. Where aluminum is used, this will be saltwater durable according to Class regulations.

Necessary precautions shall be taken with regard to insulation when employing aluminum, wood or steel. All stainless steel shall be acid-proof. All cast iron shall be without defects. No asbestos containing products shall be used. Special precautions shall be taken to prevent material corrosion. Where materials of different electrical potential are used together in humid surroundings, special attention shall be paid when deciding upon type of insulation.

2.12.2. Sub-Contractor's Requirements

Builder’s sub-contractors requirements and indications will be acted upon, in order to secure faultless function of equipment and maintenance of the warranty. This concerns system design, installation, surroundings, connected systems etc.

2.13. CONSTRUCTION AND PERFORMANCE

2.13.1. PROJECT EXECUTION

2.13.1.1. Provision of Office Facilities

Builder shall provide Owner/Levingston representatives with office space at Builder’s facilities for up to four (4) personnel for the full period of the contract, including commissioning and trials where applicable.

Each person shall be provided with desk, chair, two (2) 4-drawer filing cabinets,

telephone, and access to Builder computer network. Owner/Levingston shall provide their own PCs or Builder may supply. (To be mutually agreed). Telephone charges shall be for Owner and Levingston account.

2.13.1.2. Planning

It will be the responsibility of the Builder to supply a master version of the construction schedule for these works within 30 days of signing the contract. This schedule will reflect the key duration periods and milestones as indicated in the Builder's preliminary schedule at the time of tender. Sections under the heading of Vessel Total Construction will clearly identify and not be limited to a minimum of the following:

Engineering: A breakdown of all related stages including production planning and materials take off information.

Procurement: A breakdown of all Builder materials and equipment that is key to delivery dates.
Fabrication: Identify all the various stages of fabrication from block fabrication to final assembly and will include build methodology, blast and painting stages and pipe system installation and pre-commissioning of same.

Living quarters assembly and installation. Jacking and crane pedestal foundations. Leg & spud cans assembly and installation key dates.

Electrical: Detail cable routing plans, cable rack installation key dates, major equipment installation dates, cable pulling windows, termination of major equipment and all related pre commissioning.

Mechanical: Key installation dates of all individual major equipment, windows for installation of all Vessel minor systems equipment and all related pre-commissioning.

Outfitting: Accommodation and general Vessel items

Painting: Final painting schedule taking the tank testing plan into account for the hull

Commissioning: Dockside and sea-trials, inclining experiment, leg and jacking trials, load testing of cranes.

2.13.1.3. Progress Reporting

During the contract, the Builder shall submit an agreed form of progress report to the Owner/Levingston each month.

The report shall include planned and actual progress (and percentage complete figures)

for the design and construction activities in line with the master schedule and in agreement with the requirements of the Owner/ Levingston ;

Builder shall provide a written description of progress in all key areas, anticipated progress in the period of the next report, and highlight areas of concern.

The report shall contain progress photographs. A record of the project change orders shall be included where applicable.

The Builder will generate a weight report every month following Contract award.

The weight report will be used to predict the lightship weight prior to the Inclining Experiment.

2.13.1.4. Meetings

A construction meeting between Owner/Levingston representative and Builder's representative shall be arranged every second week. Progress, technical matters, states of variations shall be on the agenda for such meetings. Each week site meetings shall be arranged after the Owner/Levingston representatives are permanently on site. When required, sub-contractors or suppliers shall attend the meeting. Such meeting shall also be arranged whenever called for by anyone of the parties.

The Builder is responsible for issuing Minutes of Meetings. This shall be issued for Owners/Levingstons approval, latest two (2) days after the meeting and shall confirm agreed actions and details.

2.13.1.5. Inspection and test plan (ITP)

The Builder shall forward to the Owner/Levingston a detailed ITP for approval within one hundred and twenty (120) days after the Effective Date of the contract. This plan shall include, but not limited, to inspection and testing of the hull, all tank and void spaces, piping systems, Legs and Jacking system, main and auxiliary Cranes, machinery, equipment and factory test of main items.

2.13.1.6. Commissioning Plan (CP)

The Builder shall provide the Owner/Levingston with a provisional commissioning plan 120 days into the contract period with full details for viewing.

2.14. MODIFICATIONS

The Owner/Levingston is entitled to request modifications or additional work. Such extra work shall only be carried out upon written request to the Builder.

All such work shall be carried out only according to separate written agreements, which describe the additional work or changes to Contract price, delivery conditions and information about whether the change/additional work leads to changes of deadweight, speed or other functions

For all modifications and changes the Variation Order (VO) form shall be filled out and signed by both parties. No work shall start before the VO is signed.

Changes arising during the building period, from contract date, in national or foreign rules and regulations or in the Class regulations, and which require modification to the Vessel shall be carried out by the Builder. The Owner shall pay for these modifications or shall be credited for savings.

For work of the type mentioned above, additional charges or reductions shall be calculated according to the stipulations of the contract and forwarded to the Owner for approval before the execution. Evidence that the stipulations are according to those in the contract shall be given if required. If reductions in building costs or purchases are obtained, this shall be credited to the Owner according to the same rules as above.

2.15. SPARE PARTS, TOOLS

2.15.1. Vessel Spares and Tools

Spare parts list for one (1) year's spares and special tools shall be prepared by Builder and all vendors, and submitted to the Owner/Levingston for purchase approval. Cost of the aforesaid purchase has been excluded from Builder's Contract Price and subsequent handling.

The handling of these spare parts includes the following:

- Received spare parts to be checked, marked (labeled) and preserved.
- Delivery and installation on board (including foundations) of parts with necessary racks and suitable boxes and cases for spare parts (Builder's standard).
- Compiling of spare parts list, according to Builder's standard.
- Tools will be either stored with the concerned spare parts or stored on racks in the concerned workshops upon agreement with the Owner/Levingston.

2.16. PURCHASE ROUTINES

2.16.1. Equipment Selection and Standardization in General

A mutually agreed Maker list shall form part of the Contract.

Suppliers and subcontractors will be selected in consultation with Owner/Levingston from the agreed Maker list.

If Owner/Levingston requires a Maker other than that preferred by Builder, Builder shall comply, subject to mutual adjustment of price and schedule.

If Owner/Levingston wish to add another Maker to the list of Makers appended to the contract, this may be done by mutual agreement.

Standardization of PLCs: (Programmable Logic Controllers) Prior to equipment

procurement, Owner/Levingston shall advise Builder of the preferred PLC type to be standardized throughout the Vessel.

Prior to vendor selection, Builder shall request all suppliers with PLC in their scope of supply to advise the implications (cost, schedule, technical) of standardizing on Owner/Levingston preferred type of PLC.

This information shall be provided to Owner/Levingston as part of the vendor approval process described above.

When the supplier can indicate that they can comply with Owner/Levingston preference, Builder shall obtain the equipment with the standardized PLC, subject to mutual agreement of cost and schedule implications, if any.

2.17. OWNERS SUPPLY

The supply of the following items is not part of Builder's scope:

- Fuel, lubricants and water, on board (in tanks, sumps, drums etc.) upon delivery
- Spare parts, extra mooring wires, consumable stores and other articles, in excess of what has been specified.

2.17.1. Consumables

All fuel oil and lubricating oil required for tests and trials shall be ordered by Builder for Builder's account. Owner shall pay Builder for fuel oil and lube oil remaining on board the Vessel at the time of delivery. (Price basis to be reasonable, equivalent to suppliers' prices). All consumption of bunker oil, hydraulic oil, lube oil, flushing oil

etc. shall be covered by the Builder up to time of delivery. Builder shall consult Owner on the type and make of oils to be used.

Before delivery of the Vessel, the Builder shall bring onboard and store, without extra charges (for goods under 5 t or if the ships crane can be utilized), all goods and equipment delivered by the Owner.

The Builder has the right to make use of the ship's installations, equipment and outfit for lighting, current supply, ballasting, bunkering, and testing of installations and similar activities at the end of the fitting out period and when the ship has left the Builder for final fitting out and during sea trials.

2.18. QA / QC

Builder will present a HSEQ plan (Health, Safety, Environment and Quality) for Owner/Levingston approval, covering all issues relating to Quality Assurance at the date of signature of contract. A construction risk assessment shall be performed and recorded.

2.19. TRAINING OF CREW

Builder shall arrange through its vendors for the provision of training of the Owner/Levingston crew in the operation and maintenance of major equipments / packages. Crew shall join the vessel no later than (2) two months before the sea trials to familiarize there self's with the ships mechanical operations. The Captain, Chief Mate, Chief Engineer, 2nd Engineer, and Chief Electrician.

3. GENERAL VESSEL DATA

3.1. VESSEL DATA

3.1.1. NOISE AND VIBRATION

3.1.1.1. Noise and Vibration Analysis

Suppression of noise shall be given full consideration by the Builder at the design stage. Particular attention shall be made of under main deck sound attenuating including state-of-the-art spray-on coverings.

A noise analysis shall be carried out in both the “in transit” and the “jacked up” condition by a recognized third party and shall include:

- Structure borne noise analysis
- Air-borne noise analysis
- Noise reduction analysis
- A vibration analysis of local structure

3.1.1.2. Noise and Vibration Precautions

Floating floor in accommodation shall be installed as per Owners/Levingston requirements.

- On accommodation deck
- On main deck
- On Upper deck

Special precautions shall be made for ceiling fastening to avoid noise and vibration transmission. All diesel engines shall be resiliently mounted.
Diesel machinery and hydraulic aggregates shall be installed on flexible mounting joints and shall have flexible pipe connections. Special attention shall be made for thruster installation and structure borne noise/vibration.

3.2. DRY-DOCKING

3.2.1. Dry-Docking

The Vessel shall be designed for a docking condition with lightweight of not less than 9,000 tons

At the time of delivery, the Builder will deliver the Vessel free of hull marine growth via a fresh water wash down whilst in a Jacked Up condition.

All sea chests shall be opened, inspected and cleaned before delivery.

3.3. TRIALS AND TESTS

3.3.1. Trials General

The Owner/Levingston representative shall be present at all tests and shall have the authority to accept or reject tests.

The Vessel and all machinery shall be tested to Class and Owner/Levingston satisfaction. All tests, unless of a minor nature (all tests with respect to meeting Class, operability and functionality of the Vessel are not considered minor), shall be accepted before the Vessel is handed over to the Owner/Levingston.

Procedure for testing shall be provided by the Builder for information and approval by Owner 30 days prior to commencement of tests/trials programmed.

Test and trials shall consist of the following:

- Factory Acceptance Tests
- Harbor Acceptance Tests
- Sea Trials
- Customer Acceptance Tests.

3.3.2. Machinery Testing

The Owner/Levingston shall be advised 14 days in advance of machinery FATs at the suppliers factory. Torsion and vibration calculations shall be carried out by the engine supplier and approved by the Class. All machinery shall be tested at the quay before the trial trip. Individual procedures for testing shall be submitted to the Owner/Levingston for approval at least 14 days in advance of any such tests.

3.3.3. Inclining Experiment

When the Vessel is substantially completed except for minor items of work (as acceptable by the Class), light-weight measurement and inclining experiment of the Vessel shall be carried out by the Builder. Test procedure to be prepared by Builder and to be approved by Class. For these tests the Vessel shall be effectively arranged with all tanks being empty, if possible, manhole covers open and minimum stores/loose equipment.

The inclining experiment shall be carried out in the presence of the Owner/Levingston representative or the person authorized by the Owner, Levingston and the Class surveyor. Then the position of the centre of gravity of the Vessel in light condition shall be determined by the Builder’s calculation based on the obtained results.

The inclining experiment shall be conducted according to IMO Resolution A749 (18) “Code on Intact Stability for All Types of Ships Covered by IMO Instruments”, procedure shall be approved by the Owner, Levingston and Classification Society.

This test shall be carried out by the Builder or his nominated competent contractor in

dock or in the harbor basin near the Builder under fair weather condition.

3.3.4. Light Weight Measurement

The calculation of the lightweight and deadweight shall be made by the Builder and verified by the Owner/Levingston representative and then “light weight” and “deadweight” shall be determined by experiment.

3.3.5. Consumables

All consumption of oil and other media required for testing, flushing harbor and sea trial shall be provided by the Builder. Further, Builder shall be responsible for filling up all systems, for lube oil and hydraulic oil at delivery. The Owner shall pay at cost for fuel in tanks, lube oil and hydraulic oil in storage tanks and barrels when taking over the Vessel.

3.3.6. Dock Tests and Trial Trips

Alongside tests shall be carried out when systems are ready for testing, according to ITP. During these trials, all machinery, cranes, jacking system equipment, piping systems, maritime equipment, control systems, air conditioning, ventilation and all other equipment shall be tested to satisfaction of the Owner, Levingston, and Class Authorities.

- Electronic equipment, including navigation and communication shall be tested.
- Electrical plant shall be tested.
- Pump test including test of loading and ballasting system.
- Life boat and rescue boat, if fitted.
- Thrusters shall be function tested and run at 30% MCR for 1 hour.
- Generators shall be tested at full load for six (6) hours, using load banks, and 10% overload for one (1) hour, dependent on ambient conditions.
- Before trial trip all systems shall be commissioned and function tested at the quayside.
- The Builder shall sign for tests prior to the Vessel departure for open water trials.
- The Vessel shall have one (1) sea trial test in open waters.

3.3.7. Crane Tests

Crane load & function tests shall be carried in line with ABS rules and the requirements of the manufacturer and to the satisfaction of the Owner/Levingston.

3.3.8. Open water sea trials

Open Water Sea trials shall be carried to Class, manufacturers' & Owners and Levingston requirements and in line with the Builders approved trials and test plans.

Whilst the sea trials will remain under the control and responsibility of the Builder, the sea trials marine crew, numbers to be mutually agreed, shall be loaned by the Owner/Levingston to the Builder.

Sea trials shall begin when all harbor trials have been satisfactorily completed and when the Builder and Classification Society declare that Vessel is complete, equipped in all respects and ready for sea.

During sea trials machinery and equipment shall be checked in operation. Electrical load shall be recorded at least every hour.

The sea trial programmed shall include as a minimum;

1. All tests required by Classification Society for Vessel type.

2. Progressive speed tests 50%, 75% (each two runs in opposite direction) and 100% output (two runs) will be carried out

3. Fuel consumption/speed to be recorded

4. Maneuvering test.

5. Emergency stop.

6. Thruster / azimuth test.

7. Anchor test, if required

8. Steering test, including circle and nine (9) maneuver test to SB and PS.

9. Noise measurements.

10. Compass correction.

11. Test of heating/ ventilation/air-condition system.

12. Astern maneuverability test with and without use of selected thrusters.

13. Illumination measurement of the Vessel.

14. CATs (Customer Acceptance Tests)

15. Jacking System testing as per jacking system EBI at full water dept.

16. Leg Jacking System shall be jacked down at sea water depth to test.

A report shall be made on all tests carried out during the trials.

This report shall be provided to the Owner and Levingston. Any faults found during the trial shall be corrected and if necessary, a new trial trip carried out before delivery of the Vessel. All above tests shall be completed before acceptance of the Vessel.

3.3.9. Vibration Levels

Vibration levels shall be measured to be within the allowable values provided by Reference – ISO 6954:2000 “Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships”

3.3.10. Post Sea Trial Inspection

If, during the sea trials, it is discovered that any modification has to be made in order to make the ship safe, seaworthy and satisfactory, then the Builder, at his expense, shall carry out such works prior to delivery.

4. HULL

4.1. HULL STRUCTURE DESIGN BASIS

4.1.1. Strength Design Basis

4.1.1.1. General

The Vessel structure shall be designed & constructed in accordance with Classification Society / Statutory Requirements / Rules.

4.1.2. Deck Design Loads

The following deck loading has been taken into account in the design:

- Bow Area 5.0 t/m2
- Main deck 5.0 t/m2
- Other Areas 5.0 t/m2

The total variable load will be 905 tons of which about 400 metric tons can be stowed on the main deck.

Areas where a higher local deck loading may be required shall be decided by the yard at detailed design phase.

4.1.3. Steel Construction - General

The hull is subdivided by bulkheads, as indicated on the general arrangement plan. The hull is of an all- welded construction. At the three corners of the hull, legs wells are provided.

Arranged inside the hull are the main engine room, stores, galley, mess room, provision stores, and day rooms. Hatches for proper access to the stores and the main engine room are provided within the reach of the cranes.

A double bottom is provided in the centre compartment and in part of the side compartments and is subdivided into tanks and voids compartments. Sea chests are provided at mid ship of the hull.

The main longitudinal and transverse bulkheads are reinforced around all large openings. Lower leg guides form part of the hull. A recess is provided below each lower leg guide to retract the leg footing into the hull, so that, the bottom of the spud can is flush with the keel.

The following should be used as a basis:

- All steel edges shall be ground according to good ship building practice.
- The hull form shall be well suited for this type of Vessel and the structure shall be of an all welded steel construction with watertight division as shown on the GA plan.
- A welding table shall be provided by the Builder for the Vessel's steel structures. This is to be approved by both Class and the Owner/Levingston and will form part of the test and inspection plan package along with the Builder's welding booklet.
- A watertight double bottom shall be fitted as shown on the GA plan.
- A suitable number of bilge wells shall be fitted in the engine room, thruster rooms, propulsion room areas and workshops etc.
- Tanks shall have two (2) manholes as Class sizing (only one (1) manhole on small tanks). These manholes shall be to the accepted yard standard and will have

S/Steel studs / nuts. Ladders will be treated with the same internal tank lining material.

- Shell plating in the way of thrusters, jacking systems, anchors and other openings shall be increased in thickness by insert plates, where needed, and not by any doublers.
- Special care shall be taken to ensure that the full longitudinal and transverse continuity of girders and bulkheads are maintained throughout the Vessel.
- Lower leg guides form part of the hull.
- In the vicinity of loading hoses, a half round pipe will be installed.

4.1.4. Jacking Structures

Above the three (3) leg wells, the three jacking structures are arranged. Each of these three (3) structures is made up of an upper leg guide and the attachments for the jacking system. One Leg Encircling Crane ("LEC") is made part of the starboard jacking structure.

4.1.5. Leg Guides

Leg guides are provided at the top of the jacking structures as well as to the lower end of the leg wells at bottom deck level. These form an integral part of the jacking structure and hull respectively.

4.1.6. Legs

Three circular type legs with a length of 320 ft (including the leg footing) are provided with 10" diameter.

4.1.7. Leg Footing

The footing consists of a spud can structure with a centre pin. The structure of the footing is designed in a robust way. It allows eccentric support from the seabed and impacts during the installation stage of the Vessel. Jetting nozzles are provided in each leg footing, top and bottom. A manifold is provided just above the footing to enable testing and cleaning of each jetting nozzle when the legs are fully retracted.

4.1.8. Jacking System

Three (3) electro-hydraulic driven Rack and Pinion type of jacking systems are to be provided at each leg. These jacking systems are capable of moving the hull vertically up and down the legs as required during jacking operations. Furthermore; they are capable of holding the elevated hull during pre-loading, operations and survival conditions.

Each system leg consists of eighteen (18) sets of jacking pinions, arranged as nine (9) rows. Total number of pinions is equal to 54.

Sufficient walkways are to be provided around these jacking structures to allow access and maintenance.

4.1.9. Materials

The hull materials shall be in accordance with Classification requirements. In general all steel material grades shall also be according to Class rule requirements and as specified on the design drawings.

All welding methods and consumables will also be according to Class requirements.

4.1.10. Corrosion Margin

A corrosion allowance should be applied in accordance with the requirements of the Class Rules.

4.1.11. Blasting and Priming

All steel material shall be blasted to SA 2.5 Class and painted with low-zinc silicate shop-primer in accordance with SFS 8145. The type of primer and thickness shall be suitable for the top coating and be suitable for welding by the M.I.G process in order to prevent removal by grinding prior to fillet welds being applied.

4.1.12. Testing of Tanks, Bulkheads etc.

Leak testing shall be carried out in all applicable tanks and compartments in accordance with Class requirements and in line with the Builders agreed test and inspection plan. This is to be carried out prior to final painting.

4.1.13. Welding inspection

The inspection of all welding shall be in accordance with Class requirements and the Builder’s test and inspection plan. The number of x-rays shall be according to Class rules and results shall be given to the Owner/ Levingston.

4.1.14. Welding Steel Construction

Hull and superstructure shall be of an all welded construction.

4.1.15. Shell Plating

The Builder shall take care to give the shell surface a smooth appearance. All temporary attachments will have been removed and ground smooth.

4.2. SHIP

4.2.1. After Body – General

The aft ship shall be designed for three (3) azimuth propellers according to the GA. Emergency exits from the propulsion rooms shall also be installed according to the GA.

4.3. ENGINE AREA

4.3.1. Engine Area – General

The engine room shall be one common space with suitable flush deck hatch's for engine or generator maintenance.

"Save alls" around all small tanks and oily machinery, with drain pipes to waste oil or sludge tanks shall be installed.

Sounding (remote as required by the Vessel Management System, if fitted) and ventilation piping will be installed in all tank and void spaces as required by Class.

4.4. DECK CARGO AREA & MID BODY

4.4.1. Cargo Storage

Cargo storage is on main deck only with stores located below deck on the Port side with crane accessible service hatch. Also located in this area below deck are the following:

- Engine control room
- Switch board room

- Auxiliary engine room
- Engine room workshop
- Engine room store
- Electrical workshop
- Transformer room
- Stairs access to the accommodation deck Port & Starboard

4.4.2. Double Bottom

A double bottom is provided in the centre compartment with void spaces to port and starboard. Sea chests are provided between frames 7 & 8 Pipe/cabling tunnels are incorporated.

4.4.3. Crane Related Structures

4.4.3.1. Cranes Foundations

Foundations and at least part of the pedestal for the Leg-encircling cranes will be installed as part of the Vessel's starboard and port jacking tower section. This will be located as indicated on the General Arrangement plan.

4.4.3.2. Crane Boom Rests

Builder shall provide crane boom rests for the cranes, so that the booms may be secured in the horizontal position. Hook and block stowage shall be provided which will enable the crane operator to safely stow these items. Safe, permanent means of access shall be provided to the top of the boom rests, this arrangement should be designed to minimize the efforts of manual handling.

4.4.4. Decks

The Vessel has one tank top, one machinery deck, one accommodation deck, one main continuous deck, an upper deck, and a top wheelhouse deck.

4.4.5. Wing Tanks

All tanks and void spaces are to be clearly identified on the Vessel tank plan. Builder to provide a tank and void space test plan in line with the painting program as part of his test and Inspection plan.

4.4.6. Fore Body

The fore ship shall be designed for one (1) tunnel thruster according to the GA. The tunnel thruster room shall be accessible through a hatch on the main deck connected to an access tunnel or directly above the thruster room. The doors and inner bulkheads into the room shall be insulated according to Class rules.

4.5. SUPERSTRUCTURE AND DECKHOUSE

4.5.1. Superstructure and Deckhouse

Permanent accommodation for 160 persons will be integrated into the steel hull positioned around and below the main deck. Facilities will be arranged in the accommodation block and will be suitable for 160 persons working a two shift system.

The accommodation will be made up of three (3) deck levels (below and above the main deck and also on upper deck) and will have a minimum ceiling height of 2.2 m and will conform to the details of the General Arrangement and all applicable regulatory bodies. The deck height shall be 3.05 m for the cabin decks and
3.1 m for the workshops and offices on the main deck.

The accommodation structure shall comply with the rules and regulations in force not only for the flag state of choice and the Classification Society but also with the regulations in force in the intended operational area of the Vessel .
As well as the accommodation, there is also an emergency generator room to port on the bridge deck and a CO2 room on the main deck, all as indicated on the GA. Other arrangements include but are not limited to:

- Helicopter landing deck
- Helicopter deck fire monitors / ring main.

Main Fire monitors Bow Port Starboard

Helideck administration and radio office will be located on the same level as the upper deck.

4.5.2. Top Deck

Bridge control of all propulsion and maneuvering together with navigation communications, and the jacking equipment console will be located in the wheelhouse, in line with current IMO regulations. The wheelhouse will have a raised floor to facilitate the running and connection of cabling and for the storage of converters etc.

4.5.3. Accommodation Level

Below Main deck at the accommodation deck level the following public facilities will be arranged as per the details shown on the General arrangement plan.

- Galley
- Mess room containing tables and seating sufficient to accommodate a minimum of 3 shift.
- Dry provision, cool and freeze stores
- Two (2) recreation rooms (non-smoking and smoking)
- Gym

Other spaces that are provided at the accommodation deck are:

- Laundries
- Some AHU rooms
- Various stores
- Changing rooms
- Communal showers and toilets

4.6. HULL OUTFITTING

4.6.1. Hull Outfitting

Mark	Location	Marking	Height
Operators name & Logo	On all three jack houses	Steel plate & paint	Min 300 mm TBC
Vessel Type, Name & Port of registry	Vessel sides aft, Port & Starboard	Steel Plate & paint	Min 300 mm
Draft Marks	Fore, aft & amidships	Steel plate & paint	As per Class requirements
Load line / freeboard marks	Amidships	Steel plate & paint	Ditto as above
Calling letters & tonnage	Superstructure	Steel plate & paint	Ditto as above

Mark	Location	Marking	Height
Tank boundaries	Bottom and side shell	By welding	75 mm
Bottom plugs	IWO all docking plugs indicate applicable product, FO, BW etc	By welding	
All four thruster warnings indicated	Side shells above water line fore and aft C/L of thrusters P &	Steel plate & paint	

The other marks including any marks for underwater fittings, equipment or otherwise necessary to permit underwater inspections in lieu of dry-docking shall be designed in accordance with the Classification requirements for Underwater Survey in Lieu of dry docking.

4.6.2. Bottom Plugs and Sea Inlet

4.6.2.1. Bottom Plugs

Bottom plugs from all tanks in double bottom and sides. Bottom plugs type NS 2573, dim. min. 70 mm, or as per Builders standard if acceptable to both Owner/Levingston and Class. Welded sign showing the tank numbers at each bottom plug. Two (2) keys for opening/closing of the plugs shall be provided.

4.6.2.2. Sea Inlets

Sea water will be supplied via sea chests and shall be in line with the requirements of the applicable approved system diagrams. Sea chest shall be equipped with strainers of stainless steel.

Strainer to open inboard. Location and size of sea chests shall be sufficient for relevant machinery/pumps. Strainers shall be mounted flush with shell plating

4.6.3. Foundations

Propulsion units, generator sets etc. shall be installed on seating built as part of the hull construction. The dimensions and tolerances shall be as required in rules and suppliers' instructions.

4.6.4. Bulwarks

Bulwarks IWO the accommodation will be as indicated on the GA and applicable structural drawings. Local reinforcements in way of chocks, fairleads etc. and platforms where necessary for mooring operations.

4.6.5. Uptakes

Two funnel /uptake casings for exhaust and engine room ventilation shall be installed as per the GA. The exhaust system shall conform to the engine manufacturer's requirements. The final length and angle above the casing top shall be approved by the Owner and will be manufactured in stainless steel. Ladders or steps shall be fitted inside the casings as required for inspection and maintenance purposes.

4.7. MATERIAL PROTECTION

Surface preparation shall be according to an agreed standard and to meet paint manufacturer's recommendations. Oil and grease shall be removed by use of degreaser followed by fresh water hosing.

4.7.1. Rooms Without Lining

Lugs and steel eyes on external hull and rooms without lining shall be burned away and ground flush. Cuts and minor depressions shall be filled with weld and ground flush.

4.7.2. Rooms with Lining

Lugs and eyes shall be cut to the height of no more than 10 mm. Sharp edges shall be rounded with grinding machine to minimum radius 2 mm. Cuts and minor depressions shall be filled with weld and ground flush.

4.7.3. Tanks

Cuts shall be filled with weld. Grinding where there are sharp edges or lugs etc. removed where corrosion may be encouraged if grinding cannot be done to satisfactory standard for painting.

4.7.4. Painting General

All steel shall have been blasted to grade SA 2.5 and primed with zinc primer approved

by paint supplier and the Owner/Levingston. All painting work shall be carried out with good workmanship and according to common good practice.

Painting and material protection shall be carried out with brushing, rolling or spraying according to the paint manufacturer's recommendation for the different types of paint and material protection.

All sharp edges in tanks and all outside structure shall be ground according to normal ship building practices. All external welds and damaged primer shall be to SA 2 and touched up with zinc-silicate primer. All external welding shall be finalized prior to start-up of blasting.

All internal welds and damaged primer shall be steel brushed and touched up with zinc primer (See paint spec for fuel and lube oil tanks). All edges and welding seams shall be stripe coated before next coating and only after all tank testing has been performed and passed by QC and the Owner/Levingston. All paintwork shall be carried out according to the paint manufacturer's recommendations.

The paint shall be applied as received from the manufacturer. Oils, thinner and other drying liquid shall not be added except when this is specified from the manufacturer. High pressure spraying is applied wherever it is practical.
All imperfect areas shall be touched up with primer paint before topcoat is applied. This also applies for the equipment delivered undercoated from the subcontractors.

Parts of steel, which shall be riveted or screwed together, shall have some form of applicable protection applied to the mating areas, but not in oil tanks.

4.7.5. Painting Schedule

4.7.6. General

The Builder is to submit a proposed paint system suitable for the any offshore worldwide environment. All tanks are to be coated internally with a system that is compatible with the substances contained within, with the exception of fuel and other oil tanks.

Paint Specifications

	Applicable Areas	Paint Name	DFT (microns)
1	New plates and angle bars		15

	Applicable Areas	Paint Name	DFT (microns)
		Total	**15**
2	Galvanized handrails	Penguard Primer SEA, Red Hardtop AS, Yellow 258	50 50
		Total	**100**
3	Structural internal ducting	Jotamastic 87 , Grey 38	150
		Total	**150**
4	Exposed steel pipes	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Hardtop AS, As per surrounding finishing	125 125 50
		Total	**300**
5	Steel pipes (behind insulation)	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT	125 125
		Total	**250**
6	Steel pipes in high temp. environment (service temp.	Resist 78, Grey Solvalitt , White Solvalitt , Aluminium	75 25 25
		Total	**125**
7	Crane column (internal)	Jotamastic 87 Aluminium, Aluminium (to be thinned down) Jotamastic 87 , Off White (to be thinned down)	125 125
		Total	**250**
8	Legs, Submersible components below waterline: Raw water tower, pipes, etc	Jotamastic 87 Aluminium, Aluminium RT Jotamastic 87, Black	250 250
		Total	**500**
9	Legs, submersible components above waterline: Raw water tower, pipes, etc	Jotamastic 87 Aluminium, Aluminium RT Jotamastic 87, Grey 38 Hardtop AS*	250 250 50
		Total	**550**

	Applicable Areas	Paint Name	DFT (microns)
10	Main exterior exp. area hullside, draft to t/s, deck house, crane, jack case guide & cross bracings, cafeteria, condensing units room, CO2 room, welding w/shop, paint store exterior, elevating units.	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Hardtop AS, Lt Grey RAL 7035	150 150 50
		Total	**350**
11	Exterior of living quarters, helicopter deck truss structure	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Hardtop AS, White	150 150 50
		Total	**350**
12	Main exterior exposed area. Hull side draft to keel and bottom	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Penguard Topcoat, Lt Grey RAL7035	150 150 50
		Total	**350**
13	Main deck & escape route	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Penguard Topcoat, Lt Grey RAL7035	200 200 50
		Total	**450**
14	Compartment deck, work deck	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Hardtop AS, Lt Grey RAL 7035	200 200 50
		Total	**450**
15	Main exterior exposed areas: Bulkheads, deckheads, machinery & storage space & ext.	Jotamastic 87 Aluminium, Aluminium Jotamastic 87 Aluminium, Aluminium RT Hardtop AS, White	125 125 50

	Applicable Areas	Paint Name	DFT (microns)
		Total	**300**
16	Area behind insulation & paneling. Flat surface, stiffeners, etc.	Penguard Primer, Red Penguard Primer, Grey	50 50
		Total	**100**
17	Dirty oil tank, contaminated drain tank and bilge holding tanks.	Tankguard Storage, Red Tankguard Storage, Lt Red Tankguard Special Topcoat, White	100 100 100
		Total	**300**
18	Preload, clean drain holding, void spaces, double bottom tank & misc. loose tanks, incl. piping	Balloxy HB Light, Lt Green Balloxy HB Light, Lt Beige Total	150 150
		Total	**300**
19	Potable water tanks incl. piping	Penguard Primer, Red Penguard HB, Grey Penguard HB, White	50 125 125
		Total	**300**
20	Brine tank including piping	Balloxy HB Light, Lt Green Balloxy HB Light, Lt Beige	200 200
		Total	**400**

4.7.7. Helideck

Paint used on the helideck or in connection with the helideck shall be of a type with a low flame-spreading rate, non-slip and low smoke development.

4.7.8. Cathodic Protection.

The hull, legs and leg footings are protected by sacrificial anodes. The anodes provided should give protection for a minimum of 5 years to operate in offshore environments anywhere in the world.

Buffer tanks and thruster nozzles will have anode protection.

Anodes with bolted connections shall be fitted in all SW tanks. In double bottom tanks the anodes may be fitted on the bottom structure only.

In side tanks they shall be fitted throughout the height of the tank. The anode capacity shall be determined on the following basis:

- Design life – 5 years
- Immersion ratio – 50% of time
- Immersed area – all bottom and side shell structure
- Current density on immersed area – 5 m A/m2

Maximum anode size not to exceed 25kg.

External Sacrificial Anodes to be fitted to underwater area of hull.

Sacrificial aluminum anodes shall also be installed, with bolted connections, in the following locations:

- Thrusters
- Sea chests
- Legs
- Spud cans

4.7.9. New Park Deck Covering / Cargo Tie Down System (Option)

The composite deck covering serves to protect the steel from damage. The deck covering is arranged within a steel grid, so that, recessed cargo tie down points are available to secure cargo and equipment. Additionally, this material should provide sound attenuating properties. The proposed manufacturer of this material is Newpark Durabase . No other alternative will be excepted for this application. The top coating of the steel deck for over which the Durabase shall be applied will be approved by the Durabase vendor before the application is put down over the main deck steel.

5. DECK EQUIPMENTS

5.1. HATCHES

5.1.1. General

The access/escape hatch covers shall be capable of being opened by one (1) person and

shall be operable from both sides. It shall be possible to secure the covers in open position. The covers shall be equipped with counterweights or similar arrangements as necessary.

Access/escape hatches with coamings lower than 750 mm shall be equipped with a permanent rigid railing of 1 meter. Where this is difficult to arrange in a practical manner, alternative arrangements providing an equivalent safety level may be provided. The railing for protection of access opening shall be good for an effective hand hold during ascent or descent through the opening.

The access and ladder arrangement shall be such as to permit ascent and descent with self-contained breathing apparatus (compressed air apparatus). Furthermore, it shall be possible to get a grown person on a stretcher via the escape/access hatch.

The access around hatches shall be at least 600 mm wide and free of obstructions. There shall be a free vertical height of at least two (2) meters above inclined ladders. Hatch coamings of a height of more than one (1) meter shall be furnished with necessary steps and handrail on the outside to give a safe access.

Flush hatches shall have a load factor equal to the surrounding structure.

5.1.2. Guarding of Openings

Hatchways open for handling cargo or stores, through which persons may fall or on which they may trip are to be fitted with guard rails or fencing. The guard rails or fencing should not have sharp edges and suitable stops or toe boards should be provided. Each course of rails should be kept substantially horizontal and taut throughout their length. Guard rails or fencing should consist of an upper rail at a height of one (1) meter and an intermediate rail at a height of 0.5 meters. The rails may consist of taut wire or taut chain.

For smaller hatches, typically stores hatches, rigid, removable rail sections are to be constructed which comply with the above rail height requirements and include integrated toe board to stop small objects rolling over the edge into the hatches.

5.1.3. Hatches and Covers

All hatches shall be made of steel. Small hatches from open deck shall have central closing. All hinges shall have lubrication points.

All exits shall be fitted with opening mechanisms that are easily handled from the inside. Emergency hatches shall be spring-loaded or weight loaded for easy opening.

5.1.4. Main Deck & Access Hatches

Flush hatches for access and removal of equipment will be arranged in the main deck as per the GA. Hatches will be waterproof and have a design load equal to the surrounding structure. Hatches will be completely flush and have recessed lifting points for lift by deck cranes

5.2. DECK CRANES

Two (02) Ram Crane units of Leg-encircling pedestal mounted cranes are installed on forward port and starboard legs. The crane cabs are arranged to be on the inboard side of the vessel in the lift operation.

All components will be suitable for operation in a marine environment. The cranes shall be diesel hydraulically powered. The main and auxiliary cranes shall comply with the lifting appliance rules as per Class requirements and shall be supplied with both design and manufacturing certification accordingly.
Cranes are of winch luffing lattice boom type with main & auxiliary load winches installed. SWL capacity of cranes is reeved to be 500 kips (226 MT) at 45feet (14.2 m) and 88 kips (40 MT) at 129 feet (40 m) respectively.

The two cranes are equipped with hook load and boom angle indicator and auto overload warning devices.

The leg encircling crane is a jack tower mounted with fixed lattice-type boom, marine crane design and built in accordance with API Specification 2C, 6th Edition. The crane includes the following features:

- Bearing with internal swing drive gear
- Frame type gantry
- Jib for fast-line and Intermediate
- Ladders and platforms for access
- Fully enclosed operators cab with console to house all control functions and gauges
- Open/closed loop hydraulic system to operate all functions
- Load cell for main hoist
- All sheaves include anti-friction bearings
- Parts and maintenance manual provided

5.2.1. Boom

- 129 feet Lattice type boom of tubular construction
- Positive boom stops for boom hoist

- Flood lights for Hazardous Area Zone II (boom only)
- Automatic boom kick outs
- Angle indicator, pendulum type
- Load Indicator for Hazardous Area Zone II (boom only)

5.2.2. Gantry

- Frame Construction
- Ladders with safety cage to A-Frame sheave maintenance platform
- Anti friction bearings on all sheaves
- Flood light

5.2.3. Pedestal

- Overall Height (4') Four Foot
- Single flange

5.2.4. Operator's Station

- Cab is fully enclosed with safety glass with Air Conditioning
- Front and side windows
- Pilot valves for all functions
- Console for control functions and gauges
- Windshield Wipers
- Lighting

Main Hoist Load Chart

BOOM RADIUS (Ft)	BOOM ANGLE (Degrees)	STATIC RATING (X 1000 lbs)	DYNAMIC RATING (X 1000 lbs)
34	80	500.00	333.333
35	80	500.00	333.333
40	77	500.00	333.333
45	75	500.00	333.333
50	72	445.462	296.975
55	70	400.351	266.901
60	67	362.750	241.834
65	64	330.927	220.618
70	62	303.643	202.429
75	59	279.989	186.660

80	56	259.285	172.857
85	53	241.008	160.672
90	50	224.754	149.836
95	46	209.344	139.562
100	43	194.592	129.728
105	39	180.223	120.149
110	35	165.995	110.663
115	30	164.529	109.686
120	25	136.314	90.867
125	17	118.630	79.086
129	0	87.918	58.612

Basis of rating:

- Auxiliary hoist maximum safe working load - 12,000 lbs at all radius.
- Static ratings are for lifting and landing loads on the platform.
- Dynamic ratings are for lifting and landing loads on a floating vessel.
- Rating does not include weight of hook block, overhaul ball, slings and rigging.
- Load chart radius from center of rotation to center of gravity of LOA

5.2.5. Hydraulic System

- Open/closed loop system
- Swing consists of swing drives with static brakes
- Hydraulic pumps
- Components include all necessary hydraulic equipment needed for a fully functional and smooth operating crane
- All control valves allow precise variable speed control
- Air cooled oil cooler
- Hydraulic tank

5.2.6. Prime Mover

- Diesel engine to drive hydraulic units
- Fuel tank
- Engine fully accessible through engine housing
- Radiator cooled
- Platform, ladders and handrails for safety and accessibility

5.2.7. Winch Performance

Main Hoist

- Planetary geared

- Employs power load lowering (no freewheeling) against a hydraulic counterbalance valve with internal, automatically applied spring-loaded fail-safe brakes.
- 2,000 foot 1-1/2” diameter wire rope

Intermediate Hoist

- Planetary geared
- Employs power load lowering (no freewheeling) against a hydraulic counterbalance valve with internal, automatically applied spring0loaded fail-safe brakes
- Hydraulic
- 1500 foot 1” diameter wire rope

Auxiliary Hoist

- Planetary geared
- Employs power load lowering (no freewheeling) against a hydraulic counterbalance valve with internal, automatically applied spring-loaded fail-safe brakes.
- Hydraulic
- 400 foot 3/4” diameter wire rope

Luffing Hoist

- Planetary geared
- Employs power load lowering (no freewheeling) against a hydraulic counterbalance valve with internal, automatically applied spring-loaded fail-safe brakes.
- Positive locking ratchet and pawl
- Hydraulic

5.2.8. Swing

- Swing brake, fully enclosed
- Infinite variable speed control
- Swing gear reducers
- Hydraulic gear motors

5.2.9. Engine Controller

- Engine controls to be electric
- Pneumatic throttle

5.2.10. Safety Equipment

- Load Indicator – Main Hoist
- Angle Indicator – Pendulum Type
- Boom control – Automatic Max. / Min. boom kick-outs
- Positive Boom Stops
- Anti-two block for main and auxiliary hoist
- Fire extinguisher

- Signal Horn

6. MARINE EQUIPMENT

6.1. MANOEUVRING MACHINERY AND EQUIPMENT

6.1.1. Maneuvering Control

Control stations shall be arranged in Wheelhouse level by for all thrusters, the control stations in wheelhouse shall be arranged as follows:

- One (1) Navigation and control position fwd wheelhouse
- One (1) Portable joystick outlet Starboard side
- One (1) Portable joystick outlet Port side
- Controls will be arranged to the left and right of the captain's chair, so that, the captain is nearest the leading wheelhouse window to provide clear visibility of the Vessel's bow.

6.1.2. Thrusters

The Vessel shall be fitted with three (3) Schottel Ruderpropeller Type SRP 1012 FP which shall be rated to approximately 3 x 1,100 kW.

The Vessel shall be fitted with one (1) Schottel Tunnel Thruster Type STT 2 FP. Which shall be rated to 1 x 570 kW.
All thrusters shall be fixed pitch and variable speed. The thrusters shall be electrically driven. All thruster systems shall be remotely operated from the wheelhouse by the Thruster Control System provided by Schottel and shall be interfaced with the DP/Joy-Stick Control System provided by Imtech / Praxis Automation.

Stopping of thruster motor shall be possible from the control panels in wheelhouse, and from local control panels in the thruster spaces. In the wheelhouse, controls will be arranged to the left and right of the captain's chair, so that, the captain is nearest the leading wheelhouse window to provide clear visibility of the Vessel's bow.

6.1.3. Thruster and Propulsion Control

Operator positions for manual and automatic thruster control shall be installed in the following locations:

- Forward bridge

- Port Bridge (portable joystick outlet)
- Starboard bridge wing (portable joystick outlet)

The installation positions of thruster control system should be such that, it ensures clear view of the vessels bow.

Thruster control shall be executed in three (3) different ways:

- Via Thruster Remote Control System provided by Schottel
- Via DP1 System provided by Imtech / Praxis Automation
- Via Independent Joy-Stick System provided by Imtech / Praxis Automation
  (The independent Joystick Control System complements the Dynamic Positioning System DP1 in order to fulfill the rules of IMO DP1)

6.1.3.1. Thruster and Propulsion Remote Control System

This is a full-follow up (FFU) electric steering system with non-follow up (NFU) back-up system.
The thrust of each azimuth thruster can be directed to any desired direction around the vertical axis either by turning the steering lever or through external systems using a 4-20 mA signal.

The Propulsion & Thruster control system is a microprocessor based system. Following main functions are included:

- Thruster motor speed setting, allowing accurate and reliable control of the motor speed via convertes for prime mover
- Thruster direction control, allowing accurate and reliable control of the thruster direction
- Follow-up control via control lever for speed and direction
- Non-Follow-up backup control via push-buttons for speed and direction

Interfaces to External Systems:

- Interface to frequency converter for prime mover
- DP1 System interface
- Independend Joy-Stick System interface
- Autopilot System interface
- VDR System interface
- Conning System interface

6.1.3.2. Dynamic Positioning System DP1

The DP1 Dynamic Positioning System shall automatically control vessel's heading and position by activating thrusters based upon data as received from position reference systems, gyrocompasses, wind sensors and motion reference units.

It shall have at least the following operational modes:

- Auto Position Mode (Station Keeping):
  (The position of the vessel is kept automatically to set position and the heading is kept automatically to the set heading
- Auto Position-Joystick Mode
  (As long as the Joystick is in neutral position the function is same as in Auto Position Mode.
  As long as the Joystick is out of neutral position the vessel can be controlled via Joystick in Surge direction only
- Autopilot Mode
  (The vessels heading is kept to the Set Heading and the operator has the ability to control the speed of the vessel by Joystick control (forward direction).
- Auto Track Mode
  (The operator has the ability to fill in a way-point table on the DP Operator Workstation. In this mode the vessel moves automatically along pre-programmed tracks according to a Set Track Speed)

6.1.3.3. Independent Joy-Stick System

An Independent Joy-Stick System shall be provided by Imtech / Praxis Automation with a portable operator unit for operating by connecting to plug-in sockets in above mentioned operator positions.
The system shall allow the operator to automatically control the heading and manually position the vessel based upon data as received from gyrocompasses and wind sensors.

It shall have at least the following operational modes:

- Joystick Manual Heading Mode
  (The operator manually controls the position and heading of the vessel using the joystick with integrated heading knob)
- Joystick Auto Heading Mode
  (The operator manually controls the position of the vessel via Joystick and the heading is kept automatically to the set heading

6.1.3.4. Gyro Compasses

The Vessel shall be fitted with two (2) separate gyro navigational compasses located in at least two (2) separate compartments. The gyro compasses shall be arranged for digital output. They shall be IMO Wheel mark approved.

6.2. NAVIGATION & EXTERIOR COMMUNICATION SYSTEM

6.2.1. General

The layout of the bridge shall be in accordance to Class requirements. The design of the structure will follow best practice for safety and functionality.

Selected windows shall have nozzle for defrosting system. All windows shall be equipped with solar reflective blinds. Some windows shall have electric heating and external screen wipers and washer system

The Vessel shall be outfitted with new navigation equipment for navigation and operation of an offshore MOU according to rules and regulations.

All cables for navigation installation shall be Class approved types and shall be fixed according to Class requirement.

Bridge operator stations for all subsystems, including the navigation system, shall be provided in consoles.

The bridge arrangement and antenna arrangement shall be approved by the Owner/Levingston, Class and Flag Authority.

All navigation equipment provided shall be of IMO approved type, supplied with IMO certificates, and shall be of high standard and of a recognized brand. The navigation equipment shall have all interfaces necessary to fulfill the requirement stated in Class and Authority rules.

6.2.2. Navigation System

The system shall be complied with Class Requirement and at least consisting of the following:

	Description	
	Furuno 3CM ARPA Radar, Model FAR-2117 BB	
	Furuno 10CM ARPA Radar, Model FAR-2137S BB	
	Furuno DGPS Satellite Receiver, Model GP-150	
	UPC 3002, SLS 2-6 NMEA distribution box	
	Lilley & Gilley Walker 2080 MkII	

	Furuno Automatic Identification System, Model FA-150	
	Furuno IMO/SOLAS Echo Sounder FE-700	
	Furuno Doppler Log, Model DS-80	
	Furuno Depth indicator DS 830	
	Furuno Voyage Data Recorder, Model VR-3000	
	Anschütz NautoPilot 5100	
	Gyro Compass (as above mentioned)Anschütz STD22	
	Std. Magn. Compass Binnacle REFLECTA 1 - cutube version	

6.2.3. Exterior Communication System

The system shall be complied with Class Requirement and at least consisting of the following:

	Description	
	Furuno Navtex Receiver NX700A	
	Furuno Inmarsat-C Felcom-18	
	Furuno Inmarsat-C Felcom-18 SSAS	
	Furuno VHF Radiotelephone FM-8900S	
	Jotron EPIRB Tron 40S MKII	
	Jotron Radar Transponder Tron Sart20	
	Jotron portable VHF Tron TR-20	
	GMDSS equipment c/w A3	
	GMDSS Power Supply	
	Furuno VHF Radiotelephone FM-4721	
	Motorola GP380 ATEX UHF	
	Aeronautical VHF/AM, portable, ICOM IC A6	
	Helibeacon, Southern Avionics SE125	

6.2.4. Clinometers and Roll/Pitch Indicators/Loading Calculator

Two (2) Clinometers, located one (1) in wheelhouse and one (1) in engine room. A load calculation program shall be installed in network, included the tank sounding program. The data shall be updated when the stability calculation is final. An office version of the load calculation program shall be delivered to the Owner/Levingston.

6.3. ANCHORING AND MOORING EQUIPMENT

6.3.1. Anchors

One (1) 2,000 kg high holding power hand winch for emergency anchor only shall be provided. The anchor will be installed on a billboard installed on the deck at 60º to the horizontal capable of quick deployment upon releasing of securing ties.

6.3.2. Anchor , Cables and Shackles etc.

One (01) anchor complete with anchor wire rope to suit 480 kg. shall be provided. Steel wire rope has to be 275m in length with thimbles eyes at one end.

6.3.3. Fixed Mooring Equipment

The fixed mooring equipment should comply with relevant rules. The following should be provided as a minimum:

- Six (6) double bollards
- Four (4) smith brackets
- Four (4) panama chocks

Bollards shall be of welded design and shall be welded to the deck.

6.3.4. Loose Mooring Equipment

Hawsers and ropes to be delivered to meet the recommendation of the Classification.

6.4. WORKSHOPS, REPAIR AND MAINTENANCE EQUIPMENT

6.4.1. Workshops and Storage Spaces

As a minimum, the following work and storage areas shall be provided in the Vessel.

6.4.1.1. General Workshop

Location as per GA on tank top adjacent to engine room

Minimum outfit:

- One combination lathe milling machine
- One pillar drill with drill bit pack
- One automotive bar saw
- One electric welding transformer 400amp with cable, hood electrode carrier, gloves
- Outlets for 220/110 volt power tools
- Outlets for high pressure air
- Outlets for oxy / acetylene with hoses and fitting
- Work bench with vice
- Lockers and shelving to builder standard
- Forced air ventilation with extractor hood over welding area
- One double wheel bench grinder
- 03 ton overhead gantry rail with chain hoist (air operated) rail to run from aux engine room to centre of workshop

6.4.1.2. Store Room

Location as per GA on tank top adjacent transformer room.

Minimum outfit :

- Shelving and lockers to Builders standard according to space available
- Forced air ventilation

6.4.2. Electrical Workshop

Location as per GA on tank top adjacent engine room

Minimum outfit

- Workbench with small vice
- Wall mounted test panel with capability 3 phase 440V AC, 230V AC (10A) single phase 0-30V AC (10A) and 0-23V AC (2.5A) and DC range 5-110V (10A). Panel should include test facility for fluorescent take and starters
- Sufficient 220V and 110V outlets for test equipment and hand tools
- Compressed air outlets with shut off valves
- Shelving and lockers to Builders standard and as space will allow
- Forced air ventilation

6.4.3. Deck Workshop(Option)

Location as per GA aft side of accommodation block adjacent to hospital.

The deck workshop is a space primarily designed to support work on deck and on the oil company's jacket, platform or alongside.

Outfit will generally be advised by Owner/Levingston to suit the type of vessel operations but as a minimum should include:

- Outlets for all services air, hot/cold ware and adequate 440V, 230V, 110V outlets
- Work bench with vice and double wheel grinder
- Clothes and tool lockers
- 03 ton overhead gantry rail with travelling chain hoist (air operated)
- Outlets for oxygen / acetylene with hose and torches
- One 400A welding transformer with 50m leads/ hood/gloves
- One welding station with suction overhead
- Forced air ventilation

In general, Builder to provide shelving, workbenches etc as appropriate for the above spaces.

Tools shall be provided as required for maintenance of all Builder-supplied equipment and systems. Space shall be provided for Owner supplied tools and equipment (requirement shall be advised by Owner/Levingston).

An acetylene/oxygen bottle room shall be arranged in the Deck Workshop, fitted with a non-return valve for each gas cylinder, high-pressure hose, manifold, stop valves, regulators and pipes with outlet stations.

Outlet stations: Two (2) on main deck, one (1) in each workshop (except el-workshop).

Testing calibrators for E0 testing of oxygen and gas sensors, temperature sensors and pressure sensors shall be supplied, according to Buyer's standard.

6.5. LIFTING AND TRANSPORT EQUIPMENTS

6.5.1. Pad Eyes (Option)

Certified pad eyes shall be located overhead where required for maintenance of equipment. Lifting capacities shall be approved by Owner/Levingston.

In addition, an allowance of twenty (20) off 'D' ring type recessed, pad eyes, average rating 15t SWL, shall be included by Builder, to be located on main deck level to be agreed during the design phase. All lifting equipment, including pad eyes, shall be load

tested and marked with the SWL.

6.5.2. Deleted

7. ACCOMMODATION, LIFE SAVING AND SAFETY SYSTEMS

7.1. ACCOMMODATION AND LIFE SAVING EQUIPMENT

7.1.1. LIFESAVING EQUIPMENT

7.1.1.1. Mob-Boat and Life Boats

If required and after discussion with Class, one (1) MOB boat shall be fitted. The MOB boat shall be approved by SOLAS as a Fast Rescue Craft (FRC).The MOB-boat shall be delivered and installed according to GA. The MOB-boat shall be handled by its own davit/crane which shall be fitted with constant tension device, and delivered acc. to rules for man riding. This will remain an option until confirmed.

7.1.1.2. Life Boats

Four (4) totally enclosed lifeboats with diesel engines, and capacity of eighty person per each and shall be installed as per GA on main deck. NDM(Ned-Deck Marine) Hydraulic Davits shall be installed for handling life boats.

7.1.1.3. Life Rafts with Equipment

Four (4) x twenty five (25) man life rafts shall be installed on each side of the Vessel.

Two (2) launching davits shall be provided by NDM . They shall be manual type and installed one (1) on each side. Survival suits with offshore standard, for all beds (160) shall be delivered. In addition the same type of survival suits equivalent in number to 50 % of the POB capacity shall be kept at each lifeboat station. These suits shall be stored in lockers, which are clearly marked and cannot be locked. The Owner/Levingston shall approve size and type of suits. Survival suits to be NMD/MOU (2005 Red Book) approved. Lifebuoys shall be provided according to Class and other rule requirements.

Life jackets as by rule requirements in lockers on muster station. All equipment shall be of approved type. All life jackets, life buoys and survival equipment shall be marked with the ship's name and homeport. Safety danger and rescue plans shall be put up on

the bulkheads in the LSA areas.

7.1.1.4. Emergency Marking

All escape routes shall be marked with illuminating signs at the floor level. Under deck and in the engine room the escape routes shall be clearly marked by means of painted arrows pointing to exits. Outside all escape routes shall be painted yellow. Marking should also be done at eye level if necessary.

7.1.1.5. Medicines and First-Aid Equipment

Medicines according to SOLAS and Owner's medical list shall be delivered, details to be defined at a later date.

7.1.1.6. Loose Fire Fighting Apparatus and Equipment

Accommodation spaces, machinery spaces, service spaces and other areas, shall be provided with a sufficient number of certified portable fire extinguishers, according to rule requirements.

In addition one portable dry-powder extinguisher shall be provided for each generator room, each fitted with a kink-free hose containing at least 25 kg powder, and also at least one certified portable foam applicator unit.

As general fire extinguishers shall have total weight not exceeding 20 kg, CO2 extinguishers shall have a CO2 charge of at least 5 kg; water extinguishers shall have a charge of at least 9 Liters. Dry powder extinguishers shall have a charge of at least 12 kg.

Sufficient quantities of recharging material for the portable fire extinguishers shall be provided by the Builder at the time of delivery.

Glass cabinets containing axe and torch shall be fitted near all exit doors to deck in line with the agreed escape plan.

The Vessel shall be fitted with work vests, chemical suits, first aid boxes, eye wash and safety showers as per regulations.

The Vessel shall be provided with at least 4 sets of fireman's outfits. (30 min. capacity)

Each set of fireman's outfit shall include, one (1) certified self-contained compressed air breathing apparatus set. The outfits shall be stored in minimum two separate compartments. 120 x escape B.A. sets to be provided (15min. capacity and suitable for H25).

One (1) high pressure compressor suitable for filling air bottles for compressed air-operated breathing apparatus shall be provided, along with adequate spare bottles.

The compressor shall have a capacity of at least 75 liters free air per minute. The compressor shall be located where the air is clean enough to be used as breathing air.

Fixed breathing air (cascade) system to be fitted with compressors and B.A. sets – to be confirmed by Owner/Levingston.

One (1) portable certified UHF radio set for internal communication for each set of fireman's outfit, extinguishing supervisor, technical fire team, and wheelhouse, will be provided. The radio sets may be used for other internal communication on board but the required number of sets shall always be available in case of fire.

The UHF sets shall have connecting cables for smoke diving equipment.

The Hose stations shall be marked with "Fire Hose". Hose station equipment in accommodation, if required, shall be kept in locker built in flush with bulkheads. Fire hoses and nozzles acc. to rules and regulations. Fire coupling according to rules. There will also be two (2) 1250 GPM Battle Cannon type Fire monitors mounted at the highest point on the bow , Port and Starboard to furnish Fire Fighting protection when jacked up on location.

Portable extinguishers and other crash equipment at helicopter deck according to UK CAA CAP 4.37 and Norwegian CAA requirements (or equivalent).

7.2. INSULATION, PANELS, BULKHEADS, DOORS, AND WINDOWS

7.2.1. Accommodation, General

The arrangement shall be according to GA-Plan. The accommodation shall be arranged for one hundred sixty person (160) . The living quarter shall be arranged for both male and female. Cabin arrangement according to GA, with communal shower/WC facilities.

Hatches for pipes, ventilators, cables etc. shall be arranged where necessary. Access blind passageways of more than 5 meters in length shall have an emergency exit / escape route. The emergency exits / escape routes shall have a width of at least 600 x 800 mm.
Height in accommodation shall in general be 2200mm from top finish floor to lower edge ceiling, ceiling shall be arranged in cooperation with joiner contractor.
In general bulkheads solutions shall be total 50mm panels between the cabins,

Free width in corridors shall be at least 900 mm and shall be provided with minimum one (1) handrail. Corridors of more than 1600 mm width shall have handrails on both sides.

All doors, corridors and passages shall be constructed so that an injured person on a stretcher can be carried through and so that they allow passage with portable breathing apparatus strapped on.

Corridor bulkheads, including doors shall satisfy the requirements for fire-safe Class A or Class B divisions.
Stairways shall be made of steel or equivalent material. A stairway connecting two (2) decks shall be enclosed on at least one (1) of the decks. The enclosure shall be of steel or non-combustible bulkhead Class B.

Stairways connecting more than two (2) decks shall be enclosed on all decks.

7.2.2. Insulation, Bulkheads and Paneling

Special consideration shall be made towards requirements for both sound and fire. External floors, ceiling and bulkheads in living quarters which are exposed to the water and/or are bounded by machinery, equipment, works area, etc. shall be adequately insulated.

The insulation material shall be laid in such a way that condensation is avoided and be securely fastened.

Ceilings, linings, bulkheads and insulation, except for insulation in cooling and refrigerating rooms, shall be of non-combustible material.

Vapor barriers and adhesives used in connection with insulation and also insulation materials for cold water pipes need not be of non-combustible materials.

The use of such materials shall nevertheless be as restricted as practicable and uncovered surfaces shall have low flame-spread characteristics.

Insulation against shipside, outer walls and deck shall be approx. 50 mm fireproof mineral wool.

The insulation shall be calculated in accordance with design conditions, according to the requirements of B0 ceiling.

Air spaces enclosed behind ceilings, paneling or linings shall be suitably divided by closefitting draught stops not more than 14 m apart.

A complete module based incombustible partition and ceiling system shall be used for the whole accommodation. Included in the system shall be all internal doors complete with frames and hardware. Plastic laminate as surface material shall be used throughout the accommodation. All to be in accordance with the regulations. Store rooms shall be paneled with Warkhaus or similar panel.

Special noise and heat insulation shall be provided against the emergency generator room, ventilation room and the casing, below the main deck and wherever required to meet maximum sound requirements as laid down by the authorities. A unique design feature of this MOU is certain accommodations below deck.

All wet-rooms shall have 200 mm steel coaming.
Bulkheads surrounding engine spaces, heated tanks, and areas with low and/or high temperatures bounding directly on living quarters, and also hot water pipes in living quarters shall be adequately insulated.

7.2.3. Doors with coamings in accommodation

Doors in accommodation shall be type B - 15 covered with 1.5 mm plastic laminate on both sides or as Alve doors or similar in steel with panels. Coamings shall be of steel. Door frames in living quarters shall have an interior width of at least 700 mm.

Door frames in doors to sanitary rooms and to toilet enclosures in common sanitary rooms nevertheless have an interior width of 600 mm. The door frame to the hospital shall have an interior width of at least 850 mm.

Doors to cabins shall be equipped with a kick through panel or be un-lockable.

The height of thresholds in doors in escape routes and in doors with heavy traffic shall not be made unnecessarily high. Doors to accommodation may be provided with a small closable ventilation grill in the lower part.

All doors and hatches in emergency exits shall open in the direction of the escape route and shall be easily opened from each side by one (1) person.

The dog bolts of steel doors shall be marked with the direction of openings or closing and be arranged so that they are locked in the open position. Doors in escape routes shall have centrally operated dog bolts. It shall not be possible to open doors which give direct access to a stair leading to a lower level, unless a suitable landing has been arranged in connection with the stair.

Doors to stairways shall be type A –0. Doors in stairway enclosures shall be close-fitting, self-closing and without ventilation openings.

Self-closing doors shall not be capable of being kept open by means of a hold-back hook. Doors may be kept open by means of magnetic door holders or the like which are released in conjunction with the fire alarm system or which can be remote-released.

All fire doors shall be equipped with self-closing device. All steel doors shall be painted in epoxy, if not laminate covered F- laminate according to rules.

Ventilation opening below the bathroom doors.

All doors shall have handles and a master-key system. Doors to galley and casing shall be A-0 steel doors.

7.2.4. Watertight Doors

Necessary numbers of remote controlled sliding doors in bulkheads below main deck according to GA.

Any remote operated sliding doors shall have indicating panel on the bridge and main deck with light and buzzer alarm. The sliding doors shall be remote-operated from bridge and main deck, electrical operated, both opening and closing. Local emergency control will be fitted.

7.2.5. External doors with Coamings

Doors from open deck to wheelhouse accommodation, storerooms etc. shall be steel doors with steel coaming.

Doors with dog bolts shall be operated centrally.

Doors to accommodation shall have windows or portholes. Doors to main deck are to be weather tight.

All doors shall have handles and master-key system.

7.2.6. Windows

7.2.6.1. Wheelhouse

Windows in wheelhouse according to GA-Plan. Blind covers according to the rules. The window frames shall be welded to the wheelhouse.
Selected windows in wheelhouse shall have window wipers.

Selected windows in wheelhouse shall have fresh water flushing with means for air-blowing of the system.

Solar Blinds shall be provided for all wheelhouse windows.

7.2.6.2. Accommodation

Windows in all living rooms and portholes at main deck level will be to Class standard.

7.2.7. Security

All doors to main control areas shall be fitted with numeric keypad or similar entry system.

Dark stairwells, i.e. up & down from bridge shall be illuminated by discrete built-in low level lighting.

7.3. INTERNAL DECK COVERING, LADDERS, RAILINGS ETC.

7.3.1. Deck Base Covering, Internal

Steel deck in accommodation shall be covered with 8 - 10 mm Semtex/Weber or equal underlay. Floating floor shall be arranged to comply with all noise regulation if required and as per Noise and Vibration study report.

7.3.2. Deck top covering, internal

Fire retardant carpets or equivalent shall be installed in all VIP cabins and Prayer Rooms. All carpet will be of a industrial, easy-clean standard.

Vinyl flooring(such as Kentile/Polyfloor) not less than 2 mm thick shall be laid in all cabins, working passageways, offices, dirty conference room, dry provisions rooms, stores, linen rooms, cleaning gear rooms, gymnasium, and in the hospital. Vinyl tiles shall not be used

Rubber/Vinyl of approved type shall be used in the switch board rooms and control rooms containing electrical equipment.

Control and switchboard rooms shall have raised floor covering main and secondary beams with adjustable legs. Top floor shall be electrostatic conductive.

In galley, change room, coffee shops, sanitary rooms and other wet-rooms Epoxy cover shall be used.

The floor / wall junction shall be designed as to make it easy to keep clean. Stairs in accommodation shall have light metal anti-skid nosing.

Storeroom floors will be painted.

Bridge shall have raised floor.

7.3.3. Ladders, Handrails

Ladders/handrails according to the Builders standard. Handrails on both sides in all stairways. Handrails in engine rooms and thruster rooms shall be of seamless steel and unpainted.

7.3.4. Floor plates, platforms and ladders in engine room etc.

Loose floor plates in engine rooms, propulsion rooms, thruster rooms and emergency generator room shall be made of galvanized grating . Steel plates, screwed or tag welded onto steel beams shall be provided at other locations.

All escape routes in engine room shall be of steel. Above valves, mud boxes, filters etc. removable floor plates shall be fitted.

Further ladders, steps, rail stanchions and handrails, grating and platforms shall be arranged where necessary for access.

Ladders in engine room and propulsion room shall be removable/welded. Handrails in engine rooms and propulsion rooms shall be removable/welded.
Gratings and ladders shall be provided in casings as required for maintenance and inspection.

7.3.5. Ladders, Platforms and Steps in Tanks

Stairs shall be placed in routes where the difference in level is more than 450 mm. Permanent ladders may be permitted in cargo rooms, storerooms, tanks etc. and on cranes where it is impracticable to arrange stairs.

In principle the ladders shall be inclined. However, vertical ladders may be permitted where it is difficult for practical reasons to arrange inclined ladders.

For practical reasons, should it be not possible to arrange fixed ladders/stairs, removable ladders/stairs may be permitted provided they can be securely fastened.

Fixed ladders shall be placed at all points where it is necessary to climb more than 1.5

meters to carry out inspections.

Ladders in ballast tanks shall be bolted and coated as per the tank coating.

7.4. EXTERNAL DECK COVERING

7.4.1. Deck Covering, External

Suitable platforms shall be arranged above cable or pipe-lines which cross passageways. Openings in the deck, passageways, and platforms etc. which are more than 100 x 100 mm shall be covered with rigid grating or be protected by railing, or the like. Anti-skid paint shall be applied along walkways.

7.4.2. Hand Rails, Railings and Rail gates

Rails shall be provided on all decks where no bulwarks are provided. Storm rails shall be fitted outside of the accommodation where necessary. Pipes and stanchions shall be hot galvanized.

Decks, passageways, scaffolding, and platforms which are 800 mm or more above the level below, shall be furnished with fixed strong railing with toe boards along the outer edge. Railings at main deck level will be fitted with continuous toe boards where spillage of liquids overboard may occur. These to be fitted with removable drain ways for transit mode.

An alternative arrangement to fixed railings may be accepted if, for practical reasons, it is impossible to arrange a fixed railing.

The height of railings, hand ropes, etc. shall be to rule requirements and at least 1 meter from deck to upper rail. The distance between stanchions shall be maximum 1.5 meters. Front of barge hand rails will be removable for gangway access –total bow area.

7.4.3. External Ladders and Steps

Stairs shall be placed in routes where the difference in level is more than 450 mm. Permanent ladders may be permitted on cranes where it is impracticable to arrange stairs.

In principle the ladders shall be inclined. However, vertical ladders may be permitted where it is difficult for practical reasons to arrange inclined ladders.

For practical reasons, should it be impossible to arrange fixed ladders/stairs, removable

ladders/stairs may be permitted provided they can be securely fastened. Fixed ladders shall be placed at all points where it is necessary to climb more than 1.5 meters to carry out inspections.

Stairs shall have railing on both sides and the inclination shall not exceed 50°. The steps shall be at least
150 x 600 mm and shall be slip-proof in all directions. Steps in outside stairs and steps which may be exposed to oil spills, mud, etc., may be required made of self-draining grating. Railings shall have a vertical height above steps of at least 1000 mm and shall be furnished with at least one middle railing. The projection of the steps shall overlap one another.

Fixed vertical ladders shall have a breadth of minimum 350 mm and will be to Builder's standards.
All vertical ladders having fall backing on them.

7.5. FURNITURE

7.5.1. Furniture for crew

Furniture, cupboards, curtains, carpets etc. shall be Builders standard but shall comply with the following requirements: The Owner/Levingston is free to choose type and color of the complete interior based on typical country of operation standards. Furniture with drawers or cabinets or cupboards, desks, wardrobes, dressing tables, chests of drawers or dressing chests shall be made off with top surface finish with a noncombustible veneer not more than 2 mm thick.

Free-standing furniture such as chairs, sofas, beds and tables shall be made with frames of non-combustible material.

Curtains and other hanging textiles shall be made of materials certified in respect of their resistance to the spread of flames as determined in accordance with the FTP Code (IMO Fire Test Procedures Code).

Carpets shall be certified in respect of their low flame spread characteristics.
All rooms in accommodation shall be clearly marked with intended use and where appropriate, number of berth/persons.

Refrigerator shall be installed in selected offices, coffee shop, VIP cabins shall have 40 liters refrigerator integrated in cabinets.

All beds shall have min dimension of 2060 x 860 mm, mattress 2000 x 800 mm. Unless otherwise stated in the GA.

Two (2) drawers shall be arranged underneath each bed, minimum 0.06 m3.

The wardrobe lockers shall have locks. Size of lockers h=1800 mm and inside 450x600 mm.

The chairs and sofa benches in dayrooms, mess rooms, state and crew cabins shall have cover in IMO approved leather or cloth.

All cabins with windows shall have “blackout curtains”.

The upper bed in two-man cabins shall be fixed bed, (not Pullman type), w/ladders and bed horse. Free- standing furniture shall have means of securing.

Outer edge of shower recess in module floor shall be sloped in order to drain water back to the recess.

All changing/washrooms, all bathrooms, galley, common toilets, cleaners’ lockers and workshops with sinks shall have soap and toilet paper dispensers and paper holders and garbage bins.

7.5.2. Sanitary Rooms

Bulkheads and ceilings in sanitary rooms shall be of steel or another equivalent material and be insulated against external bulkheads.

7.5.3. Toilets

In addition to the toilets provided in cabins and in the main changing rooms, toilets shall be provided according to GA. All toilets shall have soap and paper dispensers and toilet paper holders and garbage bins.

If provided for in the G.A., one (1) Separate toilet with hand washing facilities shall be available for galley personnel, with one (1) toilet with hand washing facilities for engine room personnel with one

All doors in sanitary rooms shall be lock able.

7.5.3.1. Hospital

The hospital area shall have separate medic’s room adjoining the hospital for rapid response, with medicine lockers.

The hospital will be fully equipped in line with the GA and will have the following as a minimum.

One (1) Refrigerator for medical use

- One (1) Lockable medical / poison cupboard
- One (1) Office desk with drawers
- One (1) Office chair
- One (1) Work bench with lockers and drawers. Stainless steel top
- One (1) Chair
- One (1) Sink with hot and cold water
- One (1) Resuscitator
- One (1) Examination bench

The hospital shall have:

- Three (3) Beds
- One (1) Chair
- Two (2) Lockers
- Two (2) Bed-side tables

The bathroom shall have:

- One (1) Toilet
- One (1) Toilet roll holder
- One (1) Washbasin with hot and cold water
- One (1) Bathtub with hot and cold water and with shower
- One (1) Handle
- One (1) Soap dispenser
- Two (2) Paper dispensers
- Two (2) Double hooks for cloth and towels
- One (1) Mirror
- One (1) Shower set

7.5.4. Hospital Alarm

A hospital alarm system in hospital and sick-bay cabin shall be fitted with buzzer and indication light in galley and on bridge. Push-buttons shall be fitted at each bed and toilet. The buzzer and indication light shall be clearly marked. The system shall be supplied from the 24V DC system.

8. MAIN MACHINERY

8.1. MAIN MACHINERY

8.1.1. General

The machinery shall consist of a minimum of following main components and shall be in line with the requirements of the electrical single line diagrams, the piping system schematic drawings and the main equipment list:

- Three (03) Main Diesel Generators with 3-phase alternators, feeding the main electrical circuits of the Vessel
- Three (3) main propulsion units, including electric motors and electric drive systems with converters
- One (1) bow tunnel thruster, including electric motors and electric drive systems with converters
- One (1) emergency diesel generator
- Three (3) leg jacking systems
- Two (02) deck cranes

All machinery shall be of recognized marine type. Machinery and equipment shall be standardized to the maximum extent possible in order to facilitate maintenance and reduce spare part inventory.

The machinery shall be arranged for safe operation, easy access and minimum mechanical handling.

All components and systems shall be designed for operation under the environmental conditions and Class / Authority requirements as described in section 2, General.

The three (03) Main Generator sets shall each form an independent unit, including all the required accessories to make the power system and support systems complete and operational. For monitoring and controlling, the system shall be connected to the electronic remote control system with interface to the control system.

Flexible mounts shall be used between engine bed and foundations.

Torsion vibration calculations shall be provided by the supplier according to open water situations. Fuel for main diesel generators: Marine Gas Oil (DMA, DMZ) or Marine Diesel Oil (DMB)
Spare parts according to Class and manufacturers requirements shall be delivered. A recommended list for 2 years spares shall be supplied by the Builder for Owner approval.

8.2. PROPULSION MACHINERY

8.2.1. Propulsion Motors

Azimuth Thruster Motor
Three (03) of electric motors
Type – WH 450 L6, Make AEM
1100kW/690V 60Hz /0-1200rpm
B3/IP55 F.W Double Water Jacket 38dg.C
Max. Ambient temp. 45dg.C
Roller* bearings, DE- & NDE-side insulated seat including NDE ground earthing brush
Insulation class F / Temp. class F
3x Double PT100 in windings
2xDouble PT100 in bearings
Heating elements
Inclination level: -Static: 10º in any direction
-Dynamic: 15º in any direction

*Due to 0-100% rpm operation, sleeve bearings is not recommended.

Tunnel Thruster Motor
One (01) of electric motor
Type – WH355 L4, Make AEM
570kW/690V 60Hz / 0-1800rpm
V1 IP55, Double Jacket Water cooled 38dg.C
Max. Ambient temp. 45dg.C
Roller bearings, DE- & NDE-side insulated seat
Insulation class F / Temp. class F
3x Double PT100in windings
2x Double PT100 in bearings
Heating elements
Inclination level: -Static: 10º in any direction
-Dynamic: 15º in any direction

The motors should be oversized to take the additional heat losses caused by harmonic distortion. Further designed for constant torque till rated speed and constant load in the area of field weakness (overspeed) up to 1,300rpm.
s
The electrical propulsion motors shall be remotely operated from the wheelhouse

Power cables used between converters and electrical motors shall be suitable and approved for frequency converter drives.

8.2.2. Variable speed drives (frequency converters) for electrical propulsion motors

The frequency converters shall be water-cooled with output voltage according to propulsion motor voltage. They shall be fitted with a temperature alarm.

Technical data:

- Quantity 3 pieces for azimuth thruster, 1 pcs for tunnel thruster
- Rated power as above
- Method of cooling closed cooling-system with water heat exchanger equipped with a redundant pumping system
- Ambient temp. 45ºC
- Protected by Enclosure IP44

The speed drive control system shall provide rapid power reduction to avoid blackouts in case of failure of the power supply system. . Converter housings to have AC and filtered air supplies. The converters shall be mounted in the propulsion rooms.
One (1) converter for tunnel bow thruster will be similarly fitted to accommodate 570 kW thruster.

Schottel azimuth propeller plants with nozzles

Three (3) Azimuth propeller units with fixed pitch variable speed propellers shall be installedaft.
Design criteria:

- Power applied to input shaft : 1,100 kW
- Type…..... : FP
- Propeller diameter, about : 2100 mm
- Number of blades ……. : Four (4)
- Propeller speed, approx. . : 0 - 310 (rpm)

The propeller shall be designed for developing 100 % power at full speed, both in light and loaded Vessel condition. Special consideration shall be given for minimum fuel oil consumption. The propulsion units shall have electronic remote control from bridge, and shall be interfaced to control systems.

Thrust from full ahead to full astern shall be possible with the Vessel proceeding at full speed ahead as per Schottel and class requirement.

Schottel tunnel propeller plant

One (1) tunnel propeller unit with fixed pitch variable speed propeller shall be installed fore.
Design criteria:

- Power applied to input shaft : 570 kW
- Type…..... : FP
- Propeller diameter, about : 2100 mm
- Number of blades ……. : Four (4)
- Propeller speed, approx. . : 0 - 420 (rpm)

N/A

8.3. MAIN ELECTRIC POWER GENERATION

8.3.1.1. Main Diesel Engine

- Number of main diesel: three (3)
- Model: MAN Diesel & Turbo Generating Set 9L21/31
- Type: 4-stroke diesel
- Rating, diesel engine (MCR): 1940 kW
- Speed: 900 rpm
- Fuel: Marine Diesel Oil (MDO)

The diesel engines shall be arranged with following systems, built-on or separate:

- Lube oil system incl. priming pumps
- Cooling; heat exchanger
- Fuel oil system incl. supply pumps and coolers
- Engine pre-heater
- Air starting equipment acc. to Class requirements.
- Control air system
- Charge air system
- Electronic speed control system
- Engine safety and control system SaCoSone

8.3.1.2. Main generator

- Number of generator: (3)
- Model: HFJ7634-08P
- Rating: 2048kVA / 1843 kW
- Voltage: 690V

Frequency: 60 Hz

- Speed: 900 rpm
- Cooling method Air to water
- Type: Brushless, 3-phase synchronous for marine use
- Bearing: Anti-friction bearing; self lubricate
- Mounting: B20
- Enclosure: IP 44
- Terminal Box: Enclosed IP 44

- Cable Inlets: For cable inlets from below
- Insulation Class: "H"
- Temperature Rise: "F"
- Voltage characteristic: Constant Voltage
- Space Heater: 220 V / 630W
- Regulator: Mounted into switchboard or separate cabinet.

The generators shall further be equipped by MAN Diesel & Turbo with:

- Automatic voltage regulator w/low pass filter module (according to MAN Diesel & Turbo recommendations)
- Cold air temperature sensor
- Winding temperature sensors PT100 (2x3 off)
- Two (2) Bearing temperature sensors (NDE and DE), PT 1000
- Two (2) Cooler leakage detector
- Current Transformers for differential protection
- Anti condensation heater
- Air inlet and air outlet with flaps open for emergency operation
- Anti friction bearings; self lubricated
- Charge air system
- Exhaust system

Cooling water system

8.4. EMERGENCY ELECTRICAL POWER GENERATION

8.4.1. Emergency Diesel Generator

One MTU 12 V2000 series Emergency Generator Set will be provided by Imtech to provide power for a separate circuit as required by Class.

If a black-out occurs for the generator systems, the emergency generator set shall start automatically and connect to the Emergency switchboard, according to Class and Authority requirement. The connection between emergency switchboard and main switchboard shall be automatically disconnected, upon failure of the main source of power. A low level alarm shall be installed in the fuel tank for the emergency diesel engine. This alarm shall be activated before the fuel level is decreased to a level corresponding to 18 hours emergency service.

One (1) air cooled emergency diesel generator shall be installed generally as indicated on the GA to provide electric power for emergency services in all operational and harbour conditions. The diesel engine and generator shall be installed on a common base plate, flexibly mounted to steel structure.

Technical data diesel engine:

- Output ……..: 600 kW
- Speed ……... : 1800 rpm
- Fuel …… : MGO (Marine gas oil)

The generator shall be of 3-phase synchronous generator, for constant speed, self-excited, self-regulated with on-build voltage regulator, self-ventilated, brush less and with damping windings:

- Output …… : 605 kVA / 484 kW (approx), approx.. 44 kW will be used by own fan power
- Voltage …….. : 440V
- Frequency ……. : 60 Hz
- Speed ……. : 1800 rpm
- Enclosure (acc. IEC 34-5) ….... : IP23
- Bearings …… : Anti Friction
- Insulation / temp. rise …… : H/F
- Mounting …… : B3/B5 - SAE

9. AUXILIARY SYSTEMS

9.1. AUXILIARY SYSTEMS

9.1.1. General

The systems including piping, pumps, valves, coolers, etc. shall comply with the requirements of the Classification Society and statutory regulations applicable to the Vessel, unless higher requirements are explicitly stated in this specification.

As a minimum all piping shall be in accordance with system diagrams approved by the Owner and Levingston, Classification Societies and involved suppliers of equipment and machinery. Pipe wall thickness shall be according to Class requirements. Galvanizing of pipes shall be according to DIN 2444 or equivalents. The piping shall be designed to provide sufficient flexibility to accommodate hull deflections, thermal expansion and general vibrations etc.

Shell plate penetrations shall be made with bracket strengthening and without doubling plate.

Fuel oil, lubricating oil and hydraulic oil pipelines shall be cleaned by acidification, other pipes shall be cleaned mechanically.

After completion of fabrication work and pressure testing all lubricating oil pipelines and fuel oil pipelines from day service tanks to consumers shall be pickled, oiled and blanked prior to final installation.

Thermometers, pressure meters, draining plugs, etc. shall be fitted in suitable places according to good shipbuilding standard. Machinery piping shall not be led through cabins.

As a guide, the flow speeds in the piping systems should not exceed the values given below. All flow speeds (velocities) should be clearly indicated on the system diagrams

- Seawater pressure side ..... : 3.5 m/s
- Seawater suction side ..... : 1.5 m/s
- Fresh cooling water suction ..... : 2.0 m/s
- Fresh cooling water discharge..... : 3.0 m/s
- Hot water circulation discharge..... : 2.0 m/s
- Hot water circulation suction ..... : 1.5 m/s
- Compressed air ..... : 25 m/s
- Marine Gas Oil pressure side ..... : 2.5 m/s
- Marine Gas Oil suction side..... : 1.5 m/s
- Bilge suction ..... : 2.5 m/s
- Bilge discharge and ballast ..... : 3.0 m/s
- Fuel oil pressure side ..... : 2.5 m/s
- Fuel oil suction side ..... : 1.5 m/s

9.1.2. Pumps and Piping General

Garbarino brand pumps shall be furnished for all internal pump applications. All pumps shall have mechanical seals. All seawater pumps shall have Ni – Al bronze casing, impeller and stainless steel shaft. Freshwater pumps shall have bronze impeller and cast iron casing.

The submersible hose reel system will be from Conductix Wampfler single submersible pump system by Aturata. There will also be one spare submersible pump in this application.

Special consideration shall be taken to avoid cavitations in pumps and piping.

The above shall apply to all pumps in this specification.

Particular attention shall be given to the design, installation and commissioning of all piping systems with particular reference to the matching of pump and system characteristics. Power required for pumping duties shall be minimized by selection of pumps close to the points of their maximum efficiency and by designing heat

exchangers and piping systems to reduce flow rates and total head requirements.

9.1.2.1. Pipe Supports

All piping and fittings shall be securely supported and suitably mounted to prevent transfer of heat, vibration and movement to the supporting structures. Pipe supports are not to be attached to machinery, floor plates, gratings or ladders.

Pipe supports for non-ferrous pipes shall be lined with sliding pad of copper, brass, plastic or synthetic rubber to avoid direct contact with pipes.

Special hangers and supports shall be used for high pressure and high temperature piping to prevent excessive stresses in piping.

Anchoring piece shall be fitted to the pipes to prevent the excessive free moving where necessary.

9.1.2.2. Sliding Pads (Non – Application)

9.1.2.3. Arrangement of Piping

Piping shall be arranged to give maximum accessibility to all valves and machinery without removing adjacent piping or equipment. Pipe lines shall be run as directly as practicable with a minimum number of bends with sufficient joints for easy access and removal.

Exhaust gas and piping carrying fluid shall not be installed adjacent to electrical or electronic equipment or wiring.

Special attention shall be given to the sitting of pipe joints or valves on fuel pressure pipes. Such joints and valves shall be visible and accessible and installed remote from heated surfaces and electrical equipment.

A ‘dry tank top’ concept shall be arranged. All drains shall be taken to a suitable tank and not to the tank top or bilge. Coamings shall be arranged around all pumps, (except where engine mounted), compressors, air receiver and starting air auto drain traps, dryers, etc. Drains shall be led to the bilge holding tank.

Where pipes penetrate watertight or oil tight bulkheads, decks or tank tops ‘three flange’ spool fittings of 90/10 copper nickel, gunmetal, cast steel or welded steel construction shall be used as appropriate for the connected piping system. Spools in way of insulation or deck covering, etc., shall have sufficient length necks to allow fitting and removal of flange bolts and nuts without disturbing insulation material.

Pipe runs under engine room floor plates, shall be run in vertical tiers wherever possible to ensure maximum area of accessible tank top. Bottom tier of pipe routes shall be kept to a minimum of 150 mm clear distance between tank top plating and the underside of the pipe.

Pipes shall be routed clear of walkways, access routes, head room, withdrawal spaces, doors, manholes and cleaning spaces for heat exchangers, etc.

Pipes passing through bulkheads are not to form a rigid connection between the bulkhead and any other structure or equipment.

Where black steel pipe, fittings, etc., are run under floor plates the external pipe surface irrespective of contents shall be galvanized or fully coated with an approved protective coating system.

Where galvanized piping is specified, the pipes shall be hot dip galvanized after fabricated and attachment of flanges. Any minor damage that occurs as the result of onsite welding etc. shall be well coated with zinc rich paint. Major damage shall be made good by fully re-galvanizing.

Minimum average weight of galvanized coatings on steel pipes shall be 610g/mn. Pipes shall be checked at random during manufacture.

Logical, direct, practical routes shall run pipes. Unless specifically agreed otherwise, headroom in machinery spaces shall be not less than 2.0m and walkway width not less than 0.7m.

Individual pipes shall be arranged with flanged joints at all necessary positions to ensure ease of removal and replacement.

Pipe systems subject to galvanic corrosion are to be galvanic isolated from hull structure and from other dissimilar materials within the system by the use of sleeved bolts, insulating washers, etc. Gauge piping is to be isolated from the support structure, pipe clamps are to be rubber or plastic lined and anodes are to be fitted at all necessary locations.

Capillaries and small-bore pipes are to be clipped to dedicated support rails or to suitable structure as appropriate. Small pipes are to be protected against contact damage where necessary.

All visible piping and plumbing fittings in cabins, accommodation alleyways, bathrooms, toilets, mess room, laundries, galley, etc. are to be chrome-plated
Electrical systems and equipment are not to be earthed or attached to piping systems.

Water cooling systems, wherever possible, are to be arranged as being inherently self-

venting. Where this is impractical lockable vent cocks with tailpipes arranged to discharge into fresh cooling water drain tank via tundish are to be arranged.

Lowest points in water-filled systems are to be provided with lockable drain cocks with tailpipes such that the system can be completely drained when required. Tail pipes are to be led to the fresh cooling water drain tank tundish.

Pipes are to be routed well clear of and not above starter panels, section boards and all other essential electrical equipment.

All fittings associated with or used in the assembly of piping systems are to be compatible with relevant piping material and in accordance with fitting supplier's standards.

Any piping passing through a tank shall be without flanges in such a manner that any leakage of liquid shall not result in cross contamination of the tanks or pipe contents.

9.1.2.4. Installation

All piping shall be securely supported and braced to prevent damage from vibration, but where subject to movement, piping shall be supported on spring hangers and dampers. All engine exhaust pipes shall be flexibly mounted.

Unless otherwise stated, the minimum test pressure of all piping systems shall be in accordance with minimum Class requirements.

Measures shall be taken to avoid corrosion problems at interfaces of dissimilar metals in systems conveying sea water.

Larger bore piping is not to act as a support for small bore piping. Piping within tanks shall be kept clear of access holes with sufficient clearance provided to permit removal of dirty oil from the bottom of the tanks. All piping connections to double bottom tanks through the engine room tank top shall have bolted flanges located at least 150 mm above the tank top.

Flat bar comings 100 mm high shall be fitted around pipe openings in decks and platforms in machinery spaces.

All piping connected to diesel alternator sets, resiliently mounted machines or other equipment shall be provided with suitable bellows type flexible connections appropriate for the intended service. The flexible bellow, diesel engine, motor, machine and alternator manufacturers' requirements for the installation of these pipes shall be obtained and implemented. Flexible pipe connectors shall be installed in easily visible and easily accessible positions.

Chilled and refrigeration piping shall be fully insulated and sealed with vapor gap to ensure no build up of condensation and subsequent leakage particularly where piping is installed behind ceiling linings in accommodation spaces. This shall include complete sealed insulation of flanges and all associated pipefitting.

9.1.2.5. Bolts and nuts for flanged joints & pipe fastening

The material of nuts, screws, hexagonal head bolts & U- type bolts less than 22 mm diameter and bands for pipe flanges and pipe fastening with supports on the exposed deck shall be of hot-dip galvanized or equivalent or non-ferrous, except those fitted on the equipment or components such as valves, air vent heads, etc. which shall be decided in accordance with the manufacturer's standard.

Bolts and nuts for all flanged joints in other areas shall be galvanized or zinc coated mild steel as appropriate for the associated pipe system. Screwed joints are not to be used for pipes above 40 mm. Only proprietary standard hydraulic screwed fittings are permitted. All jointing used shall be asbestos-free non- flammable material. The galvanizing of bolts and nuts shall be hot-dip galvanized or treated by electric method in general. Threads of steel bolts and nuts in pipe flanges shall be coated with suitable lubricant during assembly.

9.1.2.6. Pipe cleaning and flushing

After fabrication of the steel pipes of oil systems, acid cleaning shall be carried out before or after installation on board.

For the steel pipes applying the polyethylene lining, blasting shall be carried out instead before lining. Phosphate treatment after acid cleaning shall be processed for the steel pipes except for the pipes applying galvanizing or polyethylene lining.

For proper prevention from rusting, the following pipes shall be blown out with compressed air and dried before installation on board.

9.1.3. Material Guide Pipe Material

System	Nominal size or equivalent	Description
Hydraulic pipes for valve control	All dimensions	Stainless steel
Low pressure hydraulic piping	All dimensions (in/outdoors)	Steel
High pressure	Indoor, all dim. Outdoor & in	Precision steel

System	Nominal size or equivalent	Description
Hydro piping	tanks	Steel (dim.<=50mm) Steel (dim. > 50mm)
Refer. Cooling	All dimensions	Steel (dim. >50mm)
Air Con System	All dimensions	Carbon steel
Sanitary supply	All dimensions	CPVC pipe
Sanitary Drain	All dimensions above freeboard deck All dimensions below freeboard deck	UPVC pipe Steel pipe
FUEL OIL	DN <32 DN <40	Precision steel pipe steel
LUBE OIL	DN <32 DN <40	Precision steel pipe steel
Sea cooling water	All dimensions	Steel pipe & fittings
Fresh water cooling	DN <32 DN <40	Precision steel pipe steel
Chilled water cooling	All dimensions	Carbon Steel pipe
Starting air	DN >32 I inside DN 40 outside	Precision steel pipe Steel pipe
Service air	All dim outside All dim inside	Steel pipe Precision steel
Control air	All dimensions	Stainless pipe
Exhaust pipes, ME Exhaust pipes		Rolled steel pipe
Exhaust pipes, Aux engines		Steel
General, bilge ballast & Fi Fi Deck wash	All dimensions	Steel pipe
Co2	All dimensions	Galvanized steel
Foam	All dimensions	Galvanized steel
Air & sounding	All dimensions	Steel pipe
Sample lines	All dimensions	Stainless steel

9.1.4. Material guide of valve material

System	Nominal size	Description	Standard Body Material	Standard Internal
Hydraulic system	All dim	According to suppliers standard		

System	Nominal size	Description	Standard Body Material	Standard Internal
Hi pressure washing		Ball valve	Bronze	Bronze
Fuel oil	DN<40 DN >	Ball valve Butterfly valve	Bronze Ductile or Iron or Steel	Bronze Bronze
Lube oil	DN<32 DN40 DN>50	Ball valve, globe valve and gate valve Butterfly valve	Bronze Ductile or Iron or Steel	Bronze Bronze Al. Bronze
Sea water cooling	All dim	Butterfly / gate valve	Ductile or Iron or Steel	Al. bronze/Buna-N
Fresh water cooling	DN<32 DN>40	Globe valve/Butterfly valve with EPDM seat		
Chilled Water	DNupto50 DN>50	Gate Valve Butterfly Valve with	Carbon steel	Bronze/Brass Al.Bronze
Starting air	DN<32 DN>40 DN	Ball valve Steel Globe	Forged steel Steel Cast steel	
Service air	All dim	Ball valve Bronze body	Brass	Brass
Bilge system	All dim	Butterfly valve	Ductile or Iron or Steel	Al. bronze/ Buna-N Note: Shipside valves, Duct Iron. Sea inlet valves. Bronze
Ballast system	All dim	Butterfly valve	Ductile or Iron or Steel	Al. bronze/Buna-N Note: Shipside valves, Duct Iron. Sea inlet
Fire & deck wash hydrants	All dim	Angle Valve include hose/ Globe valves	Carbon steel	
Deck wash general service	DN<40 DN<50	Ball valve Butterfly valve Angle Valve include hose	Bronze Ductile or Iron or Steel	Bronze Bronze
Co2	All dim	Ball valve	Bronze	Bronze

System	Nominal size	Description	Standard Body Material	Standard Internal
Foam	DN<40 DN>50	Ball valve Butterfly valve	Bronze Ductile or Iron or Steel	Bronze Bronze
Soundings	All dim	Self closing valve/gate valve ABS cert	Bronze	Bronze Note: Cylindrical self closing cock w/ Test cock screw

Butterfly valves shall be used in lines of ND 50 and above (where applicable) for fresh water cooling system, seawater cooling system, lube oil and other systems and shall comply with the following material standards:

- Body.....Ductile Cast iron (FCD).
- Disc.....Al-bronze
- Seat .....Synthetic rubber (NBR) of replaceable type.

The pipes of ND 10 and below up to 30 Kg/cm²g pressure line shall be of seamless copper or stainless steel.

The valves and fittings of ND 10 and below shall be of brass or stainless steel.

The joints of ND 10 and below shall be of screw or compression connections made of brass or stainless steel. .

9.2. FUEL OIL SYSTEM

Fuel oil system for handling of MGO (marine gas oil) and MDO shall be provided. The system shall include bunkering, at a flow rate to be agreed by the Owner, overflow, transfer, purification and all service systems required for diesel engines.

Waste oil containment and drip trays shall be provided in accordance with good marine standard. Due consideration shall be taken to avoid fuel leakage from piping, valves, pump seals etc.
Fuel oil handling equipment and piping shall be arranged to facilitate easy cleaning.

Ample drains from coamings / save all's round equipment where fuel leakage might occur shall be arranged. Fuel oil piping to main engines shall be of ample dimension for pulsation dampening.

Fuel oil pumps shall have shaft seals suitable for purpose ensuring no leakage due to

operational changes (stop/running, cold/warm).

Fuel oil purifier, transfer and service pumps shall have remote stop facilities from outside machinery space according to regulations.

9.2.1. Bunkering System

Fuel Oil bunkering stations shall be provided with shut-off valves, blank flange and sign, located port and starboard side on main deck as shown on the GA.

From the bunker stations piping shall be led to fuel oil tanks in the engine room via shut off valves.

9.2.2. Transfer System

Transfer system shall be arranged for transferring fuel oil between all bunker tanks, settling / service tanks and from bunker stations. The system shall be based upon the details shown in the above referenced schematic drawing. System is to include 1 x F.O. transfer pump.

9.2.3. Drain System

All fuel oil tanks in machinery spaces above double bottom shall be equipped with drip trays of sufficient capacity for collecting any leakage which may occur from valves, fittings etc. The drip trays shall be drained to waste oil or sludge tank.

Fuel oil service tanks shall have an accessible drain (self-closing valve) fitted at the lowest point of the tanks, for removing water and sediment. These drains shall be arranged directly to sludge or waste oil tank.

A dirty oil pump is to be fitted in order to pump out the sludge/waste oil tank – (see system schematic drawing fuel oil purifiers)

Following MDO purifiers shall be installed.

- Number .....: ONE (1)
- Working principle ..: Automatic self-cleaning
- Manufacturer.....: Samgong-Mitsubishi or Alfa Laval is prefer by Owner/Levingston
- Capacity, each.....: 2.45 M3/h MGO (effective throughput)
- Equipment.....: Manual overriding control on the purifier with alarm for lost water-trap.

The purifiers shall have separate electrically driven feed pump arranged for variable speed pumps / variable liquid capacity.

The purifiers shall be arranged for purifying from main fuel tanks to service tanks, as well as from service tank and back to same service tank. The purifier shall also have possibility for purifying direct from fuel overflow or fuel drain tanks to service tanks. All controls and alarms available in maker's control unit shall be fitted.

The purifier shall be arranged with trolley beam above and suitable washing table with sink and taps for hot and cold water. Purifiers shall be built as modules with separate feed pump, suction filter, control cabinet and integrated sludge tank. The purifier shall be arranged for easy access, operation, maintenance and easy cleaning of the area.

9.2.4. Fuel Oil Service System

Main diesel engines, shall all be arranged for MGO (marine gas oil) and MDO (Marine Diesel Oil) operation.

The following system tanks for MGO/MDO shall be included:

- Two (2) service tanks

Emergency diesel engine, shall all be arranged for MGO (marine gas oil) operation.

The following system tanks for MGO shall be included:
- One (1) service tank for the emergency generator

From service tanks, individual branch lines shall be arranged to all consumers.

Approved valves of quick-closing type shall be arranged on tanks according to rules and requirements. The systems shall be arranged for full operation of all consumers.

Fuel return lines from engines shall be arranged according to engine makers recommendations. All branch lines to individual consumers shall be sized, and arranged with filters, in accordance with the recommendations of the manufacturer and with special attention to avoidance of pressure pulsation from the engines.

All service and settling tanks shall have level gauges.

9.2.5. Emergency- Diesel Fuel Feed System (MGO)

The emergency diesel generator shall be located in a separate location, and shall have

separate MGO system including automatic service tank filling from engine room. The MGO supply pipe shall be fitted with quick-closing valve, manual operated from outside emergency generator room.

Necessary filters and other fittings shall be included, according to engine manufacturers' recommendations.

9.3. LUBRICATING OIL SYSTEMS

9.3.1. Lube Oil Purifier System

Following L.O. purifier shall be installed.

- Number .....: One (1)
- Working principle .....: Automatic self-cleaning
- Manufacturer.....: Mitsubishi or Alfa Laval is prefer by Owner/Levingston
- Capacity, each.....: 1.65 m3/h MGO (effective throughput)
- Equipment.....: Manual overriding control on the purifier with alarm for lost water- trap.

The purifier shall have separate electrically driven feed pump arranged for variable speed pumps / variable liquid capacity. Suction and return to main engine sumps with cross-over's if required.

9.3.2. Main Diesel Engine Lube Oil Systems

Each main diesel engine shall have a lube oil system in line with the engine manufactures requirements.

9.3.3. Emergency Diesel Lube Oil System

Emergency diesel engine shall have a lube oil system in line with the engine manufactures requirements.

9.3.4. Azimuth Thrusters Lube Oil System

Each Azimuth thruster unit shall have its own complete built on lube oil system, as per manufactures requirements.

9.4. COOLING SYSTEM

9.4.1. General

Provision shall be made for all machinery to be adequately cooled as per maker's recommendations. Heat balance calculations and cooling system diagrams shall be submitted for Owner/Levingston approval prior to commencement of manufacture.

Due to the behavior of the MOU (jacking out of the water) a de-aeration system to be installed on the sea- inlets in order to vent off the air when necessary.

9.4.2. Remote Heat Exchangers

All main engines and the auxiliary engine will be cooled using shell /tube heat exchanger and expansion tanks installed in the engine room per the MAN Diesel & Turbo arrangement drawings.

9.4.3. Sea Chests

Sea chest and cross-over pipe shall be installed as detailed in the above referenced drawings and the GA.

9.4.4. Sea Water Cooling System

Sea water will be supplied by one S&N Pump/Clyde Union Neptune Hose Reel System. Reel will consist of (2) submersible seawater pumps on the reel and (1) spare submersible pump. (1300 g.p.m at 260 ft. head).

Sea Water cooling will be supplied by 2 x seawater submersible service pumps.

For full details, refer to seawater system schematic drawing.

9.4.5. Freshwater Cooling System

Necessary equipment and access for injection and filling of fresh water treatment

chemicals (inhibitors and cleaning chemicals) shall be installed at required location for equipment such as air coolers, turbochargers, expansion tank, etc.

The PH value and hardness shall be within normal values. The chlorine and sulfur content shall be as low as possible, max total content shall be 100 mg/l.

9.4.5.1. Fresh Water Cooling Systems for Main Engines and Accessories

Each main diesel engine and the auxiliary diesel engine shall have separate closed fresh cooling water circulation system through heat exchangers shell tube or plate type.

Fresh water cooling system for thrusters: Two (02) x cooling water pumps will supply fresh water for cooling thrusters – see system schematic drawing.

9.5. PRESSURE AIR SYSTEMS

9.5.1. Compressed Air Systems

Oil and water separators shall be fitted in the pipe between compressors and receivers.

Connections for typhoons, service air and instrument air shall be arranged from both air receivers.

Valve and piping arrangement between the air receivers shall be such that pressure loss in one receiver does not cause pressure loss also in the other receiver.

9.5.2. Service / Control Air System

A separate system for supplying of service starting and control air shall be provided. The system shall include one (1) main air compressors, one (1) emergency air compressor with one (1) service air receiver, two (2) engine start receivers, as shown on system schematic drawing. System should be 150psi with suitable pressure regulation/filters/driers etc.

As per the Equipment list

Starting Air Compressors	No.	2	22,5 m^3/hr @ 30 bar
Starting Air Receivers (Based on minimum 3 starts or as required by Class)	No.	2	750 Liters (to be confirmed from Engine Requirement)

Service & Control Air Compressors with Dryer, pre-filter and after-filter	No.	1	201.7 m³/hr @ 7.2 bar
Service & Control Air Receivers	No.	1	3000 Liters at 10 bar

9.6. EXHAUST GAS SYSTEMS

9.6.1. General

Exhaust gas from the MAN main engines shall be carried to open air through water protected collar penetration at the top of the funnel.

Exhaust gas pipes shall be made of fabricated steel or welded steel pipe, and fitted with necessary number of bellows type expansion joint of acid proof steel.

Exhaust piping, included silencers, from all diesel engines shall be flexible suspended to the steel structure. Exhaust gas pipes shall be rigidly secured against lateral movement with brackets, but so arranged as to allow for necessary expansion. Drains from all engines exhaust gas silencers and exhaust pipe low points shall be led to the bilge water storage tank through a valve and water seal.

The maximum total resistance in diesel engine exhaust gas pipes shall not exceed the engine manufacturer's recommendations. Spark arrestors will be fitted to all uptakes. All exhaust pipes shall be thermally insulated and covered with galvanized steel sheet in the engine rooms and close to service platforms and with glass fiber cloth elsewhere in way of funnel.

The bends shall be done with largest possible radius, and the minimum used radius shall not be less than 1.0 x pipe Dia. Pipes shall be provided with water separating pockets and drainage. The un-insulated exhaust pipes above the top of funnel shall be of stainless steel /acid proof. Length and angle of exhaust outlets shall be agreed upon with Owner/Levingston representative.

9.6.2. Main Diesel Engine Exhaust Gas System

Each of the three (3) MAN Main Diesel Engines shall have a silencer with noise

absorption of 35dB (A). Silencers shall be of absorption type and provided with soot collection, water drain and spark arrestors. Silencers shall be installed vertically in engine casing with spark arrestors.

Max flow velocity and back pressure shall be as per recommendations of the engine makers.

9.6.3. Emergency Diesel Generator Engine Exhaust Gas systems

The MTU 12V 2000 Emergency Diesel Generator engine shall be fitted with silencer with noise absorption, 35 dB (A). The silencer shall be of the vertical type and be provided with soot collection, water drain and spark arrestor. Max flow velocity and back pressure shall be as per recommendations of the engine makers.

9.7. FRESH WATER SYSTEM

9.7.1. Fresh Water Makers

Two (2) Aqua Mar make freshwater makers AQE-30D, Reverse Osmosis (RO) type, each have a capacity of 40 tons per day. UV units and other necessary auxiliary systems shall be installed as per details shown on system schematic drawing.

The salinity indicator shall actuate a solenoid valve, which discharges the produced condensate to bilge in the event that salinity exceeds given limit.

The aggregate shall be manually controlled with indication and alarms in engine control system.

9.7.2. Water Pressure Set

The potable water system is to be included as follows:

- Two (2) potable water pumps 20m3/hr @ 30m each
- Two (2) potable water pressure tanks at 900L

9.7.3. Water Calorifier

Two (02) Calorifier units Calorifier units each 30kw with Capacity 1000L are to be installed.

9.8. SEWAGE TREATMENT PLANT

Two (02) Ecomar-50 model Sewage Treatment Plants, are to be installed. Units shall support both Black and Gray water treatment. Each unit for 100 people. The Sewage treatment plants are to be located in Machinery space below Accommodation deck.

9.9. AUTOMATION SYSTEMS FOR MACHINERY

9.9.1. General

Automation system shall be supplied by Imtech.

Main principles of the control systems are:

- To make it possible to run the Vessel and its equipment safely and in most economical way both in transit and offshore working conditions.
- Centralization of control functions improving man machine interface ergonomics.
- To utilize the redundancy of the machinery to ensure that change-over of standby functions will be safe and does not cause any interruption to the ships operation.

Workstations:

- Two (02) independent workstations in engine control room, each with 23" TFT flat screen and keyboard-trackball combination
- Two (2) independent workstations on bridge, each with 23" TFT flat screen and keyboard-trackball combination.
- One (1) portable (laptop) operator station with connection boxes in engine rooms, for maintenance and trouble shooting.

The alarm-, monitoring and control system of the Vessel shall be an integrated system, with distributed processing and technology concerning both hardware and software.

The integrated system shall include:

- Alarm, monitoring and control system
- Remote tank level measurement system
- Remote controlled valves as per Class requirements
- Remote control of other systems, as required by ABS Class

9.9.2. System Maintenance Functions

A number of interactive operator functions shall be available for maintaining and modifying the system in accordance with the changing requirements of the environments.

Facilities for restricting the use of any of the functions through key lock and/or password shall exist. The system supervisor shall be capable of imposing or releasing this restriction on any one function under his supervision.

Maintenance function shall be available through the operator station and from portable facilities.

9.9.3. Communication

The System shall provide an Ethernet ringbus topology to allow a failsave data transfer between the operator workstation and all distributed substations and alarm panels.
The System shall have an internal supervision and error reporting for the Ethernet ringbus.

9.9.4. Operator Stations

Each operator station consists of one keyboard-trackball combination and one display unit. Addressing of variables on the display may be done by tracker ballor touch screen. The operator shall, from operator station, be able to request a hard copy from either of his displays. The password protection/logon system shall enable different access levels for the individual users, from basic system operation to full system configuration. The operations will be carried out through the interactive display. The operators' current choice of picture shall not restrict his operation capabilities

Configuration and Parameterization for all stations shall be performed from operator stations. Transfer of control between operator stations shall be controlled by the operator in charge. Facilities shall be included to force a change of control. This function shall be restricted.

9.9.5. Process Stations

The process stations shall be stand-alone units; connected to the data highway. The process station shall be capable of data storage and process capability. Loss of communication shall not affect the internal operation. Before execution of any control function, the system shall check the validity of the control action.

The system shall perform "bump-less" transfer between manual and automatic modes of control. All control schemes shall be based on functional modules.

All control cables shall be laid separated from power cables.

9.9.6. Maneuver Desks, Main Console, Instruments

9.9.6.1. General Requirement and Arrangement

The equipment shall generally be mounted on the top of the console.. The consoles shall have detachable covers in the front or where practicable according to arrangement. In order to reduce the number of separate indicators and panels for subsystems, controls and indicators shall as far as possible be provided as display solutions.

For maintenance and repair, a receptacle for a working light shall be installed inside of each console.
One (1) Engine room console shall be installed in engine control room.

In addition provision shall be given for the display of CCTV operational pictures which may be provided by separate monitors.

The following minimum controls shall be via machinery automation workstations:

- Remote control for Main Generator engines
- Starting and stopping of main gen. engine's aux. and stand by pumps
- Switch for selecting man./auto for stand by pumps
- Indicating of main gen. engine's aux.- and running stand by pumps
- Starting and stopping engine room ventilation fans
- Indications of running ventilation fans

9.9.7. Bridge Consoles

. Forward bridge console assembly for maneuvering and navigation. One (1) portable joystick socket at each bridge wing. The Forward Bridge Console is designed to maximize the Captain's visibility as well as functional interface with controls for maneuvering, navigations and jacking operations, and DP-1 system

Final bridge arrangement shall be approved by Levingston Basic Designer before construction.

Overhead consoles for monitors over the console in the wheelhouse shall be provided in the overall pilot house layout.

Bridge consoles forward shall include the following equipment as a minimum:

- One (1) Workstations for machinery automation

- One (1) Intercom telephone (depending on yard`s decision)
- One (1) Sound powered telephone (depending on yard`s decision)
- One (1) Set of remote control panels for Thruster Remote Control System for all azimuth thrusters and the tunnel thruster, including emergency stop, hard wired

- Emergency maneuvering systems for main propulsion (included in Thruster remote control panels
- One (1) Operator panel for Independent Jock-Stick-Control System
- One (1) Operator panel for DP1 System
- Echo sounder
- Radars displays, - X-band and S-band, • One (1) ECDIS
- One (1) Conning display
- One (1) Push button for fire alarm (according to yard`s decision)
- One (1) Push buttons for SSAS (optional)
- Operation of window wipers, window flushing, etc..
- Loud hailing and public address (according to yard`s decision)
- Control panel for autopilot
- One (1) Whistle controller incl. Morse Light Button

One (1) Group alarm panel connected to eng. alarm plant

In addition following minor equipment shall be mounted in wheelhouse console forward typically.

- Search light controllers
- VHF stations
- Gyro repeaters
- Wind measuring indicators Etc
- All revolution counters, rotation- and pitch indicators for main propellers, azimuth and bow thrusters, all instruments in bridge consoles shall be illuminated.
- All lights in the maneuvering desk exclusive the warning lights shall be provided with step less dimming.

Some equipment installation in overhead console may also be possible.

9.9.8. Engine Control Console

The ECR-Console shall include the following equipment as a minimum:

- One (1) Intercom telephone (depending on shipyard`s decision)
- One (1) Sound Power telephone (depending on shipyard`s decision)
- Two (2) Alarm-, monitoring and control system operator workstations (for unmanned machinery operation)
- One (1) Push button for fire alarm (depending on shipyard`s decision)
- Loud hailing and public address (depending on shipyard`s decision)

9.9.9. Elevating Control Console

Bridge control console shall integrate the Jacking control equipment, to be done by IMTECH.
The jacking system will be controlled from a central jacking system control console. The console will be typically suitable for indoor mounting on a foundation in an air conditioned control room. Cable entry will be from below.

The console will comprise a top section with color video display units and a bottom section with keyboard, track ball, inclination display, joystick, alarm buzzer, emergency stop button, push buttons and indication lights.

The video display units will show systems status (pinion load via pressure readings, brake status, motor temp) and alarms via various user-selectable graphic screens. The alarms will be indicated continuously on a separate section of the screens.

Each leg can be controlled individually by joystick. In addition, a master joystick will be provided for simultaneous control of all legs. Main functions are selectable via push buttons and indicated via separate indicating lights. Other parameters can be changed via the key board, track ball and screen with password protection where required. A separate small display is provided for continuous indication of the platform inclination.

9.9.10. Alarm, Monitoring and Control System

9.9.10.1. General, Sensors and Instrumentation

Transmitter shall be used in order to avoid sensing lines carrying fluids, being led into the control room.

Local instrumentation, such as thermometers, pressure gauges, etc., shall be provided as necessary for manual start-up, control, and monitoring of equipment in the machinery spaces. Units shall be metric.

All sensors shall be installed in places where it is a minimum risk for damage during normal operation, overhaul and maintenance. Cables for sensors shall have sufficient length allowing for withdrawal during replacement or calibration. Shut off and test valves with standard test flange connection shall be fitted for all pressure regulating and measuring units as well as for local instruments.

Pressure sensors exposed to shock and large vibrations in their working medium shall be protected by damping chambers. Temperature sensors shall be installed in pockets and be capable of being withdrawn for replacement or calibration.

Test equipment for temperature and pressure sensors shall be suitable for connection to the respective sensor types.

All components and wires shall be marked with number codes in accordance with the instrumentation list and installation drawings.

The system shall be based on 2000 I/O units.

9.9.11. General, Alarm, Monitoring and Control

The Alarm Monitoring and Reporting System shall monitor and report all alarm conditions instrumented as contact closures, driven by alarm circuits external to the system for Vessel system. In addition, the system shall permit the calculation of high and low level or deviation alarms for every integrated measurement signal and the assignment of an alarm condition to any status input signal. It shall also be able to issue an alarm when a measured state fails to agree with commanded state within an operator adjustable time interval.

Alarm occurrence shall be indicated to the operator by an audible signal, by flashing visual indication at the control station and by a printed record. Visual and printed indications shall clearly identify the point in alarm, the alarm condition, and the time of alarm occurrence.

Visual alarm indications shall remain flashing until acknowledged by the operator.

Visual alarm indications shall remain lighted for each alarm occurrence until the occurrence is acknowledged by the operator and the alarm condition has been eliminated, at which time the printer shall record the time of return to non-alarmed condition.

The operator shall not be able to acknowledge an alarm without first calling the description of the alarm to the display screen. When a Vessel alarm occurs, the system shall flash an alarm symbol on the TFT. The display shall clearly indicate those points in alarm states. In addition, the Vessel Control system shall maintain a record of all active alarms. The operator shall be able to call up multi page alphanumeric display containing a list of such active alarms, arrange chronologically by occurrence, with the time of occurrence of each shown.

From the alarm list each alarm may be acknowledged separately or all alarms on the alarm page might be acknowledged at the same time.

Due to the importance of the alarm monitoring system, there shall be three completely

independent means of monitoring and presenting alarms to an operator (visual, audible and printed record), so that no failure in an alarm processing device can shut down the alarm monitoring. Each alarm monitoring means shall connect directly and independently to the data transmission system.

9.9.12. System Self-Monitor Alarm

The Vessel control system shall be self-diagnostic and shall automatically report component malfunctions and anomalies to the operator. By selection of a single display page at any TFT, the operator shall be able to identify:

- The device experiencing the malfunction / anomaly
- The type of device

9.9.13. The Malfunction / Anomaly Condition

Self-checking and diagnostic routines shall be performed on-line by each system device without interfering with the Vessel control functions.

System faults shall automatically be audibly and visually reported to the operator and logged. As with the Vessel system alarms, color changes and flashing shall aid the operator in discriminating among new system faults, previously acknowledged faults and normal operation.

9.9.14. Alarm and Status Change Report

A chronological system history shall be maintained on a printer giving precise identification and time of the following events:

- Alarm occurrence
- Alarm recovery
- Selectable non-alarm status changes, for example, individual generators starts and stops, etc.

Alarm cut-out and delayed cut-in:

The system shall be provided with necessary interlocking so that to avoid untimely alarm conditions, considering the working/idling condition of various machines/equipment. (i.e. if a machine is stopped at operators request or if alarm is a shut down on sequence, the alarm doesn't come out). An alarm shall be initiated only when a fault does occur.

Other details about the monitoring and alarm system:

- Temporary alarm conditions (liquid level etc.) shall be avoided with time delay up to 30 sec. max.
- The same philosophy shall be adapted also for the substitution of a generator for load transfer operation due to possible temporary fluctuation of signals.
- The signal period from safety monitoring system shall be regulated for over sensitivity.
- Blocking of alarms or group of alarms shall be actuated directly from the selector switch in the starter's equipment.

Alarm indication in engine room:

- Alarm presence shall be indicated in each engine space by means of sirens and rotating lights.
- The sirens shall be delayed to allow the watch-keeper if present in E.C.R to acknowledge the alarm before the sirens sounds.
- The telephone (automatic and sound powered) shall be connected to the same system which shall have also the indication of the type of alarm (i.e. engine alarm, telephone call, dead man alarm and fire alarm).
- Alarm indication in ECR and ship command centre (wheelhouse):
- Alarms shall be indicated with buzzer, flashing alarm lamp section and combined on the video system and printed out of printers.
- Alarm in engine room should be printed out in engine control room and on Vessel command centre.
- Alarm in ballast, bilge and bunkering area should be printed out in Vessel command centre.
- With the audible acknowledgment, all audible alarm devices shall be silenced and the rotating lights in engine room stop.
- With the visual acknowledgment, the alarm lamp shall show a steady light and steady indication on the TFT screens. It shall go off automatically when the alarm condition has expired.

9.9.15. Group Alarm and Watch Responsibility System

A responsibility system shall be fitted and shall have the following positions:

- Engine room manned / unmanned
- Engine room one man (personal alarm system on).

9.9.16. Bridge and in Accommodation shall be provided with the following equipment

On bridge console:

- Indication for group alarms including dead man alarm
- Push-buttons to silence the acoustic alarm
- 7” Duty alarm panel with touch screen indicating the engineer on duty
- In cabins for Captain, Chief engineer, 1st engineer, 2nd engineer
- Duty Alarm Panel with touch screen for individual alarm indication in clear text with dimmalbe backlights and colours
- Different group alarms
- "Call from bridge"
- "Call from E.C.R"
- Pushbutton for "accept call.

In mess and dayrooms:

7” Duty Alarm panel with touch screen for individual alarm indication in clear text with dimmalbe backlights and colours:

- Different group alarms
- "Call from bridge"
- "Call from E.C.R."

9.9.17. Principle of Function

During manned E.C.R. operation:

No alarm shall be indicated outside the E.C.R. except critical alarms for main engine, which shall be indicated on wheelhouse. If an alarm is not acknowledged within a reasonable time, the alarm will be initiated in wheelhouse.

During Unmanned E.C.R. Operation:

On the bridge, in crew public spaces, in the selected duty engineer’s cabin there shall be initiated group alarms (optical and audible). An alarm in the chief engineer’s cabin is given when the alarm in the duty engineer’s cabin is not accepted within a configurable time delay.

On the bridge and in public spaces audible alarm is given without delay. On the bridge and on chief engineers' cabin the audible alarm can be silenced from E.C.R. or the duty engineer’s cabin. The optical group alarms can only be accepted from the E.C.R., i.e. flashing light is changed to steady light upon acknowledgement from the E.C.R.

The lamp shall be switched off if the alarm is accepted from the E.C.R. If the alarm is not acknowledged from E.C.R. within a reasonable time an individual alarm is

given on the bridge and in the chief engineers' cabin. The audible alarms in the chief engineer's cabin and in public spaces can be switched off.

The audible alarm in the duty engineer's cabin and the public spaces can only be acknowledged from E.C.R. and the duty engineer's cabin. Each new alarm in the same group shall initiate the audible and the optical signal, when the previous alarm is acknowledged but not corrected.

9.9.18. Responsibility System

Change over from manned to unmanned room is made via the workstation located in the E.C.R. The change of responsibility initiates an audible and optical alarm on the bridge and in the relevant duty engineer's cabin. The alarm can be silenced from the relevant group alarm panel.

The duty engineer's cabin is selected via the same workstation in E.C.R. In the wheel audible and optical alarm is given indicating watch responsibility change-over. This alarm can be accepted from the wheelhouse.

The duty engineer's cabin is indicated on the engineers alarm panel on bridge. The duty engineer can be called from the bridge (Duty engineer call). The engineer call is initiated at the E.C.R. workstation to each engineer's cabin, to the bridge and to public spaces. Any call initiates an audible and optical alarm which can be cancelled from E.C.R. The above system shall be fed from the no-break power supply and shall be totally independent of the computer system.

9.9.19. One-Man Watch in Engine Room

If one-man watch in engine room is performed an integrated personal ("dead man") alarm with safety timer according the rules should be switched on.

Minimum of five (5) alarm timer reset pushbuttons and two (2) activation boxes with key switch shall be fitted according to rules and Owner/Levingston recommendations.

9.9.20. Remote Control of Propulsion Machinery

9.9.20.1. General

Remote control systems for main propulsion units and thruster shall be arranged according to Class requirement.

9.9.20.2. Main Propulsion / Thruster Control

All propulsion units shall be controlled by the Bridge. Also manual controls of propulsion shall be a part of the integrated control system. For manual controls, control levers for control of each main propulsion unit shall be provided.

9.9.21. Indication of Propulsion and Thrusters

For propulsion azimuth thruster units and the bow thruster relavant data shall be displayed on alarm-, monitoring and control system workstations.

9.9.21.1. Diesel Engine Control and Monitoring

The relevant data of electrical power plant shall be displayed on alarm-, monitoring and control system workstations.
Following functions shall be provided:

- Remote start / stop of diesel engines from the computer keyboards and from each generator panel in the main switchboard (locally also)
- Automatic start of diesel engines and emergency diesel engine when blackout
- Automatic start and synchronizing of diesel engines in accordance with load demand and standby selection
- Automatic start and synchronizing and load balance of selected standby diesel engines in case of alarm condition at one of the working generator sets
- Automatic control of generator breakers
- Pre-lube oil pump and preheating pump control

Stand by Starter System:

This system shall be used for starting of the stand by motors. The situation of working and stand by motors shall be displayed on the alarm-, monitoring and control system workstations The commands to the starter system to come from the keyboard, locally mounted start stop switches, start stop switches in the starters or automatic from process.

The machinery which requires standby function / auto change over shall be as follows:
- Cooling Water systems
- Service/Starting air compressor
- Sanitary water

9.10. POWER GENERATING PLANT AND POWER MANAGEMENT SYSTEM

9.10.1. General Engine Safety System

A safety system for protection and control of each of the generator engines shall be provided as MAN's requirements design. The safety system shall control and protect the generator engines in order to prevent faulty operation and/or major failure. The system shall automatically stop the engine upon critical failure that may lead to breakdown of the engines, such as low lubricating oil pressure, high coolant temp., over speed, in addition to any further requirements according to the Class.

9.10.2. Emergency Diesel Engine Safety System

A safety system for protection and control of the emergency diesel engine shall be provided. The safety system shall be according to Class requirement.

9.10.3. Control and Operation of Generator Sets

9.10.3.1. General

The entire power plant shall be automatically controlled by a Power Management System (PMS), which shall interfaced with the machinery automation system. The power management system shall be provided with the following functions:

Automatic power management of the generators depending on the necessary power demand and the generators ability and stand by situation. The correct and suitable combination should automatically be established.

In case of starting of big consumers the available power should automatically be checked and if necessary the stand by diesel generator should be started automatically and connected to the switchboard. As soon as available power is accepted, the big consumers should start.

The power management system shall include a load limitation function for thrusters in order to prevent generator overload.

During operations, the control system shall ensure that the thruster power demand does not exceed the available power. If a limitation is reached, the system shall optimize the thruster force allocation within the limits for best possible power usage.

The PMS system shall, however, automatically start up stand by main diesel engine in order to ensure sufficient power is available for thruster operation. All shall be

provided by Imtech packages.

9.10.3.2. System Structure

The power management system shall ensure consistency and maximum efficiency of power generation equipment. The system shall be controllable from the alarm-, monitoring and control workstations located in the Engine Control Room.

The system shall perform at least, but not limited to the following functions:

- Automatic load dependent start and stop of diesel generating sets(including blackout start of stand-by generator)
- Automatic speed/frequency control of all diesel generating sets
- Automatic operation of air circuit breakers for generators
- Automatic generator off-loading prior to load free disconnection of generator circuit breakers
- Automatic control and protection of main and ship service switchboards
- Automatic reactive power sharing.
- Operation of bus-tie breakers
- Synchronizing of all motor operated breakers
- Automatic load sharing and load control with software for black-out prevention caused by sudden overloads due to stop of generators
- Heavy consumer control including start request and start accept of heavy consumers (with analogue feedback)
- Critical alarm handling / shutdown
- Auxiliary pump status indication
- Propulsion mode control with overload protection
- Automatic preferential tripping of non-essential load
- Indication (mimic diagram of all necessary parameters for electric power plant)

The situation of working generators, standby generators, supply transformer, propulsion motors and thruster motors shall be displayed on alarm-, monitoring and control system workstations indicating important data as:

- Supplied power for each generator
- Generator amps as a % of generator full load value
- Nominal power for each generator
- % loaded
- Bus bars voltage and frequency
- Position of main circuit breakers
- Total power
- Standby situation
- Generator set available or not available

Reduction in propulsion motor loads, must be introduced in the period it takes to start and bring a new generator set on the line.

Each generator set shall automatically shut down in accordance with the manufacturer's design criteria. A shut-down condition shall be identified by an alarm connected to the alarm-, monitoring and control System. Each generator set shall be fitted with its own electronic governor, with the speed setting remotely carried out by the PMS or manual by the governor control switch on main switchboard.

9.10.3.3. Preferential Trip

When the running generator(s) is overloaded, non-essential consumers shall be automatically tripped to prevent the complete power failure of the Vessel. This shall be included in the PMS system. The preferential tripping system of non-essential consumers shall be arranged as follows:

- If bus-bar frequency relay detects under-frequency (setting 57Hz, of the generators – suitable delay to be built in.
- If generator load relay (kW and/ or current) detects generator overload above 100% load. – suitable delay to be built in.
- If generator load relay (kW and/ or current) detects generator overload above 107% load. Instantaneous trip.

The following non-essential consumers shall be tripped:

- HVAC system (A/C compressors and heating element)
- Galley equipment
- DG pre-heaters
- Laundry Equipment
- Workshop Equipment
- Chiller Units

Philosophy for further levels of preferential tripping involving heavy consumers to be discussed on completion of detailed design.

9.10.3.4. Manual Operation of Generator Sets

If a failure occurs to the PMS system, it should be possible to operate the generator sets and switchboard locally in local mode, by manual starting, stopping, connecting, synchronizing and load sharing (synchronizing scope and the control switches for speed governor) and operation of actual breakers

Diesel engines

The Generator diesel engines shall at least be automatically tripped in the following conditions:

- LO inlet pressure, low-low
- Cooling Fresh Water outlet temperature, high-high
- Over-speed
- Turbocharger LO pressure (dependant on engine manufacturer)

When the voltage of the main bus fails, the emergency generator set shall be automatically started with time delay and the emergency switchboard shall be energized automatically, and disconnect the connection to the main switchboard.

Safety devices shall be provided on the engine and arranged so that the engine shall automatically shut- down according to regulation.

9.10.3.5. Automation for Other Machinery Equipment

Control of Pumps

The following pumps shall be capable of being manually started/stopped.

- Bilge and Ballast Pumps
- Main DO Supply Pumps
- M.E. Cooling Water Pumps
- Auxiliary Sea Water Pumps
- Fresh water filling and transfer system
- Starting air system
- • Service Air compressors
- Air condition and ventilation system
- Sewage treatment plant

Fuel Oil Transfer System

Starting MDO transfer pumps shall be a manual operation. However, the transfer pumps shall be automatically started and stopped upon detecting a low or high level in any tank served.

Air Compressor Control System

Main air compressors shall be stopped automatically at the following conditions:

- Discharge air temperature, high
- Lubricating Oil pressure, low

All air compressors shall be fitted with both automatic and manual controls. Manual stop/start buttons shall be provided for each air compressor and additionally. Each compressor shall also be automatically started/ stopped by detecting the pressure of the air reservoirs.

Separate alarm pressure switches and low sump level alarm switches shall be installed for each compressor.

Engine Room Bilge System

The engine room oil/water separator pump shall be started manually, shall alarm on detecting a high level in the bilge holding tank and shall be stopped automatically by detecting low level in bilge holding tank. If the separated water's oil content is higher than the set limit, the water shall automatically be returned to the bilge holding tank with alarm given.

High-level alarm shall be provided for the bilge holding tank.

High-Level Alarms

Individual remote alarms by use of float switches shall be installed in each machinery space bilge well, each machinery space, void spaces and other areas as required by rule requirements.

Open Door Alarms

Individual remote alarms by use of door switches shall be installed at every WT space sliding door, each machinery space hinged door and other openings as required by rule requirements.

Remote Level Measuring System

Remote reading of level of fuel oil, day tank, settling tank, ballast tanks, fresh water tanks and lube oil tanks for main engine shall be installed.

Remote readings shall be integrated into the stability computer to enable real time stability calculations to be undertaken.

Operator Panels shall be installed in wheelhouse and engine control room.

9.10.4. Cable/Leads and Piping for Automation Systems for Machinery

Special care shall be taken to avoid electromagnetic interference.

Where necessary, screened twin conductors or multi-core cables with twisted pairs shall be used. All cables shall enter connection and termination boxes upward. Water pockets shall be avoided in the pipe systems for remote control and measuring.

All components and wires shall be clearly marked with number in accordance with the drawings. All name and number plates as well as reference shall be engraved laminated PVC unless otherwise specified.

All cable connectors shall be individually crimped and not multi-pin type. Water and oil pipes inside the consoles shall be avoided. Necessary air pipes shall be separated or eventually shielded from electric and electronic equipment. Air ventilating pipes from pneumatic equipment shall be led outside of consoles.

9.11. CO2 /NOVEC SYSTEM

A full flooding CO2 system consisting gas bottles c/w quick operated valves and auto alarms is to be provided for engine room & ECR & MSB. The CO2 bottles to be stowed inside a separate compartment. Operation is to be manual arranged both on the bottle(s) and in a "break glass" pull box at the engine room access.

9.12. HELIDECK FIRE FIGHTING

9.13. FIRE EXTINGUISHERS

Fire extinguishers as required by the classification and Government Authority are to be supplied and installed. For guidance, they are as follows:

- 1 nos of 45kg trolley dry powder
- 1 nos of 22kg CO2 fire extinguisher
- 1 nos emergency locker c/w equipment required by CAP 437

Helideck foam system as required by the classification and government to be provided.
The capacity of the helideck foam system is to be sized for helideck system comprised of water monitor, water pump, foam concentrate storage tank, and stationary inlet inductor etc.
Foam system water led from Buffer tank during jacking up status.1200L foam concentrate storage tank fitted with pressure vacuum valve and level sight glass to be provided.
Quantity of AFFF shall be 10 minutes for the foam solution.
The helideck foam pump also shall be able to supply low pressure water to jetting system.

10. HEATING, VENTILATION AND AIR CONDITIONING

10.1. Refrigeration System

- Refrigeration plant of non-CFC system, direct expansion type (R404a or equal), air-cooled, electrically driven, to be installed complete with all necessary accessories.
- Two (2) compressors are fitted, one acting as 100% standby. Condensers are air-cooled, radiator type.
- The plant is to maintain temperatures of -20 degrees C and +4 degrees C respectively in freezer and refrigeration store spaces.
- Dual type thermometers are fitted for each chamber with dial mounted on outside of chambers. Stainless steel shelves are fitted and floor is ceramic tiled and water-proofed.
- Refrigerant pipes are seamless copper and insulated and lagged outside of cold chambers.
- Refrigerating system is of the fan/coil blower type and automatically controlled, c/w auto defrost cycle.
- Scupper pipes are fitted draining to main scupper lines and led to overboard. Except for refrigeration lines, no other pipes to pass through cold rooms.
- Cold room temperature high alarm and man-trap-in alarm are fitted, with alarm indications in mess room and wheelhouse.
- The dry provision store is to be fitted with wooden shelves on steel bearers. The room is adequately ventilated and air conditioned from Air Conditioning System.

10.2. Air Conditioning System

HVAC air conditioning plant will be 2 x 100% (1 Operating and 1 Standby) Chiller Units with Sea Water Cooled Condensers. It is fit for cooling and heating(centralized in AHU) in winter and serves accommodation, galley (Spot Cooling), common spaces and Wheelhouse. ECR and Switchboard shall be DX type. The refrigerant for Chiller Units shall be HFC and Eco Friendly.

Design Conditions as Follows:

Summer Season	Outside condition	Inside condition
Dry Bulb Temp	45°C	22°C - 24°C
Relative Humidity	70%	50%
Seawater	32deg C	
Winter Season	Outside condition	Inside
Dry Bulb Temp	1°C	+20°C
Seawater	4deg C	

Fresh Air Circulation/ Air Re-Circulation: ~40% (25.5 m3/hr per person in summer and as per ANSI/ASHRAE Standard 62-2001 – Ventilation for acceptable Indoor Air quality.)

Refrigerant	:	R134A
Primary Cooling System	:	Chilled water Cooling System 2 x 100% Chiller units
Heating In AHU	:	Electric Heater
Power Supply	:	440V/3Ph/60Hz or 220V/1Ph/60Hz.
Classification	:	ABS
Regulation	:	Solas 1974 with latest amendments.
Motors	:	Motors are of IP 54, Insulation Class 'F'.

At ambient conditions other than stated above, the AC system is designed as far as practicable, to be able to maintain a difference of not less than 10deg C dry bulb between the outside and the inside environments.
Electrical heating element, thermostatically-controlled in the AHU is provided for heating in winter.

Air changes Requirements
The minimum number of changes of conditioned air per hour is to be:

- 8 - changes per hour in sleeping quarters.
- 12 - changes per hour in wheel house.
- 10 - changes per hour in public rooms.

Air handling units suitable for chilled water systems, serves for the port, starboard & aft accommodation area & other living spaces with one additional AHU dedicated to the galley. The ECR is served by a DX type split unit with 2x100% capacity and the switchboard room is served by 2 x 50% Split Units

Supply ducts are either structural ducting where required or spiral pre-insulated ducts and fittings.

Fire dampers are fitted according to rules but all quick closing with remote manual closing or local automatic closing by fusible link.

Return from cabin or compartment to be through louvered grille in the lower part of the doors and/or strategically placed return ducting inlets.

Emergency stop push button of Machinery Space - A ventilation fans is located in pilot house.

All vent outlets are fitted with diffusers and adjustable dampers capable of closing

completely. Cooling of the air through the mechanical ventilation system is thermostatically controlled individual control panel of the air-handling unit.

Special cooling consideration is given to the Pilot house to account for heat transfer via the glass windows. Additional louvers are provided.

10.3. Ventilation

10.3.1. Diesel Generator Engine Room:

Two (2) forced supply fans. & 2 exhaust fans.

2 Nos x 50% supply fan at stbd side and 2 Nos x 50% exhaust fan at port side to have proper forced air distribution across the engine room and to maintain the temperature (50°C) inside the engine room when outside ambient temperature goes maximum to 45°C.
Fans are sufficient for combustion & cooling air consumption for 3 diesel engines running, and maintaining Engine room temperature within 5deg C of ambient temperature.

10.3.2. Azimuth Thruster Compartment:

1 unit forced supply fans and 1 unit forced Exhaust fan.

Supply air is ducted to furnish air to the thruster engines and VFD converters and prevent hot spots.
Fans are sufficient to maintaining thruster room temperature within 10deg C of ambient temperature (Maximum inside room temperature up to 50°C).

10.3.3. Bow Thruster Room:

Once forced supply and one forced exhaust.

10.3.4. Emergency Generator Room:

10.3.5. One unit forced supply fan, powered by emergency circuit only. Natural exhaust

10.3.6. Air supply and exhaust louvers are to be supplied with watertight closures. as required by Class.

10.3.7. Toilets, wash places, changing room – combined exhaust fan

10.3.8. Galley and Provision rooms –individual exhaust fans. Galley unit is foam protected.

10.3.9. Hospital – individual exhaust fan

10.3.10. AHU rooms – will be ventilated by providing branch duct from main supply duct of the same AHU and return air to be re-circulated.

10.3.11. Other Machinery spaces – to be ventilated with force supply and natural exhaust.

11. ELECTRICAL SYSTEMS

11.1. ELECTRICAL SPECIFICATION

11.1.1. General

11.1.1.1. Class, Authority, Approvals

All electrical installation, systems, equipment, switchgear, etc. shall fully comply with Classification society and IEC standards, described in General 1. The complete electrical installation shall comply with ABS Class notation and Class notation according to General operational and construction data (section 1).

All major equipment shall be supplied with Class certificate. All electrical equipment shall be to the standards of both Class and country of origin operating standards and shall be approved by Owner/Levingston before purchase.

11.1.2. Electrical design requirements and standards

The electrical system, equipment, components and materials shall be designed, produced and installed by Builder in conjunction with Imtech in accordance with specification, proven marine practice, Class requirements, Flag Authority requirements and furthermore with rules and regulations as stated in the general section. It will be

noted that all equipment shall conform to the standards identified in General section 1 of this specification.

The electrical installations shall be compatible with the recommendations of the International Electro- technical Commission (IEC).

Consideration shall be given in the design of all equipment to the environmental conditions of shipboard service, and proven marine components shall be employed.

All electrical equipment shall be designed and rated for a humid, salt laden atmosphere with vibration and acceleration suitable for marine environment and under continuous tropical condition. Particular emphasis shall be placed on corrosion, temperatures, vibrations, power supplies and electrical interference effects.

Requirements in IEC 60533 concerning EMC, “Electromagnetic Compatibility of Electrical and Electronic Installations in Ships”, shall be fulfilled as a minimum.

Special attention shall be given to prevent equipment from being affected by harmonics, transients or distortions imposed on the main supply by, e.g., IGBT/ Thyrister / Diode controlled units.

All electrical equipment, instruments, regulators etc. shall not be interfered by induced current or radiation from other electrical or electronic equipment fitted onboard.

Sensitive electronic equipment shall be located in a safe distance from frequency converters and cables connected to the same. Frequency converters shall be located as close as possible to the motor it serves.

Electrical installations shall be designed to ensure proper operations when the Vessel is inclined as specified by the Class Society and regulatory body requirements.

A complete electrical load balance shall be prepared and submitted by the Builder for the main and the ship's service plants for each of the Vessel's functional modes.

The accuracy of the load analysis shall be confirmed by observing and recording electrical loads by all parties at steady state conditions during sea trials.

The Builder shall prepare voltage drop calculations in form and content to confirm adequacy of conductors.

The Builder shall provide short circuit calculation of the high (if any) and low voltage electrical systems, and the adequacy and selectivity of the protective devices.

The design of the electric plant including generators, motors and controllers shall be coordinated to insure that the voltage dip, when starting the motors with the highest

inrush current shall not exceed 15 percent of the rated voltage.

Electrical and electronic equipment shall be designed, constructed and installed to tolerate transient AC voltage of –15%/+20%, recovery time 1.5 to 2 Sec, and frequency variation of ±10%. Voltage transients shall stabilize to steady state conditions within 2 seconds. Frequency transients shall stabilize to steady state conditions within 5 seconds.

11.1.3. Electrical Installation Requirements

All electrical equipment shall be so located that, they are not exposed to risk of mechanical injury or damage from vibration, water, steam, oil or excessive heat. Where unavoidable, exposed to such risks, the equipment shall be suitably protected or enclosed.

All electrical equipment shall be protected from vibration and acceleration under normal operating services by mounting equipment with sufficient structure and hardware, bracing etc. All electrical equipment exposed to the weather shall be designed to withstand the environment.

All electrical equipment shall be of the latest design employing reliable components and shall be selected to provide maximum availability of spare parts and service on a worldwide basis.

Each generator, each propulsion drive, each thruster drive and switchboard operations shall be monitored and interconnected with the alarm-, monitoring and control system for monitoring of malfunctions control and operation .

All electrical equipment shall be designed and located for readily accessibility for operation and maintenance and to provide access to all relevant parts that require inspection, repair, removal, and maintenance without the removal of structure or other equipment.

11.1.4. Marking of Electrical System

All electrical equipment shall be clearly and durably labeled for easy identification.

All cables (at both ends), conductors and terminals also shall be clearly labeled for easy reference to drawings, etc.

Cable tags shall be provided to show cable designators at each cable termination.

All switchboards, distribution panels, junction boxes, etc. shall be permanently marked at the outside using engraved durable labels

All circuits and outgoing feeders shall be properly and permanently marked using engraved durable labels. Electrical equipment and measuring instruments shall be scaled in metric units.

11.1.5. Painting Requirements

All metal surfaces except stainless steel brackets shall be grit- blasted to white metal and powder-coat painted /Epoxy paint. Alternatively properly degreased and painted with two coats of primer and at least one top coat of Epoxy paint/ power coating.

Bare metal surfaces of electrical equipment shall be painted in accordance with the painting schedule, except for equipment that is specially treated for corrosion resistance and does not require paint. Metal surfaces shall be protected by a painting system appropriate for use in a marine environment, not enamel alone. The finish color for the electrical equipment shall be in accordance with the painting schedule.

11.1.6. General Switchboard Requirements

Feeder circuits shall be protected by molded-case circuit breakers with both time-over current and instantaneous trip features.

Molded-case circuit breakers for motor circuits shall have only a short circuit current protection trip unit, overload trip realized in the motor starters.

All molded case circuit breakers in the switchboards shall have plug-in mounting. These breakers shall be removable from the panel front without de-energizing the main bus.

All doors for switchboards, distribution panels and starter panels shall be possible to open 90°.
Oil resistant rubber mats, 10mm thick, 10.000V grade, shall be fitted in engine control room. Final decision of generator and transformer capacities shall be taken in accordance with the approved load analysis.

11.1.7. Harmonic Distortion

Equipment producing transient voltage, frequency and current variations is not to cause malfunction of other equipment on board, neither by conduction, induction or radiation.

In distribution systems the total harmonic distortion in voltage waveform shall not exceed 5%, nor shall any single order harmonics exceed 3%.

11.1.8. Total Harmonic Distortion Analysis

An analysis of the Total Harmonic Voltage Distortion (THD) on the 690V network and the 440V network shall be performed when several harmonic sources are presented, to confirm that no harmonic filters are required.

The simulation result shall be presented in time-domain waveform and in frequency-domain spectrum and shall be presented in graphic and text formats.

Maximum acceptable levels on the 690V network shall be documented harmless for the connected equipment and the maximum acceptable levels on the 440V network shall be less than 5%. On site measurement shall also be taken onboard the Vessel, with all machinery and equipment running, during sea trials, for comparison with the THD calculation.

11.1.9. Voltage Drop Analysis

A Voltage drop analysis during start of large AC motors shall be performed, to ensure that voltage dip during the starting period of such motors will not cause disturbance to other loads on the AC system and that the voltage dip is within the Class requirement.

11.1.10. Battery Sizing Calculation

A battery sizing study shall be performed to determine the required minimum capacity for the various 24VDC battery systems mention above. The study shall also include recommended charging rate.

11.1.11. Documentation of Electrical Installation in Hazardous Area (if any)

Electrical installations in hazardous areas shall be documented by a list containing the following information:

- Identification Tag number or other reference used for marking of the specific equipment. This shall be the same in the documentation as on the physical installation
- Equipment type, Descriptive title of equipment, e.g., "cable gland", "fire detector"
- Location of equipment the relevant location of the equipment, according to the hazardous area
- Classification drawing
- Manufacturer, Name and nationality of manufacturer
- Type designation, Manufacturers' type designation
- Certification body, Certificate number and type of protection

• Identification of certifying body, the Ex certificate number and type of Ex protection.
• Special conditions if the certificate number ends with "X" or "U", compliance with the special conditions given in the certificate shall be stated.
• Is-circuit limits and values for intrinsic safe circuits the maximum parameters and values contained in the circuit with respect to voltage versus capacitance (Ceq) and current versus inductance (Leq) shall be listed for each circuit. The maximum values for the applied safety barrier shall be included.
• TE –time for motors and transformers located in a zone 1, certified as "Increased safe", the TE -time shall be listed together with the release time of the associated over current protection.
• IP-rating, Ingress protection rating of the equipment

11.1.12. Emergency Stop of Fans and Pumps

Arrangement for manual stop of fans and pump shall be arranged according to Class and Authority requirement (see emergency stop systems)

11.1.13. Electrical Power System

Electrical plant for this Vessel shall consist of the following main equipment:

Equipment	Qty	Capacity each	Remarks
Main Generator	1 set	1843kW	690V 60Hz
Emergency generator set (Will also be used as Auxiliary Generator during Harbor Ideal	1 set	605 KVA, p.f. 0.9 (approximately 484kW)	440V 60Hz
Electrical motors for main Azimuth thrusters motors and for Tunnel Thruster	4 sets	three (3) 1100kW for three main thrusters and one (1) 570 kW	
Frequency converters for electrical propulsion motors and Tunnel Thruster motor	4 sets	TBC	AFE
Motor starter for offshore pedestal crane	1 set	TBC	

Equipment	Qty	Capacity each	Remarks
Motor starters jacking electric motors	3 sets	Each jacking motor is rated for 350 kW (3 Nos.)	
690V Main switchboard	1 set	TBC	
440V Ship Service switchboard	1 set	TBC	
230V Ship Service switchboard	1 set	TBC	
440/230V Emergency switchboard	1 set	TBC	
Transformers 690 / 440 – 2 sets	2 sets	1250 kVA Approx.	According to calculation
Transformers for 440/230 – 2 sets	2 sets	150 kVA approx,	According to calculation
Transformers for 230 emergency distribution – 1 set	1 set	75ss kVA Approx	According to calculation
Transformers for galley	1 set	TBC	
Transformers for UPS	2 sets	TBC	
Motor control centers for auxiliaries	2 sets	TBC	

11.1.14. Administrative IT for the Vessel

Two (2) servers shall be delivered together with three (3) laser printers, two (2) A3 color printers and two (2) A4 color printers supplied by Owner. Power supply via ship's UPS. Owner shall approve the detailed specification of the equipment before it is ordered.

The Vessel shall be equipped with a star Ethernet cabling system. The system shall be connected by switches/patch panels to wheelhouse, conference rooms; dayrooms control rooms, offices and selected cabins via single Ethernet socket

All Ethernet connections and servers shall be terminated at one location (rack) for easy and flexible use of the net, also for purpose other than connecting computers.
. All software shall be supplied registered by Owner. CDs, diskettes, user manuals and other documentation shall be delivered by Owner.

All software and hardware (incl. external communication) shall operate as a fully integrated Administrative IT-system.

11.2. ELECTRIC POWER SUPPLY

11.2.1. Principal Electric Diagram

The electrical power generation and distribution system shall be designed, constructed and installed as shown in enclosed block diagram.

11.2.2. Electrical Load Analysis

An electric balance shall be worked out to indicate the load at the following conditions:

• Sailing mode
• Harbor maneuvering mode
• Harbor idle mode (In this Mode Emergency Generator is used for supplying auxiliary loads with interlocks)
• Emergency power
• Jacking Mode

Final sizing of generators and transformers capacities shall be according to approved load analysis.

The electrical plant shall be powered by three (3) MAN Main Generators provided by Imtech, or by the shore connection.

11.2.3. Generating Sets

Main generators : 690V AC - 60Hz
Emergency Generator : 440V AC - 60Hz

11.2.4. Main Distribution Systems

Main Distribution Systems shall be provided by Imtech following bellow table:

Switchboard name	Voltage/frequency/ phase	Supply obtained from	Connected consumers
690V AC Main switchboard	690V AC-60Hz-three Phase-three wire	690V AC main generators	Propulsion/thrusters / jacking motors transformers
440V AC Ship Service switchboard	440V AC-60Hz-three Phase-three wire	690V / 440V AC Transformer.	440 V AC Power consumers
230V AC Ship Service switchboard	230V AC-60Hz-three phase- three wire	440/230V AC transformer	230V AC Power consumers
440V AC Deck switchboard	440V AC-60Hz-three phase- three wire	690V / 440V AC transformer	440V AC Power consumers
440/230V AC Emergency switchboard	440V AC 60Hz-three phase- three wire. 230V AC-60Hz-three phase- three wire.	440V AC Emergency Generator,	440/230V AC Emergency consumers
230V AC UPS Clean power switchboards	230V AC-60Hz-three phase- fore wire.	230V AC UPS.	230V AC Navigation and computer
24V Battery systems	24V DC, two wire	Battery chargers or battery	Automation /navigation/ communication

11.2.5. 690V AC Main System

690 VAC system is for propulsion system and large consumers

11.2.6. 440V AC Ship Service System

440 volt ship service system is to supply auxiliary Vessel systems.

11.2.7. 440V AC Deck Switchboard

The 440Volt AC Deck switchboard shall be supplied from the 690 Volt AC Main switchboards via appropriate (690 Volt/440 Volt AC) transformers. The 440 Volt AC systems shall supply the 440 Volt Deck equipment, or export power supply.

11.2.8. 440V AC Emergency System

Normal power for the emergency switchboard shall be supplied from the 440 Volt Ship Service switchboard through bus tie breakers. Upon loss of normal power, the emergency generator shall be automatically started and shall open the bus tie breakers to the 440 Volt AC Ship Service switchboard. Then the emergency generator breaker shall be energized and supply power to the emergency consumers. The emergency generator circuit breaker shall be electrically interlocked in order to prevent damage to electrical systems.

11.2.9. 230V AC Ship Service System

The 230V AC Ship Service system shall be supplied from the 440 Volt Ship Service switchboard via appropriate (440 Volt / 230 Volt AC) transformers. The 230 Volt AC systems shall serve all lighting circuits, domestic equipment and other 230 Volt AC power consumers.

11.2.10. 24V DC System

- One (1) 24V radio battery GMDSS reserve source (normally the GMDSS radio station shall be fed from 230V main supply and 230V emergency supply).
- Two (2) 24V DC battery systems (redundant systems) shall be fitted for supply of 24V bridge equipment.
- Two (2) 24V DC battery systems (redundant systems) shall be fitted for supply of 24 Volt engine room/ ECR equipment.
- Two (2) starting battery for emergency generator.

11.2.11. Generators

11.2.11.1. Main Generators

Brushless 3-phase synchronous water-cooled alternators for marine installations with sliding bearing. Voltage: 690V, 60Hz; Rating:

- three (3) sets of 1843kW Generator, Mounting: IMB20, Insulation: H; Enclosure: min. IP 44 (IC81W) .

The generators shall be equipped with:

- Automatic voltage regulator
- Over voltage protection
- Water temperature sensor
- Winding temperature sensors Cooler leakage detector
- Transformers for differential protection in both ends also for switchboards
- Anti condensation heater
- Purge air ventilation from non-hazardous area with supervision accord to Class requirements.

Generators shall be built on common skid with diesel engines.

11.2.11.2. Emergency Generator

Brushless 3-phase synchronous air-cooled alternator for marine installations. Voltage: 440V, 60Hz; Design: B5/B20, Insulating: H/F; Enclosure: min. IP 23.
Rating: 1 set of 605kVA, p.f. 0.8 Generator (approx. 484kW).

The generator shall be equipped with:

- Automatic voltage regulator
- Anti condensation heater
- Winding temperature sensors

11.2.12. Transformers

11.2.12.1. General

Transformers shall be so located that they will be protected from excess moisture or exposure to liquids and so that the ventilation is not impeded by other equipment, structure or protective shielding.

All power and lighting transformers shall be of the 3-phase marine type having insulation Class F, temperature Class H, Vector group Dyn5, IP 23 enclosure and designed for ambient temperature 45°C , Main lighting & Hotel transformers for 55°C.

They shall be installed in dry, clean and well-ventilated rooms.

The transformers' windings shall be vacuum pressure impregnated (VPI), shall resist moisture, sea air and oil vapors, and shall be braced to withstand the thermal and electromagnetic effects of short circuits.

Each transformer for distribution shall have capacity of 120% of the total load of the actual switchboard indicated in the electrical load analysis. No paralleling of transformers is allowed. The transformers shall be arranged with stand-still heating and manual change over to standby transformer, should the supplying transformer fail. All transformers above 100kVA shall be approved by Class.

Full transformer requirements will be as per electrical single line schematics drawing.

11.2.12.2. Transformer for 440V System, 690V / 440V AC

Two (2) transformers 690 Volt / 440 Volt shall be installed, with sufficient capacity for supplying 440 Volt ship load. The capacity of each shall be approx. 1250 kVA, but final decision by load analysis. The transformers shall have high reactance in order to reduce the short circuit capacity on the 440 Volt distribution system. These transformers shall meet IP 23, if not located in separate high voltage room. Anti-condensating heating shall be provided.

11.2.12.3. Transformer for 230 Volt Systems, 440V / 230V

Two (2) transformers 440 Volt / 230 Volt shall be installed, with sufficient capacity for supplying 230 Volt ship load. The capacity of each shall be approx.150kVA but final decision by load analysis. The transformers shall have high reactance in order to reduce the short circuit capacity on the 230 Volt distribution systems.

11.2.12.4. Emergency Lighting Transformers, 440V / 230V

One (01) transformer with sufficient capacity to supplying all 230 Volt emergency power and lighting shall be installed in emergency Generator room. The capacity of emergency transformer shall be approx. 75 kVA but final decision by load analysis. The transformer shall have high reactance in order to reduce the short circuit capacity on the 230 Volt distribution systems.

11.2.13. Batteries and Battery Chargers

11.2.13.1. Batteries

All batteries shall be maintenance free and shall be so located that the batteries' temperature at all times remains within the manufacturer's specification. The battery H2 emission shall be limited as mentioned in the Class in order to keep batteries in normal area (i.e. to avoid hazardous atmosphere.)

Battery banks shall be provided and installed for the following consumers:-

- GMDSS radio equipment
- Fire detection plant (internal)
- Alarms, controls, navigation & radio equipment on bridge
- Alarms, control, monitoring equipment for engine room
- Starting of emergency generating set.

The voltages shall be 24Volt DC unless otherwise specified by the makers of the receptacle equipment. Capacity, discharge rate as well as number of sets for each of the above batteries shall be in accordance
with regulations and maker's recommendation.

All battery banks shall be labeled on the outside on the box cover with Duty, DC System Voltage and
Ampere-hours, and shall be labeled inside on the cover with recommended battery charging current.

The following consumers shall be supplied from the alarm, control, navigation & communication battery:

- Command communications plant
- Automatic telephone plant
- Other essential consumers for alarm and control etc.
- Autopilot etc.

11.2.13.2. Batteries for UPS Units

Batteries for UPS units shall be installed in racks/enclosures, according to Maker’s standard. The UPS battery banks shall be installed in the compartment below wheelhouse and shall preferably be installed in heavy-duty fiber glass boxes with rubber waffle matting underneath them. Battery capacity to ensure full power, min. 30 minutes after main power cut. Monitoring of essential parameters shall be connected to the IAS.

11.2.13.3. Battery Chargers

Each battery bank shall have separate charging device with volt and current control for high rate and trickle charging with uninterrupted power supply to the specified consumers.

Battery banks for navigation and automation battery sets shall each have two battery charges. Each of the chargers shall have sufficient capacity for 100% of the load in order to get 100% redundancy of power for important equipment. One of the chargers

for each of these battery banks shall be fed from the emergency switchboard.

Each battery charger shall be fitted in the vicinity of the respective battery in a dry area.

All battery chargers shall activate alarm when charging failure/power failure occurs. Each battery charger shall be designed for 100% charging capacity.

All battery chargers shall withstand a total harmonic distortion (THD) of at least 8%.

The charging rate shall be sufficient to replace 100% battery capacity within 12 hours at which point the charger shall automatically revert to trickle charging rate.

11.2.13.4. Rectifiers/Converters

Frequency converters for propulsion azimuths.

The converters shall be fresh water cooled, if not otherwise specified, and suitable for starting and speed regulation of the concerned electric motor. The converters shall be water cooled with dual pumps and shall have temperature supervision/alarm.

Converters shall be mounted on shock absorbers in propulsion compartments.

11.2.14. Electric Shore Supply System

The shore connection shall be min. 3ph x440V, 400A .Suitable location on deck and cable entrance from below shall be arranged for the shore connection cables. Shore connection shall be interlocked with the generators

The shore connection shall be connected to the 440 Volt main switchboard and shall be equipped with the following:

•Moulded case circuit breaker for shore - connection with a capacity 400A.
- Phase indication
- Pilot lamp “shore power available”
- Voltmeter with switch
- Frequency meter

11.3. ELECTRICAL DISTRIBUTION

11.3.1. Main, Ship Service and Emergency Switchboards

11.3.1.1. General

The following switchboards shall be installed by Builder :

- One(1) Main 690V switchboard
- One (1) 440V Ship Service switchboard
- One (1) 230V Ship Service switchboard
- One (1) 440/230V Emergency switchboard
- One (1) Shore connection box, 440V
- One (1) Test switchboard as follows:
  - Input: 440Vac and 230Vac, 3ph, 60Hz
  - Output: 440Vac/ 230Vac, 3ph/1ph, max 16A; 0-250/500Vac, 1ph/3ph, max 2.5A; 0-30Vdc, max 10A; 24Vdc, max 1A; “continuity” & leakage test; test of fluorescent tube.
- Power distribution boards, 440V
- Power distribution boards, 230V
- Lighting distribution boards, 230V
- Emergency lighting distribution boards, 230V
- Emergency distribution boards, 230V
- UPS distribution boards, 230V
- Battery switchboards, 24V DC
- One (01) Navigation lights panel, 230V

The switchboards shall be of self-supporting 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. Each access panel shall be provided with stays to hold access panels open. The switchboard shall be provided with insulated steel handrails in both front and back.

The switchboards shall be arranged with a clear working area at the front (min. 0.9 m) and rear (min. 0.8 m) of the switchboard, and in accordance with the Class requirements.

Rubber floor mats shall be fitted throughout the switchboard room.

Built-in fluorescent fixtures shall be fitted for illumination of the front.

A simple mimic diagram indicating bus bars, bus-tie breakers, air-circuit breakers for generators and transformers, shall be fitted on the front of the switchboards.

Operation instructions shall be made available for all switchboards.

Switchboards shall be designed so that they can be extended and have spare capacity. All power plant shall be controlled and monitored by the Power Management System.

The arrangement of all main Ship Service and emergency switchboards shall be approved by Owner/Levingston before purchasing.

11.3.1.2. Meters

The rated value shall be marked in red on meters, and the scale of meters shall have the following ranges:

Voltmeters	0 to approx. 120 % of rated voltage
Ampmeter	0 to approx 130 % of rated wattage
Watt meters	-15 % (reverse) to approx. 130 % rated wattage
Frequency Meters	55-65Hz

11.3.1.3. Terminals

Cable terminals shall be of the solder less type and clearly marked with the circuit served.

11.3.1.4. Fuses

Control and instrument circuits shall be protected by mini circuit breakers or fuses. Current transformers for instrumentation shall not be fused.

11.3.1.5. Bus Bars

The bus bars shall have sufficient current-carrying capacity for continuous operation and provisions shall be made for withstanding mechanical strains created by electromagnetic forces by large motor starting currents or fault currents. The bus bars shall be made of copper.

Bus bar supports shall be provided with sufficient strength to withstand a short circuit of bus bars, and shall be made of moisture resistant materials.

11.3.1.6. Labeling

Labels shall be provided in English and shall identify all switchboard components, such as circuit breakers, control switches, instruments, indicating lights, terminal

blocks, transformers, etc.

The nameplate on feeder circuits shall indicate the feeder designation, name of application.

11.3.2. 690 V Main switchboards

11.3.2.1. General

All the Main Generators (3 off) shall supply the 690 V Main switchboards. The switchboards shall be located according to the General Arrangement and shall be fabricated according to IMO/ABS. The 690 V Main switchboards shall be connected by one (1) motor-operated bus-tie breakers.

The bus tie breaker operations shall be operated by the PMS systems in addition to local manual control.

All circuit breakers on the switchboards shall be able to withstand the maximum short circuit capacity when three (03) generators are running in parallel and all propellers (3 + 1 off) are running. All switchboard components must be sized to asymmetrical as well as peak fault level (kA/sec)

The switchboard operations shall be controlled by “Power Management System” (PMS)

The Main switchboards shall be of the “dead front” type, arranged with necessary numbers of standardized, segregated, self supporting metal clad steel sheet compartments and fitted out with a single bus-bar system. The Main switchboards shall be air insulated and designed for ship operation and equipped with draw able vacuum/air circuit breakers.

The switchboards shall be designed for free standing mounting on vibration dampers.

The switchboards shall be air insulated and arc proof and shall be tested according Class requirement. Connection of cable shall be from the bottom only.

The 690V switchboards shall be constructed in accordance with the requirements of the Classification Society and arranged with necessary bus tie breakers to allow the switchboard to be split, according to the requirements of the actual Class Notation and the design drawing.

The generators shall be protected by motor operated draw-out type air circuit breakers of the trip free type and controlled by PMS and a manual control switch. In addition, a manual-operating handle shall be provided.

The circuit breaker for the generators shall have an over current trip device with long time over current and short time delay trip action, and a magnetic coil for instantaneous and under voltage trip.

Generators shall be protected from reverse power. Differential protection for winding protection of generator shall be provided.

Each circuit breaker shall be capable of opening circuits carrying maximum rated current at rated potential and shall be capable of interrupting short circuits within their rating.

Liquid lines shall not be located over close to the switchboard. Air from ventilation ducts shall not be discharged directly on the switchboards.

Switchboard and internal components shall be capable of withstanding shipboard vibration without damage or faulty operation. All components such as breaker, contractor, and relay must be design for marine standard for rolling and pitch limits as specified in Class.

Main switchboard shall be properly illuminated and part of these lighting shall be fed from the emergency supply system.

The switchboard design shall consider absolute personal safety. Enclosure code shall be IP 22, if not located in a special room.

11.3.2.2. Parallel Operation of Generators

All the Main Generators (3 off) shall be arranged for parallel running with automatic load sharing and automatic synchronizing of all generators.

11.3.2.3. Bus-bars and wiring

Main bus-bars shall be of insulated copper. Phase identification on main connections shall be L1, L2, and L3.

Auxiliary wiring inside the panel shall be of the insulated stranded copper conductor type. All wiring shall be halogen free and flame retardant type according to IEC 332-3C and approved by Class. Voltage Class shall be 230V for all internal wiring. All internal wiring shall be terminated by ferrules.

11.3.3. Circuit Breakers for Frequency Drive for Thrusters/Propulsion

Motor operated air circuit breaker at MSB that remains switched-ON for normal conditions and internal motor operated circuit breaker at input of frequency drive that will be monitored and controlled by the drive control system itself.

In the event of emergency stop, the internal breaker of frequency drive is tripped by the drive safety system.
Emergency stop switches for converters shall be fitted in maneuvering panels on the bridge.

11.3.4. UPS

One (01) 230 Volt UPS units shall be supplied for control voltage of the switchboard. Each 230V UPS unit shall comprise battery distribution circuit breaker and battery charger.

All draw-out type circuit breakers shall be removable from the panel front without de-energizing the main bus. This includes both main power and control circuits.

11.3.5. Main Generator Panels

One (1) generator panel shall be fitted for each generator. Each generator panel shall contain equipment for protection and control of the respective generator.

The control equipment provided by Imtech and installed in the front of the panel shall at least contain the following:

- One (1) Ammeter with change-over switch (scale min. 130% of the rated full load) (per Phase)
- One (1) Voltmeter (scale min. 120% of the rated voltage)
- One (1) Wattmeter (scale min. –15/+150% of the rated full load)
- One (1) Frequency meter (scale min. +/-8% of the nominal frequency)
- One (1) Voltmeter switch
- One (1) Ammeter switch
- One (1) Synchronous Scope, double voltmeter and double frequency meter only in the middle generator panel..

Indication for running hours and power factor via PMS

Necessary push buttons and indication lamps for the generator breakers and control equipment shall be installed.

11.3.6. Power Management System (PMS)

The PMS will be provided by Imtech and shall handle the entire control of all Main- and Ship Service switchboards, including control of the three (3) main generating sets.

The generator sets shall have fully automatic operation for start and stop based on load demand.

When the available power is less than approx. 20 % of the capacity of the on line generators, there shall be automatic start of the next generator. Automatic stop of generator if the available power exceeds approx. 60% of the capacity of the online generators. Limits shall be adjustable.

The start and stop function shall be time delayed to prevent unwanted start and stop actions due to load transients.

The power management system shall have start blocking of heavy consumers if requested power exceeds the available power, until a new generator is started.

The heavy consumers shall start automatically when the requested power is available. If requested power is not available within 3 minutes (adjustable) automatic start shall be reset.

If main generators are overloaded, the Power Management System will reduce load on the propellers and thrusters. Additionally, if shutdown of a gen-sets should occur, a separate quick load reduction shall be initiated from main switchboard directly to the propeller drive frequency converters.

11.3.7. 440V AC Ship Service Switchboards

11.3.7.1. General

The 440V AC Ship Service switchboards provided by Imtech shall be installed and shall be fabricated according to IMO / ABS requirement. The switchboards shall be of the “dead front” type, and shall be self supporting metal clad single bus-bar panels for ship operation equipped with motor operated withdraw able air circuit breakers (main breakers) and Molded Case Circuit breakers (consumers). The switchboard shall be designed for free standing mounting on vibration dampers.

The 440V AC Ship Service switchboards shall be supplied by the 690 Volt / 440V AC transformers or by shore connection (440V).

All circuit breakers shall be able to withstand the maximum short circuit capacity when generators are running in parallel and all propellers are running.

Shore connection shall be connected to one of the 440 Volt AC Ship Service switchboards. All the switchboards shall be provided with ground fault detection system with alarm.

The switchboards shall be tested according to Class requirement. Connection of cable shall be from the bottom only.

11.3.7.2. Layout 440V AC Ship Service switchboards

Non-conducting handrails shall be provided at the front and rear of the switchboards. Rubber mat shall be fitted at the front and rear of the switchboards.

Type and number of components fitted on the panels shall be in accordance with Class requirement, manufacturer's standard and subject to Owner/Levingston approval during plan review.

Emergency switchboard and shore connection shall be connected to the switchboard. Each 440V AC feeder panel shall be provided with the following:

- One (1) Ammeter with a selector switch for reading each phase current of the transformer's secondary circuit
- One (1) Voltmeter with a selector switch for reading each phase
- One (1) Insulation level meter with earth indication lamp and alarm connected to the Vessel automation system (for each bus bar system)
-
- Necessary number of triple pole molded case circuit breakers
- Operation of bus-tie breakers

11.3.8. 230V Ship Service Switchboards

The switchboards shall be fabricated according to IMO / ABS requirement.

The 230 VAC feeder panel shall be provided by Imtech with following:

- One (1) Ammeter with a selector switch for reading each phase current of the transformer’s secondary circuit
- One (1) Voltmeter with a selector switch for reading each phase
- One (1) Insulation level meter with earth indication lamp and alarm connected to the Vessel automation system.
- One (1) Necessary number of triple pole molded case circuit breakers (plug-in type)
- 15% Spare breakers

11.3.9. 440/230V Emergency switchboard

The switchboard shall normally be supplied from 440V switchboard provided by Imtech. All circuit breakers shall be able to withstand the maximum short circuit capacity when three (3) generators are running in parallel and all thrusters are running.

In case of a black-out, the connection between main and emergency switchboard opens. The emergency generator will start automatically and connect the emergency generator breaker, according to Class requirement.

The generator and 440 VAC feeder panel shall be provided by Imtech with followings.

- One (1) Draw out type air circuit breaker for generator(motor operated, connected to PMS)
- One (1) Draw out type moulded case circuit breaker for bus tie to 440 V Ship Service switchboard (motor operated)
- Plug-in type MCCB for 440/230 Volt transformer (manual operated)
- One (1) Voltmeter with a selector switch
- One (1) Ammeter with a selector switch
- One (1) Frequency meter
- One (1) Wattmeter
- One (1) Generator running indicating lamp (green)
- One (1) Circuit breaker "ON" indicating lamp (green)
- One (1) Circuit breaker "OFF" indicating lamp (white)
- One (1) Indicating lamp for space heater (white)
- Spare breakers

The 440 Volt AC section of the emergency switchboard shall be fed from the 440 Volt AC main switchboard under normal (non-emergency) conditions.

Should voltage failure of the 440 Volt AC main switchboard be detected, the emergency generator will start automatically and feed the emergency switchboard.

The following consumers shall be fed from the 440 Volt AC panel of the emergency switchboard:

- Emergency lighting transformer
- Battery chargers
- Emergency air compressor
- Emergency fire pump
- Bilge pumps
- Machinery space exhaust fan

Any other emergency consumer required by the Rule and Regulation

11.3.10. 230 V AC Feeder Panel

The 230 Volt AC feeder panel shall be provided with followings:

- One (1) Ammeter with a selector switch for emergency transformer
- One (1) Voltmeter with a selector switch
- One (1) Insulation level meter with earth indicating lamp
- Necessary number of triple or two pole molded case circuit breakers and miniature circuit breakers
- Spare breaker

The 230 Volt AC feeder panel shall be fed from the 440 Volt AC feeder panel of the emergency switchboard via the emergency transformers or from the 230V MSB.

The following consumers shall be fed from this panel. Emergency lighting distribution panels

- UPS for 230 Volt AC (Navigation/Communication)
- Lifeboat embarkation and launching lights
- GMDSS console (emergency source)
- Battery charger for 24 Volt DC GMDSS battery
- Fire alarm control panel
- W/H control console
- Navigation light indicating panel
- PA / intercom panel

Other necessary navigation and communication equipment according to relevant Rule and Regulations.

11.3.11. 440 V AC Motor Control Centre (MCC)

Generally, starter units for essential motors for propulsion and starter units for auxiliaries shall be included in Motor Control Centers (MCC), except for some motors requiring special local controls, such as purifiers, machine tools, pumps connected to valve chests, etc.

All Motor Control Centers (MCC) by Imtech shall be 3-phase, 3-wire, 60 Hz., 440 V AC. , marine drip-proof with non- conductive handrails. All MCC buckets shall be draw-out type. Bus bars shall be tin-plated copper and wiring shall be halogen free Class approved type. All motors starter protectors mounted local to the motors shall be enclosed in a steel enclosure.

All motor starters shall be of combination type with circuit breaker, fused control power transformer, selector switchand “Run” pilot light.

The starter for each motor shall be built into an enclosed sheet-metal panel of drip-proof construction. The construction shall be in such a manner that problems within any one panel shall not extend to any adjacent panel. Each starter panel shall be arranged to allow inspection and repair safely without de- energizing the adjacent panel.

All the DOL starter and MCCBs shall be selected as per type 2 co-ordination. In general, each starter panel shall be fitted with the following:

- Molded case circuit breaker or disconnecting switch
- Running light (green)
- Magnetic contactor with overload relay
- Ammeter for motors of 5 kW and above
- Space heater switch and indicating lamp (blue), where required
- Running hour meter and running signals to Vessel automation system for the motors of 5 kW and above, and the sea water cooling pumps.

Each MCC shall be provided with 10% spares. Type 2 protection must be followed for all starters’ (DOL/ Star Delta) protection.

Additionally, each motor control shall have wiring diagrams on rear of doors, insulation shields on all exposed terminals and nameplates as per Class requirements.

Motors connected on the MCC’s shall also be started/stopped locally at the respective motor sides, by push buttons.

11.3.12. Motor Starters

11.3.12.1. General

The specification described in this section shall be applied, in general, to motor starters by Imtech. The single starters shall include the same equipment as described above in the MCC. All motors above 0.5kW shall be provided with DOL starter.

However, starters supplied as part of the following equipment shall be constructed in accordance with the relevant manufacturer’s standards.

Electric appliances provided in the galley, pantry, and laundry Navigation equipment such as radar, gyrocompass, etc.

Instrumentation and control equipment. Package type air conditioning units.
Auxiliary machinery such as deck cranes, lifeboat davits, ventilating fans, workshop machinery, tools, etc.

In general, starters shall be a drip-proof type and shall be of suitable construction for either deck or bulkhead mounting.

Drawings of the starter circuit shall be provided and mounted in clear plastic envelopes inside the starter enclosure.

Starters shall be of electro-magnetically operated type, except starters for non-essential motors of 0.5 kW and less, that may be manually operated with molded case circuit breakers or protectively fused line switches.

In general, starters shall be of direct-on-line starting type.

Where excessively high starting current of the large motors could cause voltage drop of the switchboard bus bars more than 15 %, the starters for those motors shall be of star to delta or auto transformer starting type. If star to delta starters is used, means should be provided to prevent transients on the main power network.

Under-voltage release and under-voltage protection shall be provided in accordance with regulatory requirements.

11.3.12.2. Stand-by Start

Essential and important machinery, where one of two sets normally is used shall have automatic stand-by start, at loss of voltage and/or at too low-pressure functional defect when applicable. The pre-selected pump shall be automatically re-started after blackout. Stand-by of pump start shall initiate an alarm in the Vessel alarm system.

11.3.12.3. Preferential Trip

When the running generator sets are overloaded, non-essential consumers shall be automatically tripped to prevent the complete power failure of the Vessel. Preferential tripping system shall be arranged in steps by the PMS system.

When one of the generators in parallel is abnormally tripped, the first step is the initiation of automatic start up and paralleling of the stand-by generator set.

If the remaining generator set is still overloaded, the second step shall be of the preferential shedding of non-essential loads is shall be initiated instantaneously.

11.3.12.4. Automatic Sequential Starting

Automatic sequential start up after restoring of power following a black-out shall be arranged and facilitated by means of proper time relays located in the starting compartment. No zero voltage relays and no manual resets of starter after a black-out must be arranged in the protection circuits (only automatic operation).

The following systems shall be arranged with automatic sequential start:

- All auxiliaries associated with propulsion and power plant
- Engine room ventilation fans

Time delays shall be adjusted as necessary during Class required design verification testing. However, the following equipment shall be started instantaneously without time delay:

- Steering hydraulic motors
- Lighting
- Navigation and communication equipment
- Control and instrumentation equipment

11.3.13. Distribution Boards and Panels

11.3.13.1. General

Each distribution board shall be equipped with an engraved plastic nameplate on the front with all necessary information (name of consumer, location, main fuse rating and feeder cable size). Inside each distribution board a directory sheet in transparent plastic cover shall be fitted, with necessary information for all feeders (name of consumer, location, fuse rating and cable size).

Protection shall be provided against accidental contact with live parts. All steel enclosures including doors shall be earthed.

A sufficient number of spare circuit breakers (20%) shall be left in each distribution panel when the Vessel is completed (one spare breaker for each five active breaker).

All fuses up to 63 amps shall be of the automatic circuit breaker type, except where for technical reasons, the other type must be used. Fuses above 63 amps shall be avoided in distr. panels.

All switchboards/panels in accommodation spaces shall be fitted in lockable cabinets, near the cable duct room on the respective decks.

All cable inlets/outlets for switchboard/panels throughout the Vessel shall be fitted with

fire resistant compound.

All distribution board shall be located for easy access. Distribution boards fitted on bridge and accommodation shall be flush-mounted type (recess mounted).

11.3.13.2. 440V Distribution Board

The 440V distribution boards for supply of 440 Volt power consumers shall be located where necessary around the Vessel.

The 440V distribution boards shall be denominated “P1”, “P2”, etc., with numbering starting on the bridge.

11.3.13.3. 230V Distribution Board

The 230V distribution boards for supply of low consumption- and domestic equipment shall be located where necessary around the Vessel, with at least one 230V distribution board fitted on each deck level.

The 230V distribution boards shall be denominated “L1”, “L2”, etc., with numbering starting on the bridge.

230V distribution panels for engine room may be centrally located in the Engine Control Room.

230V distribution panels for accommodation shall be located in a central position on the deck served. To the extent possible, lighting distribution panels will be located in the same position on each deck served. Single- phase circuits shall be distributed evenly between the three phases.

11.3.13.4. 230V AC Emergency Distribution Board

230V AC Emergency distribution boards, denominated “E1”, “E2”, etc., shall be fitted where necessary. The distribution boards shall be fed from the emergency switchboard, and shall supply all necessary Emergency consumers around the Vessel, if not supplied directly from the emergency switchboard.

11.3.13.5. Navigation Light Panel

One (01) Navigation light distribution panel shall be supplied from Pilot House

11.3.13.6. Distribution Board Galley

Amp. meter and V / k ohmmeter shall be included in the galley equipment distribution panel for easy control and testing of the galley cooking range, hot plates etc.

11.3.14. 24V DC Distribution Board

Dead-front type battery switchboards shall be provided for the 24 Volt battery distribution systems (switchboards on bridge shall be recessed type).

Each battery switchboard shall be fitted with the following instruments and devices:

- DC voltmeter
- DC ammeter with a selector switch
- Source pilot lamp
- Insulation level meter with earth indicating lamp
- Push button switch (quick charging or trickle charging)
- Necessary numbers of feeder circuit breaker with fuses
- Battery discharging alarm
- Low voltage alarm for on-line battery
- Summary alarm for machinery monitoring system

11.4. ELECTRICAL CABLE AND INSTALLATION

11.4.1. General

Cables supplying a single load, in general, shall have a continuous current carrying capacity of the connected load.

Cables supplying multiple loads, in general, shall have a current carrying capacity calculated without consideration of demand factor and/or diversity factor to the total connected loads.

The voltage drop on all power and lighting circuits from main bus bars to the final termination point shall not exceed 6% of the nominal voltage, except for DC circuits, where a maximum voltage drop of 10% of the nominal voltage is allowed.

The type of cables and installation inside switchboards, starters, panels, etc. shall be provided in compliance with the regulations of the Classification Society.

11.4.2. Cable and Wire Marking

All electrical cables in both ends, conductors and terminals shall be clearly and durably labeled for easy indication and drawing reference.

Wire marking system shall be thermally embossed or type written using permanent ink, type Brady PS-PTR-II Perma Sleeve Printer, or equivalent wire marking system.

Embossed aluminum cable tags shall be used to show cable designators at each cable termination. Embossed Nylon cable tags shall be used for cables on weather deck.

Cable marking labels shall be labeled according to the Builders cable installation list.

11.4.3. Routing of Cables

In general, all cables shall be supported by continuous corrosion resistant steel metal hangers, ladders or cable trays as far as possible. Metal hangers, ladders or cable trays also shall be provided in bends in order to get a continuous support. Expansion joints shall be provided where required. No cables shall be run on unpainted steel.

In the engine room, machinery spaces and other wet rooms, all cable hangers, ladders and trays, including their fixing devices, shall be made of galvanized steel.

On weather decks all cable hangers, ladders and trays shall be made of stainless steel or Class approved non-metallic materials with equal properties.

When fixed to aluminum structures, aluminum alloy cable ladders and trays shall be used.

Cable runs shall be located as far as possible (minimum distance 0,5m) away from spaces exposed to excessive heat, steam, exhaust and moisture.

Cables shall be protected by removable steel covering or steel conduit where exposed to hot water, steam, oil, high temperature or mechanical damage. Horizontal mounted steel conduits used for cable protection shall have 6mm holes for drainage for every 2m.

Cables run under the lowest flooring in engine room shall be protected with cable tray or steel conduits with drain holes, for protection against mechanical damage. All cable runs shall be as continuous and as straight as possible.

Cable installation on weather decks shall be minimized. Cables shall be run through galvanized steel pipes or protected cable trays and shall be as short as possible. Cables shall be provided with heat shrinkable tubes to seal the cable and gland transition for all weather deck installation.

On weather decks in cargo hold areas, and through cargo holds, all cables that may be exposed to mechanical damage shall be protected by covers of steel plates, steel grills or profiles of at least 4 mm thickness, or by being carried in steel pipes.

11.4.4. Painting of Cables

No cables shall generally be painted.

11.4.5. Separation of Cables

Where a system shall have duplicated supply and/or control cables, for safety reasons , the cable routes shall be located as far apart as possible.

F&G and PAGA System cables shall run together maintaining diverse cable tray routing and Data network cables will run on separated cable tray. Both Cable tray types will maintain a minimum distance of 300mm from power cables in service condition and a minimum distance of 200mm will be maintained in areas of space constrain

Cables and wiring serving essential, important or emergency installations shall be routed clear of galleys, machinery spaces and their casings and other high fire risk areas, except for supplying equipment in those spaces. They shall not be run such that heating through fire divisions may jeopardize the function of the cable. Special attention shall be given to the protection and routing of main cable runs for essential installations, for example between machinery spaces and the navigation bridge area, taking into account the fire risk existing in accommodation spaces.

Cables belonging to intrinsically safe circuits shall be marked specially and must be laid at a distance of 0.5m from cables of non-intrinsically safe circuits.

11.4.6. Protection of Cables during Installation

All cables shall be securely and properly protected against mechanical damage during the new-building period. If the outer sheet of a cable is damaged, the cable shall be replaced by a new cable.

During hot works, all cables exposed to sparks from welding/blow pipe works shall be properly protected by means of an incombustible carpet or curtain. If the outer sheet of a cable is burnt, the cable shall be replaced by new cable.

11.4.7. Cable Pulling

The cable manufacturer’s instruction regarding max. pulling force shall be followed.

All cable runs must be smooth and clean or covered with an additional protection, to prevent any damage on the protective covering of the cable.

Pre-cut cable section in waiting position before final installation must be protected.

11.4.8. Cable Bundles

Power cable of maximum 12 to 18 cables or signal cables of maximum 15 cables shall be bunched together by one clamp.

If bunching of larger formations is used for cables expected shall be under full load simultaneously, a correction factor of 0.85 shall be applied.

11.4.9. Cable Bends

The minimum internal bending radius for power and control cables shall be in accordance with the manufacturer's recommendations.

11.4.10. Sharp Edges

Clips, saddles, bands and supports shall not present any sharp edges against the cables.

11.4.11. Deformation of Cables

Any deformation of the external sheath of the cables caused by fixing the device shall not be more than 5% of the external diameter of the cable.

11.4.12. Fixing of Cables

Cables shall be properly fixed without damaging their outer covering, according to Class requirement. Cables shall be fixed by clips, saddles or bands, of corrosion resistant metal, except when carried in pipes.
The spacing between supports or fixing shall be suitably chosen according to the type of cable and the probability of Vessel movement and vibration at the actual point of installation, as given in the table below.

Cables shall be supported so close to an enclosure entry through a cable gland that it runs straight through the glands and the gland does not take up any mechanical forces from the cable.

When cable runs are installed directly on aluminum structures, fixing devices of aluminum shall be used. For mineral insulated cables with copper sheath, fixing devices in metallic contact with the sheath shall be of copper alloy.

The cables shall be fixed with a fixing point ratio at least according to the table below:

Cable runs	Maximum distance between plastic securing strips	Maximum distance between stainless steel securing strips	Remarks
On top of horizontal ladders/trays	0.75m	1M	
Hanging below horizontal cable ladder	0.5m	0.5m	
On vertical cable ladder	0.5m	1m	Stainless steel clamps or band can

All plastic securing strips shall be approved by Owner/Levingston representative, before installation, in order to check if the type has certificate for resisting UV radiation and shall be all weather resistant.

When cable runs are subjected to water splashing on weather decks they shall be secured by stainless steel securing strips, clips, saddles or bands. The maximum distance between fixings of cable and its support (cable trays or pipes) shall be 500 mm.

Fixing of single core cables laid in trefoil formation for 3 phase installation used for e.g. generators, tunnel thruster, etc. shall be fixed by use of specially made safety clamps. The maximum distance between the clamps shall be 0.2m, to withstand the thermo-mechanical and electromagnetic short-circuit forces.

11.4.13. Unprotected Battery Installation

The connections between the batteries and the switch or fuse-gear (un-protected circuits) are shall be installed “short-circuit-proof”, by use of single-core cables.

Unprotected generator and power converter installation

Connections from generator terminals to circuit breaker and fuses (un-protected circuits) are shall be installed “short-circuit proof” by use of single-core cables.

The same applies to connections from the terminals of secondary circuits of power converters above 25 kVA rating, and to other connections which do not have sufficient short circuit protection.

11.4.14. Short Circuit Proof Installation

Single-core sheathed cables without metallic sheath/armor/braid shall be used for Short circuit proof installation. If insulated conductors are used instead of sheathed cables, the conductors from different phases are shall be kept separated from each other and earth by supports of insulating materials, or by the use of outer sleeves.

11.4.15. Single Core Cables

To avoid undesirable inductive effect, single core cables should normally not be used for AC installation onboard this Vessel, other than for Short-circuit proof installation.

Exceptions for other installation may be given only for cables for thruster motors without converter drive, in order to save space.

Single core cables shall have no braiding or armoring of metallic material.

Single core cables of the same circuit shall be run in a separate bundle in such a way that they form a triangle. The bunch must not be divided by any magnetic material.

They shall be laid under the same clips or in the same conduit. Cable entries and glands shall be made of non-magnetic material, if the cables do not run together through the cable entry or gland.

Sufficient distance to other cables (300mm) and to parallel steel bulkhead, or other extensive surface of magnetic material (50mm) shall be arranged.

11.4.16. Parallel Connection of Cables

Cables can only be parallel connected when the following are fulfilled:

- Of equal cross section
- The conductor cross section is 10mm2 or above

- They are of equal length
- They are of the same type
- They have common electrical protection.
- Parallel connection of flexible cables is not permitted

11.4.17. Cable Inlet and Penetration

Cable inlets of electrical equipment outside the dry accommodation spaces shall be made from the bottom, or lower part of said equipment with drip proof installation. Cable inlets of main and emergency switchboard as well as group starter boards and similar equipment shall be made from the bottom only.

Watertight or gas tight cable penetrations through decks or bulkheads shall be of a Class approved multi cable transit type (MCT), with possibilities to open the transit for future additional cables. Where only one cable is passing through a deck or bulkhead, a Class approved single gland mounted on a pipe welded to the surface, can be used.

For protection of vertical cable penetration to open deck, galvanized pipe with gland on top shall be provided. The pipe shall be strongly welded to deck and shall have a height of 900mm above deck with a swan neck on top.

In coamings for cables passing through non-watertight stiffeners or bulkheads, the cables shall be protected by lead, rubber or plastic grommet to prevent sharp metal from damaging cable insulation, and fire-resistant compound shall be used in order to prevent air circulation in the event of fire.

Where cables for lighting, switches, receptacles, clocks, alarms, instrumentation, etc. penetrates a joiner bulkhead, the hole in the jointer bulkhead shall be circular, of uniform size and suitably fitted with a rubber or plastic grommet to prevent sharp metal edges of the joiner panel from damaging cable insulation.

11.4.18. Earthing

Generally shall all metal parts of the electrical installation, other than current carrying parts be earthed. Earthing may, however, be omitted for double-insulated equipment, bearing housings, low voltage equipment etc.

Metal enclosures which are installed directly on parts of the steel hull, or steel constructions which are welded to the hull, may be earthed by means of the fixing devices, provided a reliable contact is obtained.

Earth bars of non-metallic enclosures shall be properly earthed to the hull.

The connection of earth conductors to the earth bar and to the hull, shall be made by corrosion-resistant screws or clamps. Cross section shall correspond to the earth conductor. Earthing screws and clamps shall not be used for other purposes.

All current carrying parts of the electrical equipment contained in metal enclosures are shall be insulated so as to reduce the risk of electrical shock to personnel.

Noncurrent carrying metal parts of electrical equipment shall be effectively earthed by means of copper straps connected to the Vessels structure, according to Class requirement. Where applicable screened cable shall be used.

Earthing of power cables and electrical equipment shall be done according to Class rules and regulations.

Earthing of instrumentation and communication cable screens shall be done according to makers' requirement. The screen/ earthing wire shall be as short as possible, in order to prevent electromagnetic noise and interference. In general, to prevent EMI, special cable glands shall be used for earthing of cable screen outside the equipment (no cable screen inside enclosure for sensitive equipment).

For instrumentation/communication cables with only one screen, the cable screen shall be earthed in both ends (if accepted by equipment maker).

If double-screened cables are used, the outer screen shall be connected to earth in both ends and the inner screen shall then be connected the shortest way to earth in one end.

11.4.19. Electric Equipment Enclosure

All electrical equipment in machinery or similar spaces shall have at least IP 44 enclosures unless otherwise specified.

Equipment under floors and other wet places shall have minimum IP 55 enclosure and equipment on deck shall be of minimum IP 56 enclosure.

11.4.20. Cable Types

All cables shall be marine type weather resistant cables designed for 45°C ambient temperature and a temperature Class of 85°C for propulsion, power and lighting cables.

All cables to have Class certificate and shall in general be constructed by use of stranded copper conductor, insulation of Cross linked Poly-Ethylene (XLPE) or Ethylene Propylene Rubber (EPR) and with outer sheet of SHF-1.

All power cables shall be produced and tested in accordance with the following international standards: IEC 60092-351 (insulation material), IEC 60092-359 (sheathing material), IEC 60331 (fire resistant), IEC 60332-3 (fire retardant), IEC 61034 (low smoke), IEC 60754-1 (halogen free), IEC 60754-2 (non corrosively).

All control and signal cables shall be produced and tested in accordance with the following international standards: IEC 60092-352, IEC 60332-3 (fire retardant), IEC 61034 (low smoke), IEC 60754-1 (halogen free), IEC 60754-2 (non corrosively).

The Cables provided for main deck open area or hazardous area must have armored protection.

11.4.20.1. Power Cables, 690V System

Approved ship's type halogen-free cable of ample size. The Voltage grade of cables must be 1 KV.

Cables with copper braiding shall be used on deck and in hazardous areas. Color of outer sheet shall preferable be red.

11.4.20.2. Power Cables, 440V System

Approved ship's type halogen-free cable (0.6/1kV) of ample size minimum 1.5 mm2 shall be used throughout the Vessel. Cables with copper braiding shall be used on deck and in hazardous areas. Color of outer sheet shall preferable be black.

11.4.20.3. Lighting Cables, 230V System

Halogen free ship's type cables (230V) of ample size minimum 1.5 mm2 shall be used throughout the whole Vessel. Cables with copper braiding shall be used where required. Color of outer sheet shall preferable be black/grey.

11.4.20.4. Control Cables

Halogen free ship's type cables (230V) shall be used throughout the whole Vessel. Cables with copper braiding shall be use. Color of outer sheet shall preferable be orange/Black/Grey.

11.4.20.5. Signaling and Remote Control Cables

Ship's type halogen free copper wire screened twisted pair cables, min. 0.5 mm2 compliance with IEC60331, shall be used for F&G system,Magnetic door holder,watertight indication. Color of outer sheet shall preferable be orange/Grey .Pair

colour coding - White & blue

11.4.20.6. Communication Cables

Communication cables: To use Overall shield Unbraided paired cable with cross-sectional area 0.75 to 1.5Sqmm compliance to IEC60332. Color of outer sheet shall preferable be orange/Grey Pair colour coding - White & blue

11.4.20.7. Field Bus Cable

Ship's type halogen free twisted pair bus cable of stranded copper conductors, with individual screens and collective screen shall be used for field bus communication.

Standards: EN 50170. Equipment suppliers shall approve the cable type before installation.

11.4.20.8. Entertainment system

Ship's type halogen free coaxial cable of copper conductor, with shall be used for Ship's Entertainment system

Standards: IEC 60332-3, IEC 60754-1/60754-2, IEC 61034. Equipment suppliers shall approve the cable type before installation.

11.4.20.9. Local Area Network (LAN) cables

Ship's type halogen free twisted CAT6 STP shall be used for Ship's Local Area Network. The cable shall be suitable for environment with high signal/noise coefficient.

Standards: EN 50172, 50167, ISO/IEC 11801, M TIA/EIA 568A. Equipment suppliers shall approve the cable type before installation.

11.4.20.10. Fiber Optic Cable

Ship's type halogen free cables for the fiber optic communications shall be glass fiber, armored cable suitable for marine use. The cable shall be tight buffered for fast and reliable splicing and connector mounting. The cable shall have strength elements of armored yarn around the cable core for easy installation of longer lengths. The cable shall also be oil and fire retardant.

The cable shall comply with the IEC publication Nos. 794-1 and 794-2.

11.4.20.11. Flexible Cords

Flexible cords for portable or semi-portable appliances such as portable lamps, shore connection, etc., shall be of a multi stranded copper conductor type, with flexible ethylene propylene rubber insulation and oil resistance outer sheet of cross-linked elastomeric with excellent mechanical properties.

For table lamps in dry accommodation spaces, flexible vinyl cord shall be used.

11.4.20.12. Special Requirements for Cabling

Special low loss screened cables are shall be supplied and installed on a dedicated tray away from other power cables (0.5m), where necessary.

Special high standard marine cables, such as coaxial cables, compensating cables, etc. shall be used where required by equipment manufacturer.

11.4.20.13. Cables for Converters

Power cables used between converters and electrical motors shall be suitable and approved for the actual frequency converters drives (e.g. IGBT).

Power cabling from frequency converters to motors shall all be 3-wire cable with copper braiding. Single core cables shall not be used for this purpose.

All cables for high/medium voltage shall be laid with 0,5m distance to all lower voltage cables, control cables and monitoring cables.

11.4.21. Cableways

11.4.21.1. General

All cables shall be effectively supported and secured without damaging the outer covering of the cables.

Cable groups shall be supported on metal hangers, ladders or cable trays, located away from exhaust or hot pipes, and shall be installed clear of steel hull structure, in order to permit painting of the surrounding structures.

Cable ladders shall preferably be fitted with “Z”-rungs for possibilities to run cables on both sides of the cable ladders.

11.4.21.2. Accessibility of Cable Runs

Cable runs shall be accessible, except for cables carried in pipes.

Cable runs shall be accessible for later inspection. Free distance above trays, and cables laid on trays, for later maintenance and possibility for changing of cables. Distance between cable trays, or towards adjacent structures shall be a minimum of 50 mm.

When cable runs are carried behind bulkhead lining in accommodation spaces (except when carried in pipes), the panels shall be hinged or fixed for example by screws, so that they can be removed for inspection without damaging the cable or the bulkhead.

Exceptions can be made for cables to light fittings, switches, socket outlets etc. in dry accommodation spaces, when the deck head and bulkhead constructions are made of incombustible materials.

11.4.21.3. Routing of Cables for Emergency and Essential Equipment

Cables for power and control of steering gears shall be routed in two different cable runs (preferably A60 separation) from steering gear compartment to switchboard room/Emergency generator room and to wheelhouse, respectively.

Cables for essential/ emergency power for lighting, internal communication or signals shall be routed clear of galley, laundry, machinery spaces and other area of high risk of fire.

11.4.21.4. Separation of Cable Runs

Cable runs for cables for communication, signaling and remote control shall be separated from power cables by a distance of 0.2M.

Cable runs for special low loss screened cables shall be supplied and installed on a dedicated tray away from other power cables (0.5m), where necessary.

Cable runs for cables for high-voltage installations and cables between frequency converters and motors shall be run at a distance of at least 0.5m from low-voltage cables (690V440/230V).

11.4.21.5. Cableways in Engine Room, etc.

Cables under flooring in engine rooms and other exposed places shall be properly protected against mechanical damages.

All cable trays and cable ladders in engine rooms and areas exposed to water and moist

shall be galvanized steel. Cable fasteners shall be made of stainless steel of Owner approved type.

11.4.21.6. Cableways in Accommodation

The cable trunks shall have removable hatches for easy excess. Distribution boards shall be located in cable trunks at each deck.

Cables in the whole accommodation shall be concealed in conduits behind ceiling and lining. Halogen free plastic conduits, wall boxes and ceiling boxes shall be used. Where it is impossible to run concealed conduits behind linings, surface raceways with color matching the wall may be used.

Main cable trays shall mainly follow the corridors where the junction boxes for the concealed installation shall be placed, above removable ceiling or behind removable linings.

Panel work in accommodation, covering cable runs, shall be easily removable.

Cables in refrigerated compartments shall be run on stainless steel cable trays and shall be secured by means of clips, saddles or bands of stainless steel.

11.4.21.7. Cableways on External Decks

Cable installation on weather deck shall be minimized. For protection of vertical single cable penetration, galvanized pipes with cable gland on top shall be installed. The pipes, which shall be equipped with swan neck, shall have a high of 900mm above the actual deck level and shall be strongly welded to the deck.

Cables on weather decks shall be properly protected against mechanical damages.

All cable trays and cable ladders shall be of galvanized steel. Cables shall be secured by means of securing strips, clips, saddles or bands of stainless steel.

Cables installed on masts or posts shall be run in galvanized steel pipes up to 1000mm above the actual deck level.

11.5. ELECTRICAL CONSUMERS

11.5.1. General

The following general items are valid for the complete electrical and automation

installation throughout the whole Vessel.

In gas hazardous zones, special approved electrical equipment shall be used.

11.5.2. Degree of Protection

All electrical equipment shall at least fulfill the Class requirement regarding enclosure degree of protection in relation to location of equipment.

In addition to Class requirement, all weather deck control stations and instrumentation, and all socket outlets, enclosures, junction boxes, floodlights, fluorescent lights and other light fittings shall have IP56 rated degree of protection.

Equipment in dry accommodation spaces shall have IP 20 rated degree of protection or better. Equipment in engine rooms shall have IP44 rated degree of protection or better.

11.6. LIGHTING SYSTEMS

11.6.1. General

Weather fluorescent lights shall be provided for all external lighting on the main deck and above. Lighting control panels shall be installed in the wheelhouse and suitable locations as appropriate.

When control panels are located remote from the area served, sub panels with switches and breakers shall be provided as appropriate in the area served.

Permanent lamps shall be fed from the 230 Volt AC normal supply system unless otherwise specified. Switches and receptacles shall have sufficient current carrying capacity for the circuits.
Exterior lighting fixtures and receptacles shall not be connected to branch circuits used for interior lighting or receptacles.

In general, the type of lighting fixtures and fittings shall be dependent upon the intended service and the location of the fixture.

11.6.2. Lighting Equipment

High quality fluorescent fixtures of recognized standard type, constructed for marine use shall be used throughout the whole Vessel except for rooms where wall lamps or special exclusive lamps shall be fitted.

Fluorescent fixtures shall not be equipped with power compensation capacitors, due to the risk of harmonic resonance.

The number of types of light fittings shall be limited to a minimum, to reduce the spare parts and the type of fluorescent lamps.

Lighting fixtures exposed to mechanical damage shall be protected with guards for incandescent lamps and polycarbonate globes for fluorescent lamps.

Lighting fixtures shall be ruggedly constructed to withstand shipboard vibration. Fixtures for exterior applications shall be constructed of stainless steel, bronze, polycarbonate or iron free aluminum. Fixtures for interior locations shall be constructed of steel or aluminum.

All fixtures shall be accessible for maintenance.

Lighting fixtures and accessories exposed to water and water spray shall be watertight.

Provisions shall be made to eliminate the possibility of radio interference from fluorescent or high intensity electric discharge lamps.

The bodies of switches, plugs, receptacles, junction boxes, etc., may be constructed of synthetic resins, cast brass, stainless steel or steel plate. Stainless steel or cast bronze material shall be used for these applications in areas exposed to the weather.

Starting method of fluorescent lamps shall be of the glow start type except in the refrigerated rooms where the electronic or thermal type shall be used.

All lighting fixtures shall be chosen together with the Buyer.

Special rapid type starters shall be used for the high-pressure sodium floodlight fixtures.

11.6.3. Junction Boxes

Junction boxes may be provided for cable joints, where necessary, but in general, the numbers of junction boxes should be restricted to a minimum.

Junction boxes shall be clearly marked with PVC labels designating voltage and feeder circuit/system. If junction boxes are concealed behind ceiling or lining, the labeling should be located on the outside of such panels.

11.6.4. Switches

Switches used for lighting branch circuit shall be of 16A double pole type and the material of body shall be synthetic resin or cast brass.

Lighting switches in accommodation area shall be of 10A minimum.

Switches shall be flush mounted in the accommodation and other areas where bulkheads are finished with joiner work or panels and surface mounted in other areas.

Switches for bed lights/desk lights shall be fitted on the lighting fixture themselves if practicable.

Switches for ceiling lights in the day room of cabins shall be two-way type and the ceiling lights shall be switched ON and OFF at two (2) stations, one (1) of them shall be fitted near the entrance door and the other at the bed room door.

Switches for ceiling lights in lounges and other public or control spaces with multiple entrances shall be of the two-way or three-way type and the ceiling lights shall be switched ON and OFF at stations near each entrance door. Additionally, ceiling lights in lounges and other public spaces shall be divided into not less than two separate circuits so that half the lights in a space may be energized or secured as necessary from each entrance door.

For ceiling lights in other cabins/rooms, one (1) switch shall be fitted near the entrance door.

For engine room lights and passage lights, circuit breakers on distribution boards shall be used as switches.

A deck-light switching panel for all outside lighting shall be arranged on the bridge to Buyer's approval.

11.6.5. Receptacles

In general, receptacles shall be of 13A DIN type, 3-pole (2p + earth). Earth pin shall be used as earthing connection for metal frames of portable appliance.

11.6.5.1. In Accommodation

Receptacles of a sufficient number, voltage and capacity are shall be provided throughout the working and living spaces of the Vessel.

The receptacle arrangement shall include but is not limited to the following:

• At least one (1) receptacle shall be installed per room and per 10 m platform, corridors, hall, staircases and common rooms.

• In interior passageways, one (1) single receptacle shall be provided at approximately 5 meter intervals to support use of electric cleaning machine.

• In public rooms a minimum of one (1) single receptacle shall be provided on each bulkhead and be spaced to support use of electric cleaning machine.

11.6.5.2. Wheelhouse

At least 10 receptacles shall be installed around in the wheelhouse for various purposes. In addition, at least two (2) twin receptacle shall be installed inside each bridge console (fore and aft).

11.6.5.3. Engine Room/Work Shop/Propulsion Room

Sufficient numbers of receptacles for portable tools, etc. shall be fitted in engine room and workshops, and at least one (1) in each storeroom.

Sources for sockets in the vicinity of main and auxiliary engines as well as boilers shall be protected by earth fault disconnection switches.

11.6.5.4. Receptacles for Welding

Two (2) receptacles of 440 VAC (3pole+earth) for electric welder shall be fitted in the workshop with all accessories to support welding operations. There will also be 6 pack of welding machines in hull deck level with deck mounted receptacles and controls, leads and all accessories to support platform work operations to be arranged on GA for installation.

11.6.5.5. Receptacles for External Deck

• One (1) DIN-type twin socket outlet with cover shall be fitted inside each corridor entrance on all decks.

• Two (2) watertight socket outlets (single) with screw cap shall be fitted in a protected place on the fore deck.

• Four (4) watertight socket outlets (single) with screw cap shall be fitted on main deck in a protected place near to the superstructure (SB/PS).

11.6.6. Emergency Lighting and Lighting Distribution

Emergency lighting circuits shall be provided as partial lighting in at least the following areas:

- Wheelhouse & communications spaces
- Fire control station
- Public Rooms
- Galley
- Passage ways
- Exits
- Staircases
- Engine Rooms
- Engine control room
- Switchboard rooms
- Working deck
- Emergency generator room
- Thruster rooms
- Every lifeboat and raft station and passageways or ladders leading to these stations
- Elsewhere as required by Class and Authority

Lifeboat light, life raft light, chart light, bunker lights, instrument light, navigation and signal light shall also be fed from the emergency switchboard.

Emergency lighting shall normally be used as general illumination purpose and fed from the emergency switchboard via each emergency lighting distribution panel.

Where rules and regulations require lighting fixtures supplied from two (2) separate circuits, one of them shall be connected to the emergency supply system.

Around outside deck, in corridors at each deck, in each stairway and escape routes, some light fixtures with built-in chargeable batteries (90 minutes capacity) shall be mounted as part of the emergency light system (totally 10 units). The charger units need two (2) additional wires for constant charging, independent of light switch position.

11.6.6.1. Emergency Lighting Requirements

- Emergency lights shall be certified.
- Emergency lights shall be designed to withstand vibrations and other environmental requirements in accordance with IEC 92-504 or an equivalent standard.
- Emergency lights shall have such enclosure rating (IP) as is required for the intended type and place of use, however not lower than IP 56 on the open deck.

- Additionally, emergency lights shall be so designed or arranged that there will be no condensation.
- The battery source of power shall be continuously charged and immediately start to operate in the event of failure of the emergency source of power.
- The emergency lights shall have a built-in rectifier/charger provided..
- Emergency lights shall be conspicuously provided with a sign exhibiting, the date when the battery was put into operation, the normal life of the battery, and the type of battery to be used for replacement.

11.6.7. Special Lighting

11.6.7.1. Instrument Lights

Instrument lamps shall be provided for the magnetic compass, diesel engines revolution indicators, propeller revolution indicators, azimuth thruster motor revolution indicator, azimuth thruster angle indicator, switch panels and other control equipment, and all radio and nautical instruments in the wheelhouse.

The instrument lights for bridge controls shall be fed through dimmer switches, from one (1) common dimmer switch in front console and one common dimmer switch in aft console. Instrument lighting for bridge wing controls shall be fitted with separate dimmers. Red night lighting will be provided in the wheelhouse.

11.6.7.2. Chart Lamps

The following chart lamps, all provided with dimmer switches, shall be fitted over the chart table:

- Two (2) 20W halogen lamps with adjustable arms and red filters
- One (1) incandescent type lamp with magnifying glass.

Light fixtures on interior stairwells or passageways near doorways opening into the navigation spaces shall be fitted with red filters.

11.6.7.3. Sight Glass Lights(Optional)

Necessary numbers of incandescent lamps for sight glass illumination shall be fitted at suitable positions.

11.6.7.4. Instruction Board

Additional lamps shall be fitted above information and instruction boards.

11.6.7.5. Refrigerated Provision Store

Refrigerated provision compartments shall be illuminated by a special sub-zero temperature waterproof 2x36W fluorescent fittings and controlled by switch with red pilot lamp outside of the compartments.

11.6.8. Illumination Levels

In general, rooms and spaces shall be effectively illuminated according to the following standard. The figures given are the average horizontal illumination levels with a tolerance of 10% at the stated measuring points.

The measuring point for cabins and rooms in the accommodation space shall be at the centre of the space between the lamp and wall and/or between lamps in cabins and rooms. Measurements shall be taken at the height of 85 cm above the deck.

The measuring point for machinery spaces shall be at working and/or passage spaces as agreed between Builder and Owner/Levingston. Measurements shall be taken at the height of 85 cm above the deck or grating level.

No individual work area or significant portion of an individual work area in which machinery or equipment will normally be operated or maintained, will be illuminated at less than 75% of the specified average level.

Average illumination levels shall be:

Compartment/area	Illumination level (lux)	Remarks
Engine Rooms	200	300 at control panels
Propulsion Rooms	200	300 at control panels
Machinery Rooms	200	
Engine Control Rooms	300	
Switchboard Rooms	300	
Workshops	300	
Stores	200	

Compartment/area	Illuminati on level (lux)	Remarks
Galley	300	
Pantry	300	
Mess and day room	150	
Corridors/stairways	100	
Helicopter reception	300	
Offices	300	
Cabins	100	250 lux at desk
Hospital (Treatment Room)	300	
Laundry	200	
Wheelhouse (night operation) (at store)	10 150	Special red ceiling lights Ordinary lights
Cargo compartments/stores	150	
Refrigerated chambers and dry provision store	150	
Working deck area	100 (150)	
Ship side	100	10m out of ship side
Helicopter deck	200	According to rules
Mooring Stations	50	
Toilets	150	
Emergency Generator Room	100	

11.6.9. Electrical Lighting Systems for Engine Room/Machinery Spaces

11.6.10. General

In general, machinery spaces, stores, thruster rooms, workshop, etc, shall be illuminated by 2 x 18W (or 36W or 40W) fluorescent light fittings. Other light fitting types may be used for special illumination purpose.

11.6.10.1. Working Light

A sufficient number of working light shall be fitted in engine and workshops.

Flexible working lamps shall be fitted on all machine tools as well as on all working benches. Lighting fixtures in machinery spaces, engine room, stores, etc.
Machinery space lighting shall be so arranged that failure of one branch circuit will not cause complete darkness in the said space.

Engine rooms, gear/shaft generator rooms, store rooms, workshops etc. shall be provided with high quality fluorescent fixtures of the following types: 2 x 18W (or 36W or 40W) with polycarbonate shade, IP 44 enclosure (IP 56 in cargo holds).

Light fixtures in bilge wells require special incandescent light fixtures (IP 68).

11.6.10.2. Lighting ECR/Switchboard Rooms

Flush mounted fluorescent fittings of 2x18W (or 36W or 40W) shall be installed in the ceiling in engine control room/switchboard rooms.

11.6.10.3. Battery Room/Paint Store

Battery rooms and paint store shall be fitted out with Explosion Proof equipment (also cable penetration). Fluorescent light fittings shall be 2 x 18W (or 36W or 40W).

11.6.11. Electrical Lighting, Accommodation/Superstructure

11.6.11.1. Wheelhouse Lighting

Fluorescent light fittings shall be used as general lighting in the wheelhouse (2x18W) (or 36W or 40W).

Down light fixtures shall be installed above all control consoles with separate dimmer switches for each console.

In addition to the ordinary lighting, special red lighting to preserve the night vision shall be installed for the wheelhouse, and the chart space. The red lighting shall be supplied from the emergency switchboard and shall be provided with dimmer

switches, giving a variable red lighting.

The door between wheelhouse and corridor below shall be provided with a door switch for switching off the bright light in corridor while the door is open, preventing bright light from the said area to come into the wheelhouse.

11.6.11.2. Bath and Toilet Rooms

• One (1) lighting fixture 1 x 15W including a socket outlet with isolating transformer (shaver outlet), shall be mounted above the mirror. Additional ceiling light of recessed type shall be fitted, if necessary (IP44).

11.6.11.3. Cabins Lighting

The light installation shall be according to the lux levels indicated in the table above. The following equipment shall be installed in each cabin as a minimum:

• Sufficient Fluorescent fitting, 2x18W or 2x36W of recessed type shall be installed in each room (cabin and bedroom).
• One (1) Fluorescent berth light, 1 x 8W, with diffuser, shall be installed above each berth (head end), with on/off switch fitted.
• Three (3) Twin receptacles (230V) for radio, refrigerator, hair dryer etc., one of them installed above the table.
• One (1) Fluorescent fitting, 1x15W, mounted above the desk (below book shelf), with switch fitted

11.6.11.4. Mess Room / Day Room Lighting.

• Two (2) x 18W or 2x 36W recessed fluorescent lighting fixtures, shall be used as ceiling lights. • Necessary amount of ornamental type wall lamps shall be arranged to give a comfortable environment (depending of room size, design and arrangement).
• The lighting shall be so arranged that failure of one branch circuit will not cause complete darkness in the room.
• Fluorescent ceiling light, , wall lamps to have separate switches arranged at each entrance.
• All ornamental type wall lamp shall be regulated by means of dimmer switches.

11.6.11.5. Offices

• Two (2) x 18W recessed fluorescent lighting fixtures, with silver/aluminum metal screen shall be used as ceiling lights.
• One (1) light fixture with flexible arm shall be fitted above each writing desk.
• Three (3) Twin receptacles (230V) for office equipment.

• One (1) UPS twin receptacles (230V) for each PC.

11.6.11.6. Mess / Dayroom Lighting, Offices

• 18W and/or 36W fluorescent lighting fixtures, shall be used as ceiling lights.

• . Necessary amount of wall and table lamps with group switches at each entrance, separate switches for wall and ceiling lights.

11.6.11.7. Hospital

• Two (2) x 18W recessed fluorescent lighting fixtures, shall be used as ceiling lights.
• Fluorescent berth light, 1 x 8W, with diffuser, shall be installed above each berth (head end), with on/off switch fitted on the front.
• One (1) light fitting shall be provided with a 90 minutes built in back-up battery pack.
• The lighting in the hospital shall be possible to regulate down to minimum (except berth light).

11.6.12. Electrical Lighting System for Weather Deck etc.

11.6.12.1. General

• Deck lighting in working deck area shall comply with /MODU Rules.
• High-pressure sodium floodlights shall be fitted for lighting of fore-, side- and aft decks and other open deck areas and these need to be explosion proof as per regulations regarding zoning.
• All floodlights, searchlights and fluorescent fittings in the forecastle area must be given special protection against sea spray.
• Part of the deck lighting shall be fed from the emergency switchboard.
• Explosion-proof fluorescent lights shall be provided in all zones on the main deck as applicable per regulations regarding zoning.
• A control panel for all deck lighting shall be fitted in the aft wheelhouse control position.

11.6.12.2. General Deck Lighting

• High quality explosion proof fluorescent lamps made of polycarbonate, seawater resistant aluminum or stainless steel shall be installed as per regulations regarding zoning.
• Cables shall pass through accommodation with short cable pipe connections to the lighting fixtures.

• Cables between lighting fixtures shall be protected by steel conduits. No bare cables shall be run on deck. Flexible/movable lamps shall be connected via junction boxes with flexible cable entering box through covered cable gland.

11.6.12.3. Boat Preparation and Launching Lights

• One (1) 400 W, halogen floodlight with switch shall be provided at each lifeboat station on both sides of the Vessel.
• The light shall be fed from the 230 VAC emergency supply system.

11.6.12.4. Lifeboat/Life Raft Embarkation Lights

• One (1) 400 W, halogen floodlight with local switch shall be fitted at MOB boat.
• One (1) 2x18 W, fluorescent fixture with built-in battery pack(90 minutes), shall be fitted at each life raft storage space as suitable, controlled from the wheelhouse light control panel.
• The light shall be fed from the 230 VAC emergency supply system.
• Two (2) incandescent lights fed from the 24 VDC supply system shall be provided for MOB boat.

11.6.12.5. Floodlights

• High-pressure sodium and halogen floodlights shall be provided for deck illumination. Sodium vapor type floodlight shall be provided for working deck area/after deck.
• Lighting shall be controlled from the lighting control panel in the wheelhouse.
• Illumination levels shall be according to the lux table above.
• Allow for a total of 20 x 400W floodlights to be fitted at locations shown on detailed design drawings.

11.6.13. Electric Heating Equipment

11.6.13.1. General

• 230V AC power shall be used for heating of electric motor and generators.
• 440V or 230V shall be used for space heating.

11.6.13.2. Heating Cables

• Heating cables shall be installed around the freezing room doors and fire main.

11.6.13.3. Electric Space Heating

Electric heaters shall be installed for sufficient heating of the compartments specified below. All rooms and void spaces not connected to the HVAC central systems for the accommodation shall be arranged with a suitable thermostat controlled heater of sufficient capacity and shall maintain room temperature for at least +2 deg. C at -30 deg. C.

The heaters shall include, but shall not be limited to the following:

Compartment	Heater type
Wheelhouse	Panel heater
Emergency generator room	Fan heater
Day rooms	Panel
Conference room	Panel
Thruster rooms	Fan heater
Offices	Panel
Workshop Tank top	Ribbed tubular heater
Deck stores/workshops	Fan heater or panel type

Electric heaters above 1000 watt shall be regulated with at least 2 steps. All heaters shall be thermostat operated. If one compartment contains more than two electric heater(e.g. wheelhouse), the heaters shall be controlled by one 2-step thermostat.

11.6.14. General Electric Motors

11.6.14.1. General

Motors shall be of squirrel cage induction type designed for either 690V and 440 VAC, three phase, 60Hz, except for motors less than 0.4 kW, or motors for domestic service of small capacity, which may be 230 VAC single phase or three phase type, in accordance with manufacturer’s standard and IEC standard.

Motors shall be rated for continuous full load duty.

All frequency controlled el. motors shall have temperature Class F.

11.6.14.2. Enclosure

In general, motors shall be of the semi-enclosed drip-proof construction.

The enclosures of motors shall be cast iron or aluminum alloy, unless inherent in equipment design. The motor enclosures shall have the following requirements, or better.

Compartment/area	Degree of protection	Remarks
Below the lowest floor in engine room, pump room and thruster room	IP 55	Totally enclosed fan cooled type
Machinery areas	IP 44	
Weather check	IP 56	Enclosed watertight construction
Hazardous areas and spaces	IP 56	Explosion-proof type
Accommodation/dry area	IP 23	

Motors for workshop equipment, and for galley-, laundry- and other domestic equipment, shall be according to manufacturer’s standard.

Motors shall, as far as possible, not be located below the lower level of deck grating in the engine room or auxiliary machinery spaces.

11.6.14.3. Bearings

In general, ball bearings of reputable make, having international interchange ability, shall be used for vertical or horizontal motors. Special motors designed to sustain heavy thrust loads of connected machines as well as the weight of the motors shall be fitted with radial ball bearings or angular-contact bearings.

As far as practicable, sealed, pre-lubricated type bearings shall be used in order to prevent grease leaking to the motor's windings, in accordance with the manufacturer's standard.

Grease nipples shall be provided for the lubrication of large-capacity motors with open-type ball bearings, in accordance with the manufacturer's standard.

The grease shall be in accordance with the motor manufacturer’s standard.

11.6.14.4. Ventilation

The cooling fan attached to the motor shall be of manufacturer’s standard.

11.6.14.5. Insulation

Stator windings shall be treated with insulating varnish to resist oil and water. Generally, motors shall be designed and constructed into Class "B" (for motors below 45kW) or Class "F" insulation (for motors above 45kW).

The motors shall be designed for ambient temperature of 50°C. However for Main Engine Room / Open Main Deck area motors must be rated to 10 deg. above ambient temp.

The motors to comply with Class requirement and IEC standard.

11.6.14.6. Space Heater

Stator winding heating type or element type space heater shall be provided for all motors of 20 kW and above, for all motor exposed to the weather and for all motors for standby pumps.

11.6.14.7. Terminal Box

Motors shall be provided with waterproof terminal box of cast iron or steel plate construction with gland and removable cover.

The terminal box shall contain solder-less terminals of suitable size secured on an insulating board to facilitate connection of the cables.

11.6.14.8. Duty Plates

Motors shall be fitted with duty plates engraved in English with manufacturer's name and contact information, model number, serial number, rated kW, Amps, cos ø, RPM and full load.

11.6.15. Propulsion Motor for all Thruster Drives

Motor drive systems shall be designed by Imtech to preclude adverse effects from electro-magnetic interference (EMI) and total harmonic distortion should be limited to an acceptable maximum. When frequency converters are used, they should be of AFE type. Line filters and/or other suitable means shall be employed as necessary to protect control circuits.

The specifications of the Bow Thruster motor drive and azimuth thruster motor drive upon the Imtech‘s design. Imtech and Builder to send the below mentioned on the propulsion drives, propulsion motors, azimuth drive, azimuth motors, frequency converters.

For propulsion and azimuth motors:

- Rated output
- Rated Frequency
- Rated Voltage
- Full Continuous Load Rating
- Revolutions
- Type
- Insulation Class
- Enclosure Type
- Cooling System
- Mounting Configuration
- Space Heater Voltage
- Stator Winding Temperature
- Temperature Sensor Outfit and Configuration

For frequency converters:

- Rated output
- Input voltage
- Output voltage
- Type
- Enclosure
- control speed
- Cooling System Type

Maximum Permissible Harmonics (5%) THD and 3% IHD

11.7. FIRE DETECTION SYSTEM

A fire detection system shall be installed as per the Regulatory Body requirements. The

system shall consist of a Fire Detection Panel with control panels located in the Pilot House and a repeater panel in Engine Control Room. The fire detection system shall be addressable type that could identify each detectors have detected the fire.

The fire detectors shall be located in accommodation, service and machinery spaces where there is possibility of fire. The detectors shall be either smoke, heat types. Manual call points shall be installed at location where fire alarm can be manually activated.

On detection of fire by any fire detectors, alarm shall be activated on control panel and repeater panel. When operator fails to acknowledge the alarm, the Fire Detection Panel shall activate General Alarm system after a delay of two (2) minutes maximum per Regulatory Body Requirements.

Fire detection panel and gas detection panel will be two separate panels and function as integrated unit, interface with General Alarm / Public Address system.

11.8. GAS DETECTION SYSTEM

A combustible and hydrogen sulfide gas detection system shall be installed by Builder to detect the presence of combustible and H2S gas in the vessel. Builder shall install the equipment and cables.

The number and arrangement of sensors shall be as required by the Regulatory Bodies and approved by Owner/Levingston. All interconnecting cables, junction boxes, etc., shall be provided.

The system shall consist of the necessary number of remote sensors located to provide earliest possible encounter with combustible gases which could occur in the area of the sensors.

The control panel shall contain all analyzer/controllers in a single cabinet or rack and shall include audible alarms, panel indicating lights for alarm and trouble conditions, alarm reset, silencing switches, and pilot light. The circuitry shall be such that the alarm set points are adjustable between 0-50 p.p.m for H2S detectors and 5%-100% LEL for combustible detectors.

There shall be interface between F&G Detection System and IVCS.

The Combustible Gas Sensors shall be explosion proof and of the optical type and shall be constructed of corrosion resistant material.

A 230VAC power supply to the gas detection system shall be supplied from the

emergency 230VAC bus and normal power source per regulatory body requirements.
A testing kit shall be supplied and equipped with appropriate flammable material for testing. Appropriate spares and instruction/operating manuals shall be provided. Means (e.g., reach rod/grip) to reach any sensor that eliminates any climbing, as far as practicable, shall be part of the test kit.

The quantity of portable detectors shall be as required by Class and Regulatory Bodies.

11.9. INTERIOR COMMUNICATION SYSTEM

11.9.1. General

The interior communications equipment installation shall comply with the requirements of all applicable Regulatory Bodies and shall be part of an integrated Fire/Gas Detection, PA/GA, telephone system.

11.9.2. Telephone System

11.9.2.1. Automatic Telephone System

The telephone system to be supplied and installed by the Builder, the Builder will provide the following:

- Adequate space in the main distribution frame
- Anti surge protected

Telephones in noisy spaces shall be installed with noise-reducing acoustic booths and visual indicating lamps when telephone is ringing.

11.9.2.2. Sound Powered Telephone System

An independent stand- alone sound powered telephone system shall be provided. Sound powered telephone stations shall be provided at the following positions:

1.Pilot house
2.Chief Engineer Cabin
3.Captain room
4.Mess room
5.Duty mess room
6.Heliport radio room
7.Muster station Port
8.Muster Station STDB
9.Engine room
10.Thruster room
11.Emergency generator room
12.ECR

In noisy spaces sound insulated booths shall be provided with indicator lamps.

The telephone sets in the Thruster Rooms and in Emergency generator room shall be provided with a visual alarm signal and a head set with microphone.

11.9.3. PAGA System

Amplifier is prepared at Pilot house. Speakers are to be selected into the following groups at Pilot house:

Compass (exposed) deck
Machinery and Cargo space (under main deck)
Accommodation
All cabins and compartments usually occupied by crew / passengers.
Office and conference room
Heliport waiting room
Air conditioning air compressor room
Emergency Generator room
Workshop
El equipment room
GYM
Transformer room
Crane cabins
Change room
Recreation room
Lifeboat launching Area

11.9.4. Entertainment System

To be provide gyro-stabilized Antenna (Sea tele- make, Model 5004) and TV and TV provisions for the following areas.

1. Mess room
2. Gym room
3. Non-Smoking recreation room
4. Chief Engr. Cabin
5. Captain cabin
6. 2- VIP cabins
7. Heli-waiting area

The system shall be supplied with 230VAC and 24Vdc power source

11.9.5. Closed Circuit Television and Video System (CCTV)

The arrangement drawing for location of CCTV cameras and monitors shall be approved by Owner (color type). The cameras, monitors, camera housings and remote control shall be of a recognized brand.

A total of twelve (12) cameras shall be installed at locations to be agreed. Four (4) Cameras shall have a pan, tilt and focus remote capability.

All cameras shall be fitted as per client approved location layout ..

11.10. NAVIGATION AND HELIDECK LIGHTING SYSTEM

11.10.1. Navigation Lighting System

One flush mounted navigation panel for the supervision of navigation lights is to be furnished and installed. The panel is to have visual and audio alarms. Power to the navigation panel is to be from the emergency and normal 230V system.
The following navigation lights are to be furnished and installed as follows:

- One (1) double port red side light
- One (1) double starboard green side light
- One (1) double stern white light
- One (2) double white mast light
- Two (4) double red all round light
- One (2) double white all round light
- One (2) double anchor white light

In any event Collision Regulations requirements and Flag state rules and regulations shall be applicable.

11.10.2. Helideck Lighting System

The following helideck lights are to be furnished and installed as per UK CAP437:

- 26nos of laminate, Green led 30cd for Safe area.
- 4 nos Xenon helideck floodlight.
- 1 no of windsock.
- 4 nos of Junction Boxes Based on Cap 437 with latest edition we need addition one helideck status light

11.11. EMERGENCY SHUTDOWN SYSTEM (ESD)

Five groups of emergency stop shall be provided as follows:
ESD group 1: to shutdown engine room & machinery room fans. Located at pilot house

console & entrance to engine room from main deck.
ESD group 2: to shutdown engine room Lube Oil pump, Fuel Oil radiators, Lube Oil purifiers, Fuel Oil Purifier etc. Located at pilot house console & entrance to engine room from main deck.
ESD group_3: to shutdown air conditioning unit & accommodation fans. Located at main deck and Pilot house console.
ESD group_4: to shutdown air conditioning unit (azimuth thruster room). Located at main deck and pilot house console.
ESD group_5: to shutdown emergency generator room ventilation fans. Located at pilot house console & entrance to emergency generator room.

12. LEGS AND JACKING SYSTEM

12.1. JACKING SYSTEM

12.1.1. Jacking System

Make/ Model	EBIGB82
Type	Fixed,Rack& Pinion
Drive	Electro-hydraulic
Storm Holding Capacity(perleg)	2700 tonne
Jacking Capacity (perleg)	1,458 tonne
Speeds	Vessel elevating+1.2m/min
	Legs elevating+/-2.4m/min

Eachsystemleg consistsofeighteen(18) setsofjackingpinions, arranged asnine (9)rows. Total number of pinions is equal to 54.

Sufficient walkways are to be provided around these jacking structures to allow access and maintenance.

Please refer to document “Levingston_EBI_320EX_LifboatJackingSystem_EBI-GB82_8-2012.pdf”

12.1.2. Jacking Structures

The jacking structure (“jacking tower”) is an integral part of the interface between the legs and the hull. The jacking structure transfers loads from the legs into the hull. This structure provides the integration of all loads from the various components, i.e., jacking pinions, roll chock pinions, and guides. The jacking structure provides the necessary structural fixity in both the elevated and afloat conditions.

Additionally, the port & starboard jacking tower forms the foundation for the Leg Encircling Crane that is mounted on top of and will be integrated into this jacking tower.

12.1.3. Leg Guides

Each leg chord section (three per leg) has an upper and lower leg guide.

The leg guides provide the close tolerance requirements for the guiding of the leg through the hull during jacking operations and in keeping the leg in its position by a set of forces in opposite direction, counteracting part of the bending moments in elevated and afloat conditions. Additionally, the pinion-to-rack mesh serves also as an additional guide mechanism. It is this integration of the upper and lower guide along with the pinion-to-rack mesh that forms the fixity between the legs and the hull.

12.2. LEGS AND FOOTINGS

12.2.1. Legs

There are three circular legs on the Levingston 320 EX. Each leg consists of three chord sections which includes the rack. From these chord sections are affixed with the horizontal and diagonal brace pipes to form the complete leg. The jacking system is integrated into the overall leg design to ensure proper system interface.

12.2.2. Leg Footings

Attached to the bottom of each leg is the leg footing (“spud can”). The area of the bottom of the spud can along with the load on the spud can determines the bottom bearing pressure on the foundation per square unit of weight. The spud can is designed to penetrate the sea floor or bottom until a condition of equilibrium is reached. After the MOU has been fully pre-loaded on the spud cans, then, the Vessel is elevated to its operating height above the sea level.

The leg footings contain a jetting system that can be used in those conditions where deep penetration has caused the footing to become stuck. The jetting system is used to hydraulically lift the spud from the sea floor. The jetting system is used in conjunction with the Vessel’s buoyancy to dislodge the spud can from the ocean bottom. There are both jetting nozzles on the top and bottom of the spud cans. The spud can jetting piping is connected to the Vessel’s low or high-pressure system via flexible hose. There are intermittent hose connections along the entire length of each leg.

12.3. POSITIONING/ PRE-LOADING

12.3.1. Positioning/Jacking/Pre-Loading Condition

The jacking operations consists of maneuvering the Vessel in position while the legs are lowered to near the ocean floor, so that, when the Vessel has reached its desired location, the aft leg is lowered to fix the Vessel on location. The port and starboard legs are immediately lowered further, so that, the Vessel begins to lift itself out of the water. During this phase of the jacking operation, the Vessel is elevated only several meters above the wave action. Each leg is pre-loaded by putting the maximum pre-load water in each of the pre- load tanks. The pre-load tanks surround each of the Vessel's three legs.

After the Vessel's legs have been adequately pre-loaded, the pre-load tanks are dumped overboard. The Vessel then elevated to the desired operating height above the water level.