



Vessel concept final design (full technical specification, general drawings, diagrams, calculations).

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Executive summary / Abstract

This deliverable consists of the final specification and relevant general arrangement plan representing the entire definition of the an innovative small research and survey vessel, to be used for the coastal areas of the Mediterranean and the Black Sea, estuaries, as well as port areas and shallow navigation channels.

This final specification, the drawings and the main calculations, are the result of the design process that summarizes and integrates the information compiled and analyzed in previous deliverables and workshops.

The vessel should be capable to operate in all the weather condition to afford effective surveys for shallow waters and harbors surveys.

A considerable amount of scientific information and data is envisaged to be collected from the utilization of the vessel.

The research vessel is characterized by an innovative power distribution system that enables the connection of alternative power generators directly on the main power line of the vessel.

Particular attention has been paid in the design of the novel propulsion system and of the dynamic positioning system.





The following documents are integral part of the PERSEUS small research vessel design concept and are presented as Annex

- General Arrangement
- Midship section and typical transversal sections
- Horizontal and Longitudinal section
- External Shell
- Capacity Plan
- Engine Room Arrangement
- Body Lines Plan
- Design Hydrostatics
- Hydrostatic table
- Cross curves of stability
- Preliminary Displacement study and Light Weight estimate
- Resistance Prediction
- Propulsion Prediction





1 - GENERAL

1.1 Intent of documents

The intent of this specification is to describe the concept and the requirements of a innovative small research vessel of aluminium alloy to be operated in the Mediterranean Sea and Black Sea in the coastal and river areas.

The vessel will be built taking into consideration the type of service, and the simplicity of construction and maintenance.

Design, construction, installation, inspection, tests and workmanship details not covered by this specification shall be carried out in accordance to the working and construction drawings and the standard practice of the Builder.

The reference construction details shall be selected amongst the best construction standards.

Materials, engines, machinery and equipment shall be, generally, in compliance with, the Builder's standards and with the best practice for this type of vessel and, whenever possible, with European Industrial standards.

They will comply at least with the under force International Quality Standards (DIN – ISO - European Norms, Wheel marks etc.) and will satisfy the rules and requirements of the attending Classification Society by which they will have been inspected, tested and certified

In case of discrepancies between this Specification and the general arrangement, Specification shall prevail except where otherwise and unequivocally agreed.

Any item mentioned more than once at different places of this specification, but serving the same purpose is only to be supplied or carried out once the description given in the specific paragraph will prevail.

In consideration of the continuous technical progress concerning equipment especially designed for researches vessels, changes of some equipment described in the present specification with new ones, may be proposed, provided that:

- they will lead to a weight saving;
- they will have at least the same capabilities of the previous ones;
- they will result in a remarkable improvement in maintenance and/or installation.

1.2 General description

The described vessel should be classified in the category of up to date Research vessel. The operation profile will be referred to as:



- Hydrographic surveys of shallow waters. Mapping of coastal floor and subsurface for production of nautical charts and Electronic navigation Chart.
- Marine scientific research surveys/cruise sea trips/deployments.
- Facilitate establishment of reliable scientific data inventory of our region (Mediterranean Sea, Black Sea and etc.)
- Navigation in coastal waters and under adverse weather conditions.
- Research operations for medium and large scale in all types of coastal zones.
- Investigation for the identification/evaluation of promising areas for resources exploitation potentials in coordination with EU and NON-EU agencies.
- Research work/survey for coastal zone management/development of marine infrastructure including ports and harbours development.
- Conduct research and evaluate marine pollution level.

In order to achieve the whole of the requirements of the operational profile of the Research Vessel these should be designed, studied, calculated and built according to the Rules of Modern Marine Science and Practice.

The vessel will be exclusively of innovation type, aluminum alloy construction, equipped with two main engines, marine type diesels, whilst the propulsion will be supplied by two innovate propulsion systems properly designed to achieve the required service speed and DP2 service with the lowest possible absorbed power of the main engines.

For assisting in maneuvering and achieve the class notation of DP2 a Bow Thruster will be installed.

The vessel will have a continuous Main Deck, extended from stem to stern.

Double bottom tanks will be fitted only in bosun store and crew accommodation area and partially in engine room.

The areas under the main deck will be longitudinally divided in the following water-tight compartments:

- Fore peak watertight
- Bosun store and bow thruster room above D.B. Tanks
- Crew Accommodation area above D.B. Tanks



- Working area above D.B. Tanks
- Main Engine room, which will also have part of the double bottom. This area will be equipped with the diesel gensets, pumps, main switchboard and all necessary auxiliary equipment for the operation of the boat

On the main deck Crews' space and service space are provided according to the requirements. They consist of mess-recreation room, galley, two cabins with two beds each, WC with shower, stores, provision room, lockers etc., to the requirements.

On the main deck, the alleyways access between the superstructure and bulwark will be of the open type for its full length port and starboard side.

On the bridge deck wheelhouse is provided and should be of open "tug vessel" type as compact as possible to allow just the installation of the necessary controls but to allow for optimised visibility in all directions and working areas. Good all round visibility is essential and all fittings on bridge deck to be arranged to give maximum view in all directions and which should give to the Captain the ability to navigate the vessel within and outside port area with autonomy. The wheelhouse room should include control switchboard, controls and whatever is necessary for the safe control of the boat and a full inter communication system.

1.3 Classification

The ship will be built under supervision of Registro Italiano Navale (R.I.N.A.) to obtain the following class:

RINa C★ Research ship - Restricted navigation international - (Coastal area) , ★ AUT-UMS, ★AUT-PORT, MANOVR

1.4 Regulations

In addition to all the rules required by Classification Society, the ship will be corresponding to the following:

- EU flag Rules and Regulations
- International Load Line Convention 1966 and amendments(if applicable).
- International Convention for Safety of Life at Sea, SOLAS 1974, including all the sets of amendments until the Contract's date.
- Convention on the International Regulations for Preventing Collisions at Sea, 1972 and amendments up to and including 1993.
- ILO 1974 (convention No 92 as amended by No 133).
- IEC - Electrical installation in ships (Publication 92).



Other amendments made known after the date of this Contract and prior to actually building the Vessel shall be taken into consideration and if the implementation of any of these amendments should substantially affect the price and scope of the Contract (delivery, contractual performances, etc.) they must be discussed and agreed upon by the two parties.

In case of conflict between the Rules of Classification Society (R.I.Na) and EU Maritime Authorities the latter's decisions shall prevail.

1.5 Certificates

The following certificates will be delivered to the Hellenic Fire Corp together with the vessel. However, if any of these documents cannot be obtained at the time of delivery of the Vessel, the Builder to deliver those documents to the Hellenic Fire Corp as soon as possible after the Vessel's delivery. In that case provisional certificates valid until final certificates are ready, to be furnished.

- Certificate of Registry (National Authority Certificate)
- International Load Line certificate (if applicable)
- Class-certificate for hull and main engines.
- Certificate for anchor, chains, steel-rope and other mooring equipment.
- Certificate for compasses adjustment.
- Safety equipment certificate.
- Safety radio certificate.
- Vessel's fire extinguishing system certificate (Fire Plan).
- Automated machinery system AUT- UMS; AUT-PORT
- ILO Cargo gear certificate;
- Navigational lights.
- Life rafts, certificate.
- Trim and stability booklet and loading manual.
- Electric Motors
- Steering Gear
- Electrical panels sub-board
- Electric Wires

Other miscellaneous certificates including all Classification Certificates and Manufacturers' certificates, which are normally issued for machinery, equipment and outfit for this type and class of vessel.



1.6 Main characteristics

The principal dimensions and characteristics of the ship will be as follows:

Length overall (LOA)	19.50	m
Maximum beam at deck	6.70	m
Length at waterline	17.40	m
Depth	3.20	m
Maximum Service displacement	48	t
Main engines maxim. power (100% MCR) abt.	2 x 368	kW

1.7 Crew & Total Number of Persons on board

The vessel's crew is defined to be 2 persons. This means that it should be capable of transporting in operation conditions 8 pax. total, without limitations.

The vessel's save appliances should be capable of covering a respective number of people on board certified by the Attending Class.

1.8 Deadweights

The deadweight to be determined as the difference between the displacement at the corresponding draft and the displacement of the light ship ready to be loaded in sea water having a density of 1.025 tonne/m³, shall consist the following weight:

- Crew with personal effects
- Catering and consumables of any Kind
- Fuel oils contained in the storage and daily tanks
- Lube oil
- Fresh water
- Research equipment.

1.9 Speed and limiting condition

The ship at a following load condition with sea state equivalent of wind of Beaufort force 0 to 4, clean hull, main engines running at 80% of MCR shall achieve a speed of 16 Knots.

The load condition is:

- full equipment



- departure with 100% bunkers, lobs, water, supplies
- 8 pax.

The ship at the above load condition with sea state not exceeding equivalent of wind of Beaufort force 5, clean hull, main engines running at 90% of MCR shall achieve a speed of 16Knots.

As adverse Weather Conditions and consequently as limiting condition of the vessel is defined to be the following:

The vessel's behavior in wave height should be such, as in sea state 5 will be able to sustain speed of at least 16 knots without the vertical acceleration to exceed 0.2 g and the transverse acceleration 0.1 g. Furthermore the vessel should be operable at least up to Sea State 6".

1.10 Stability

The vessel will comply with research vessels rules, as far as stability is concerned with intact conditions.

Before delivery, an inclining experiment will be carried out in order to calculate all the relevant stability data.

This test will be carried out in the presence of the Classification Society and Owner's surveyors.

All the loading conditions reported in the trim stability booklet, with the exception of lightship, are also to be checked in order to investigate the capability to achieve the DP2 with the innovative propulsion system.

1.11 Vibration

Vibration level are to be minimized by careful design and the application of corrective measures, to avoid structural damage to the vessel, damage to the machinery and the equipment or discomfort or annoyance to crew.

In addition, with the purpose to avoid vibrations induced by the propulsion system, the latter shall be designed in compliance with the hull wake.

Vibration limits ISO/TEC 108 - 6954, the best of average limit to be applied.

1.12 Noise

The Builder shall take all necessary measures by providing the most effective insulation and sound proofing devices to prevent the transmission of noise of any kind, which might disturb the comfort of crew, especially in public rooms and crew cabins.

The measuring method and presentation of noise levels shall be in accordance with IMO resolution A468 (XII) and international standard ISO 2923 "Measurement of



noise on board vessels". Deficiencies discovered during trials in this respect will be corrected before delivery.

In general the noise limits are not to exceed the 80 dBA.

The above noise levels are referred to transmission of noise originated from ship sources but not from human activity sources (such as loud talking etc.) or mooring and shore activities.

1.13 Measuring system

All drawing and technical data shall be drawn to the metric system and expressed in metric units. The vessel shall be built generally to the metric system.

1.14 Marking of components

Each piece of material of machinery, whether for propulsion, auxiliary service, electric or hull and hull service, shall be marked according to an identification system as per Builder's standard.



2 – HULL AND SUPERSTRUCTURES

2.1 Structure

The hull structure will be built in accordance with the most recent experience in design and construction of research vessels.

Furthermore, foundations for the engines or other heavy equipment will be designed against vibration and misalignments as much as practicable, in accordance with manufacturer's request.

The structure of the deck and the superstructure will be strengthened where necessary, to withstand stress due to weather conditions.

The thickness of the plates/stiffeners will be 10% bigger from the ones foreseen by the Class. Rounding is allowed only upwards i.e. augmented to the next highest unit

The hull shall generally be of all welded Marine Aluminium alloy of the 5083, 5086 and 6000 series, framed and plated in accordance to class requirements. The hull shape shall be as defined by the Lines Plan and Offset Tables. The hull shall have a smooth and fair appearances, free from objectionable faults, distortion and waviness.

2.2 Hull

The hull structure will be of longitudinal type, designed according to the Classification Society rules. The vessel will be equipped with a continuous main deck and a bridge deck. Every deck will have suitable longitudinal framing.

The main longitudinal members will be made of welded plates plus bulb-shaped bars. Transversal bulkheads and web frames will be built with the same system.

The keel is to be of plate steel faired to the extreme ends of the vessel and connected to the stem and the stern.

Fuel tanks will be integral with the double bottom.

All the tanks as well as the empty, closed, void spaces to be fully equipped with the required filling, vent, and sounding pipes, liquid level indicators, manholes for access, ladders fitted in accessible, functional and easy to use position. Their scantlings will be as that required by the Rules and in relation to their volume and its internal coating appropriate to its function, use, and the type of liquid stored there in.

2.3 Superstructure

The superstructure will be of aluminium alloy (5083,5086, 6000 series) construction and longitudinal type, designed according to direct calculation carried out by the Builder and to the Classification Society rules.

Frames and web frames will be made with welded plates.

Longitudinal girders will be T-shaped.



The boat should be equipped with shape in full harmony with the ship's lines and operation, built of steel plates of suitable thickness and with appropriate stiffeners.

On the main deck, port and stbd and in all superstructure length, the vessel should be provided with access alleyways, fully open (tug type), of sufficient breadth ($\geq 0.65\text{m}$ net) so that the safe and easy movements and provide excellent operability of the Main Deck areas will be feasible.

2.4 Navigation mast

The mast shall be suitably located in the open wheelhouse and of suitable tubular robust structure to take navigational lights, aerials, daylight signal etc.

2.5 Seatings for main engines and others foundations

The main engines to be mounted on thick top plates carried by continuous girders below each engine. These girders to reach the shell bottom plating. The double bottom to be strengthened according to engine manufacturer's recommendations.

The seating girders and strengthening to be carried out to the fore and aft engine room bulkheads. The seatings for reduction gears to be very strong and carefully designed. Design of seating to be approved also by engine and gear manufactures. All welding and straightening to be carried out very accurately. Good accessibility to bed bolts for inspection and tightening.

Winches and windlasses placed directly on extra thick deck plate with all necessary strengthening undersides the plating. Seatings designed also for easy maintenance of the steel.

Drainage of liquids from all areas of foundation structure is to be arranged.

2.6 Strainer grids - Sea chests

Sea chests are to be of welded plate with thickness according to the Class Rules and will be at least equivalent to their vicinity hull material.

Sea chest grids hinged type are to be executed in accordance with European's standard and are to have openings not $> 8\text{mm}$, the ratio of the free surfaces of all the openings to the total cross-section of the pumps suction served by the specific sea chest will be 3,5: 1.

Bolts and nuts will be made of stainless steel, of hexagon shape, M10.

In every sea chest an air vent pipe with valve will be fitted ending in the engine room (at height at least one meter above waterline).

In every sea chest there will be fitted a central manifold pipe with the various individual suction.

The central manifold pipe will have cross-section of at least 150% of the total sum of cross-section of the various suction pipelines. It will also be equipped with an appropriate central isolation valve from the sea chest.



After the central valve, there will be a duplex mechanical strainer with ability of cleaning of the baskets at sea.

Each one of the sea chests will be able to serve on its own and at least the main engines, the diesel generators and the fire pumps (for self protection) of the vessel simultaneously.

The main fire fighting system will be served by separate sea chests.

2.7 Chain Lockers

Will be installed on the fwd part, under the anchor capstan, of suitable size in order for the chain to be adequately stored, while there will be a drainage system installed and the structure will be of sufficient strength. To be foreseen also a system for washing the chains of the anchors, in the lockers area. Also there will be a safety-lock arrangement of the chain in the locker.

2.8 Fendering

In all vessel's length, externally of the main deck, at the bow and stern quarters in both vessel's sides there will be fenders

2.9 Welding

The welding and relative procedures will be carried out according to the Classification Society regulations, the material characteristics, thickness of the joints and their position.

The vessel shall be of all welded construction.

Except where specified otherwise, TIG/MIG welding shall be employed in the construction of the vessel. Welding shall be done in accordance with class requirements except where continuous welding is specifically required in lieu of intermittent welding to reduce corrosion damage. Double continuous welding is to be employed throughout, at all areas exposed to weather and sea, and in areas where bilge waste and water may collect.

Electrodes used are to be approved by the Classification Society.

The preparation of plate edges shall be accurate and uniform.

All joints are to be properly aligned and, closed or adjusted, before welding. Where excessive gaps exist between surfaces and edges, corrective measures adopted shall be to the satisfaction of class.

X-ray controls will be carried out according to Classification Society requirements and welding will be remade where it may be found unsatisfactory.

In the areas where X-ray tests are not possible to be executed, (e.g. T welds) a test will be made by dye-penetrates.

Particular care will be paid to the welding sequences to avoid distortion of the plates.



2.10 Standard Procedure for Welding

All the welding will be followed according with Shipyard standard, approved by Classification society.

The Shipyard shall submit the welding procedure for the approval of the Owner prior to the commencement of construction. This procedure shall be established for the welding of all joints.

2.11 Tanks

All tanks shall be of fully welded construction and fitted with the necessary manholes, drain holes, drip-trays, filling and discharge connections, sounding pipes, air pipes etc.

2.12 Drain plugs

Adequate Number of suitable drain plugs shall be provided for each tank and collecting spaces, including peaks, bilges etc, to facilitate draining while on slip or in drydock.

Two suitable plug spanners shall also be provided.

2.13 Manholes

Manholes shall be provided in all tanks including cofferdams. For deep tanks, they are to be fitted vertically, and for double-bottom tanks, they are to be fitted adjacent to the centre line.

Where manholes are exposed to weather, suitable studs and nuts shall be used.

2.14 Access and limber holes

Access, limber holes and scallops shall be cut in the structure, as necessary, to provide clear and uninterrupted drainage to bilge suctions, pipe accesses and rope accesses. The holes shall be cleanly oxy-cut, without serrations or roughness, to minimise risks of cracks in platings and welds.

2.15 Scuppers and drains

Deck scuppers shall be fitted to all decks, house tops, etc., to prevent accumulation of water. The quantities, dimensions and positions are to be determined to ensure efficient drainage. A perforated cover plate shall be fitted over every scupper pipe.



2.16 Name, draft marks and marking

The name, draught marks and markings of the vessel shall comply to the requirements of the Owner.

2.17 Cathodic Protection

The cathodic protection will consist of a series of zinc anodes according to requirements resulting from the Builders study and in compliance with the Class relative Rules, bolted to the hull, below the waterline. Particular care will be taken to protect materials of different galvanic potential.

The cathodic protection will be sufficient for the whole vessel, adequate for corrosion and oxidation control for at least two years.

2.18 Lifting lugs and rails

Lifting lugs for securing chain blocks, and rails where applicable, each capable of taking the intended weight safely, shall be fitted in the vessel at the following positions:

- Four points, above each propulsor;
- Two points, above each diesel generator engine;
- Four points, above each generator engine;



3 PAINTING

3.1 General

The painting will be subject to the Class's approval.

The painting with primer, anti-corrosive, anti-fouling and anti-pollution paints will be performed as many times as required by the attending Class in order to comply with its approval.

The color of the research vessel will be white except the areas specially noted. The color of the submerged hull will be blue.

The draft marks will be in relief and will be painted accordingly as per Class instructions on both sides of bow and stern. Similarly with the load line.

Similar to the external painting the same applies to the internal areas also and with the same commitments including the accommodation areas, sanitary, machinery, timber construction, etc.

The internal painting, in engine room, accommodation, bridge will be with white color while in the bilges light grey will be used.

On piping various colors will be used except for the F/F network, which will be red.

All the plates and bulbs/stiffeners, which will be used for the construction, will be painted with initial coating shop primer.

After construction, all the metallic parts will be cleaned and painted.

Before painting and during the vessel's construction detailed cleaning of all weldings will be performed, while all the under deck wear resulting from weldings and undercuts will be grind with special tools and will be painted locally with the first coating.

The bottom painting will cover the whole ship for a period of two years.

The painting of maintenance and of the vessel's appearance will be responding to the standards of the Builder, which will manufacture the colors. These specifications will be followed in their integrity and in such a manner that the whole vessel sufficiently painted, according to each compartment's or area's of the vessel position and use.

3.2 Surface Preparation

All the Aluminium Alloy surfaces will be grinded and shop primed with ethyl silicate zinc based primer at 15-20 micron.

Furthermore, all the shop-primed surfaces, before receiving the coats, will be treated as specified in the following.

3.3 Paint cycle

The vessel's metallic construction will be painted as follows:



1. From the keel up to loaded vessel water line, (2) coatings of primer (epoxy-primer ~300µm DFT) and (2) coatings of anti-pollution, anti-fouling color (~250-300µm DFT). Use of approved colors (tin free).
2. The area above the loaded water line and the superstructures and the main deck, (2) primer coatings (epoxy-primer ~300µm DFT) and two (2) final coatings in white color, category RAL 3000, or similar.
3. In the engine room, the steering gear room and all the vessel internally up to bilge level, (2) two coatings of initial anti-corrosive (epoxy-primer ~300µm DFT), one coating primer and two coatings final color. These colors will be epoxy, anti-inflammable and the maximum possible years of life.
4. On the chain locker, (2) coatings of anti-corrosive material, bitumen type or similar ~150µm DFT.
5. For the potable water tanks, special colors of approved type will be used, Class approved, in order to guarantee the potable water's good presentation.

3.4 Stainless steel fittings

The following items to be of stainless steel AISI316L:

- stairs, ladders and smaller fittings on open decks;
- handrails, rail works, guard-rails and small stanchions;
- grids and gratings;
- small steel parts in cold provision stores;
- smaller davits;
- fittings for accommodation ladders and boat lashings;
- fittings for searchlight, lifebuoys, blocks and flagstaff.



4 OUTFITTING

4.1 General

Good quality suitable for the intended purpose, marine type and good overall appearance shall be the main criteria for the vessel's general outfitting. Where applicable, the shipyard shall provide samples of materials, decors, finish, and colour schemes etc.

4.2 Insulation

Thermal, acoustic and fire-fighting insulation to be fitted according to the Rules and to health and habitability regulations.

Fireproof insulation will be fitted made by rock wool panels with density and thickness in accordance with the Classification Society and EU Rules.

Acoustic insulation will be made by rock wool panels with adequate density and thickness in order to guarantee the noise levels.

Builder's will make use of the co-operation of specialists in order to obtain a satisfactory acoustical insulation.

The most suitable and technologically advanced materials will be used further than the most modern technology in the field of acoustical insulation.

Spray insulation could be fitted alternatively.

4.3 Deck covering

Deck coverings are to be laid under all furniture, except built-ins, which shall be left as bare preserved/painted material.

All floor coverings are to be laid in such manner so as to prevent water collecting in hollows.

Vinyl flooring will be use in cabins, wheelhouse, mess, laboratory area, passageways with thickness at least of 2.5mm and lain on 6.0mm thick adhesive underlay.

For the galley, showers and toilets will be non-skid type, non skid Aluminium floorback or other suitable material approved.

4.4 Grating, Rubber mat

Grating will be use around steering console, stores and etc.

Rubber mat oil resistance and reinforced will use in front of switchboards.

4.5 Stairways and ladders



Adequate aluminium alloy and wooden ladders shall be provided for access to compartments between decks and in engine rooms.

They are to be fitted with hand rails, and fitted with safety threads or non slip-materials, at the head and foot of all ladders. Ladders are to slope gently wherever possible.

4.6 Handrails

Stainless steel AISI 316L handrails and stanchions to be fitted as per General Arrangement Plan built according to the best Builder's standard.

Two doors will be placed on the rails on the main deck. Also to be installed one door on the stern bulwark, which will be equipped with one ladder ending.

4.7 Hatches (Emergency and flush hatches)

Emergency hatches shall be provided for wherever necessary e.g. Engine Room, Forward accommodations and aft stores etc. Hatches shall also be provided on the main deck on top of the Engine Room to allow the removal of engines and they shall be of the flush type.

4.8 Doors

All doors in the hull and superstructure, leading from weather decks to the interior of the vessel, or through of watertight bulkheads, shall be of aluminium (insulated) watertight on coamings, fittings with hardware and fastenings that are anti-corrosive, with grease fittings, clips and neoprene gaskets and should be capable of being operated from both sides of the door.

Safety threads shall be fitted to the footings, wherever doors are exposed to weather. Coming height of the watertight doors shall be in accordance with class requirements or otherwise approved.

All interior doors shall be fire retardant, fitted with manually-operated fixed-louvre ventilation at the bottom, aluminium hinges, rubber stoppers, retaining hook combination and good quality deadlocks.

All hardware and fittings used for doors shall be of non-corrosive type suitable for marine conditions. Two keys for each door and two master keys shall be labelled and supplied.

4.9 Windows

Wheelhouse windows shall be of fixed type, except for two open type located for good natural ventilation, with marine grade/aluminium frame, tempered glass and neoprene insulated for water tightness. Two clear-view screens and adequate



quantity of horizontal wipers shall be incorporated into the design. Water washing device will be provided for the windows.

4.10 Side lights

Hinged sidelights of adequate size shall be fitted on the port and stbd side of the superstructure and must be watertight on closing. Fixed watertight sidelights with eyebrows are to be fitted to the port and stbd side of the hull. All sidelights shall be fitted with deadlights and glasses used shall be of reinforced plate type.

4.11 Floor, Plating, Gratings in E.R.

In the E.R. a floor plating in chequered aluminium shall be provided in accordance with maintenance and inspections requirements to the Main engine and the machinery. They shall be supported on strong frame in angle or T shapes with removable sections where necessary.



5 DECK MACHINERY AND EQUIPMENT

5.1 General

Supply and installation of all deck machineries and equipment shall strictly adhere to the requirements of class and the Owner.

5.2 Anchors, Chains and hawsers

The anchoring and mooring equipment will comply with Classification Society rules requirements for this category of ship and will consist of:

- 1 Danford type anchor of appropriate weight, hot-dip galvanised, stowed in their hawse pipes at bow;
- 1 Danford type anchor characteristics as above as spare;
- 1 stud link chains, of a length and diameter according to the Rules, built in high tensile steel, grade U3;
- Ropes for mooring as required by the rules;

The anchor hawse pipes will be fitted with stainless steel rollers to protect the deck plating from the chain when the ship is anchored.

The system will be designed in such a way to guarantee a quick and easy self-stowing of the anchors in their hawse pipes.

Suitable devices will be provided to guarantee the anchor remaining locked in the hawse pipes during navigation.

5.3 Anchor windlass

One anchor windlass, horizontal type, will be provided, located on the main deck at bow and will be provided with double anchor capstan with sufficient lifting capacity for the simultaneous heaving the anchor of the vessel.

The windlass will also be equipped with two outer drums for pulling the forward mooring ropes, will comprise of guides and safety devices for the chain and all the necessary equipment which will be mounted suitably for the sound operation of the system and will be of solid construction and certified according to the international standards (ISO-DIN or similar).

Adequate structure reinforcements will be provided where the windlass will be bolted.

The windlasses will be electrically powered by means of the electrical motor and the pulling capability and recovery speed will be according to the Rules.



5.4 Bollards

Four bollards will be provided, two at fore mooring area station, and two aft port and starboard.

They will be made in stainless steel and will be bolted to the deck.

Two bits will be provided one fore and another aft.

5.5 Masts

Two masts will be fitted, one on the fore of the vessel and one on the deck of the superstructure.

Their longitudinal position and their height will be in compliance with the Rules for this class of ship and to the satisfaction of the administration.

The masts will be fitted with all the necessary foundations and platforms for the installation of radars, antennas, navigation lights, "Christmas tree", signal lights etc.

They will be also fitted with eyes for dressing lines, for company's flag, courtesy flags, signals, etc.

5.6 Life Saving Equipment

The ship will be equipped with all the necessary life saving means foreseen by the EU and International Regulations for vessel's of its category and of its size.

The life saving means of the vessel will be the following:

- Two (2) life rafts of capacity 15 persons each.
- Adequate number of life jackets of approved type for short International Navigation.
- Four (4) circular life buoys and two of them with self igniting lights.
- Line throwing apparatus and pyrotechnics according the rules
- The vessel will be equipped also with a service boat from reinforced polyester (G.R.P.) of length $\geq 4.50\text{m}$, propulsion from outboard diesel/petrol engine rated at 25 hp at least. This boat will be unsinkable of type BOSTON-WHEELER or similar and will be mounted on the aft part of the main deck.

5.7 Fire fighting equipment

The vessel fire fighting equipment shall be supplied and installed in accordance with the requirements of the class, and shall include the following:

One set of Fireman's Outfit as follows:

- Fireman's outfit complete with anti flash hood



- Helmets
- Axe
- Breathing apparatus
- Gloves

Adequate number of fire hydrants, each with adequate length of heavy duty hose, hose lockers, brass dual-spray nozzle and brass coupling.

Adequate portable fire extinguishers, including foam, CO 2 etc.

5.8 Retractable Bow Thruster

One retractable electrical/hydraulic motor driven bow-thruster of 70 Kw shall be arranged, The thrusters, being independently powered and revolving will allow the ship every transversal movement.

The bow-thruster shall be controlled from the wheelhouse console, with ability for increasing/reducing speed and to be complete of all accessories necessary to a good operation. The thrust delivered by the thruster will be regulated from the wheelhouse controlling the revolutions and the sense of rotation. The minimum medium rate of turn of the vessel's direction when it is stable and in calm sea will be $>30^{\circ}/\text{min}$.

5.9 A-frame

On the main deck stern area one electro-hydraulic A-frame will be installed, with max. operational load of 3.5 tons, easily handled for heaving up/releasing the scientific system and tools.

5.10 Winch

On the aft wheelhouse deck one electro-hydraulic winch will be installed, with max. operational load of 3.5 tons, to operate with the A-frame

5.11 Crane

On the main deck starboard side one electro-hydraulic crane will be installed, with max. operational load of 2 tons, easily handled for heaving up/releasing the vessel's service .

5.12 Other Deck Equipment

The vessel will be equipped with the following fittings/constructions:

- In the vessel's perimeter and in suitable bulwarks points, 12 cylindrical fenders will be installed, with inflated rubber of diameter at least 40cm and with rope



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line of sufficient length and diameter $\geq 15\text{mm}$ for their fastening on board, on main deck of which there will be installed the sufficient mounting storage areas for storing the fenders. Links for additional fenders.

- In suitable positions (port-starboard), outboard of the main deck superstructure there will be fixed stored two (2) suitable hooks of approach, length $\geq 4\text{m}$, wooden (from excellent quality wood) with hook from stainless steel or chromium brass.



6 - PIPING AND PUMPING SYSTEM

6.1 General Principles

All networks, with no exemption, will be Class certified.

All piping will be made of stainless steel with high strength in sea water.

All lines will be based on anti-vibration supports.

All sea water lines will be made of galvanised piping.

Joints will be flanged and bolted. The bolts will be necessarily stainless steel and where required galvanised. Every network will have sufficient number of flanges, so that dismantling will be easy.

In all lines whenever a pipe is connected with any machinery, there will also be a part of flexible pipe of equivalent strength connected to it.

The valves of lines up to 2" will be made of stainless steel.

The other valves of lines should be as per Rules and regulations with the prerequisite that their seats and valves/flaps will be of brass or stainless if they are for the sea water system.

Where required to fit Cathodic Protection (anodes) to avoid electrolysis.

In all lines-systems, there should be quick, safe and easy dismantling.

Wherever there is a sea suction line there should be installed double SW filters.

All lines will bring encoded i.d. indication with color tapes, in visible points.

The guarantee for all pipelines in their entirety will be 3 years.

6.2 Piping

Piping should be so designed and installed (elastic arrangement if necessary with large curvature radius and resistant mountings) so that they will allow the damping of all resulting stresses (thermal or bending).

Their arrangement and their sub-division will be such as to allow easy inspections and connections/disconnections for maintenance and cleaning.

All piping connections will be made with flanges and bolts, except for the small diameter piping ($< \frac{1}{2}$ ") which could be screw type.

All piping will be supported in short intervals, with supports welded to the stiffeners, shape "L" or "V" which will be lined up with suitable elastic packing at the point of intersection.

The penetrations of piping through watertight bulkheads, floor plates and decks, will be made with steel pipes of suitable dimensions, while the copper pipes penetrations will be made with stuffing glands or pipes taking into consideration that there will be no contact in any part of the copper pipe with the deck or the pipe steel.

After their installation the lines will be hydraulically tested as per Class Rules.

Wherever the piping will be galvanized, the various parts after their final arrangement with all their flanges welded and tested, will be dismantled, galvanized



and remounted in their positions. All piping will be new with continuous monitoring of their i.d. number, their DIN certification and their factory of built from the Committee of Attendance.

Attention should be given so that homogenous materials will be used for the sea water pipelines, in order to avoid or minimize the electrolysis effects.

6.3 Pumps

Arrangements and networks details, materials and thicknesses, as well as their construction will be according to required drawings and Class regulations.

The materials and workmanship should be responding to best commercial standards, be of excellent quality and considered satisfactory by the Class Surveyors.

The vessel will be equipped with pumps and piping systems necessary for its safe and efficient operation for its intended function.

The machinery arrangement will guarantee the easy operation and maintenance, as well as the max. safety for the vessel's crew.

The construction materials will be efficient for corrosion protection depending on the line serving and as per Class requirements. Should also be of the best commercial standards i.e. to be of best quality. All pumps will be electrically driven 380V/50Hz.

The following pumps will be installed:

- two (2) for general use, combined bilge/fire/ballast (one spare) capacity 25m³/h – 20/60 m head. these pumps will be centrifugal, self-priming with stage. also to be equipped with manometers in suction and delivery.
- Two (2) potable water centrifugal pumps, one of which will be reserve.
- One (1) electrically driven screw pump for dirty LO transfer and
- One (1) hand pump for each machine to drain its sump tank of LO.
- Two (2) electrical self-priming screw pumps for the filling of the service tanks.
- One (1) emergency fire pump.
- One (1) general service pump and stand by for DD/GG and port diesel diesel generator, sea water system.
- One (1) electrically driven screw pump for sludge.

In addition of the above, smaller pumps for the bilge water separator, sewage for the sanitary and wherever required for the vessel's needs, will be installed.

6.4 Sea water system

All sea water piping, for bilge, fire, deck-wash and sanitary, shall be of approved material and installed accordingly for its intend purpose and to class requirements.

Two main suction lines, with suction valves of sufficient size, to supply the whole sea water requirements, shall be provided and installed at convenient position.



The main suction lines shall be fitted with suction inlet sea chest, with removable grids, attached to have lugs welded inside the box. The interior of the sea chests shall be coated with anticorrosive compounds and have sufficient cathodic protection. A sea inlet valve shall be fitted to each sea chest and incoming sea water is to pass through a strainer and isolation valves, before passing to the system.

6.5 Bilge System

Bilge system, complying with Rules of Classification Society, will be designed and arranged to allow bilge suction from all the watertight compartments below maximum load waterline, with exceptions for tanks devoted to liquids.

Suction from the compartments to be arranged through stop check valve; bilge waters to be transferred to bilge tank.

Suction will be performed from suitably arranged bilge wells. At the suction points in the bilge wells, in E.R. and in DD/GG room, there will be suitable mud box suctions with a permanent strainer.

For the suctions of the other compartments there will be a stop check valve at the collecting manifold in the engine room and at the suction point of each compartment a suction strainer.

An alarm showing the presence of water in a compartment, sound and light, in the engine room and on bridge it will be installed. High levels remote alarms will be fitted in each machinery compartment

Pipes will be steel, seamless, galvanized, DIN, with their penetrations from watertight bulkhead or floor plates to be safely waterproof.

The parts connections will be flanged and their fixing will be done with strong and frequently spaced clamps coated with durable elastic sheathing.

Valves of the pipeline will be wholly in stainless steel. The others will as per current regulations and on condition that their valve and valve seat to be brass or stainless steel where that is required.

The distribution valves of the pipeline will be locally and remotely controlled equipped.

In E.R. compartments will be provided with an additional emergency suction system.

The one of bilge wells in E.R. the suction shall be carried out directly by the general service pump with locally and remote control and the other bilge wells suction shall be carried out directly by the emergency fire pump with locally and remote.

The pipeline will be served by the two general service pumps (one reserve) through suctions with non-return valves, from a manifold, to which all the pipelines for bilges the compartments will terminate and they will discharge through a common line with non-return valves to an oily bilge tank of sufficient capacity.

On the discharge line there will be installed a Bilge Oily Water Separator.

All pipes will be made in steel galvanized, galvanized or equivalent.

Valves of the pipeline up to 2 inches will be wholly in brass or in stainless steel. The others will as per current regulations and on condition that their valve and valve seat to be brass or stainless steel- where that is required.



6.6 Fire Fighting system

It will be installed a sea water pressurized system, designed to washing and fire services made-up by delivery piping of suitable diameter, duly arranged and resulting from two main pumps, remotely controlled, located in the engines room; from the manifolds will depart branches for connection to washing/fire hoses with suitable threaded attachments.

To be provided fixed branches on hawse pipes for chains washing.

Connections for washing/fire hoses to be in such a number and arranged so as every part off hull and superstructures can be reached by abnormal jet of two hoses. All this to comply with the Classification Society rules.

The system will be constructed of pipes made of steel, seamless, galvanized, of appropriate DIN standards.

The flanges of the pipeline network will be made of steel; pressure 16bar and packing will be made of high temperature resistant materials.

The couplings (hydrants) of the fire lines will be made completely of brass, STORZ type and the pipeline valves will be made of brass.

The suction will be drawn from the main suction line. The discharge will be common through piping and valves will be directed to the main fire line and the various local hydrants.

Besides the above pumps there will be an independent, el/driven pump for fire emergency pump duty, installed in bosun store, whose line will be connected with the main fire line according to Class regulations.

6.7 Fuel system

Fuel will be stored in two double bottom tanks and in two service tanks located immediately ahead of the fore engine room.

The fuel will be transferred by means of 2 screws electric driven- pumps, into two service tanks.

Each service tank will feed each main engine, each diesel fire pump and DD/GG room. It will also receive the fuel returns of fed engines.

Cross connection will be provided between port and stbd tank, and port and stbd pump.

Each tank will be provided with three level alarm/switches as follows:

- one high level alarm/switch to stop the feeding pump;
- one switch to start the feeding pump;
- one alarm/switch, positioned to a level below the second one, to give alarm for feeding pump failure.



The fuel amount corresponding to the alarm level will be enough to assure the functioning of the four aft engines for the required time period, in case of total loss of the fuel main tank and, of course, to allow the crew to do the proper actions in case of failure of one pump, without stopping the engines.

The service tanks will be drained by gravity.

The vessel will be provided with two bunkering stations placed on the main deck both port and starboard sides, immediately above the main fuel tank, to allow an easy loading from both sides of the ship.

Every filling pipe will be provided with international flange.

6.8 Air Vents, Sounding and Overflow

The fuel tank will be provided with ventilation pipes as per Rule's. The vent pipes, provided with flame stoppers, will end above the main deck and they will be adequately protected from water flowing in.

The fuel vent pipes have overflow pipes all interconnected by manifold, which will also connect the bunkering stations, in order to, prevent any possible sea pollution in case of wrong bunkering operations.

Overflow pipes will discharge into bilge tank, fitted with high-level alarm. The bilge tank manifold will be equipped with a vent ending in the funnel.

Manual sounding devices will be provided for double bottom tanks

All service fuel tanks will be provided with suitable level indicators, with display in wheelhouse and nearby the filling stations.

All pipes will be made in stainless steel.

6.9 Fixed Fire Fighting System (FOAG)

A fixed FOAG fire extinguishing system will protect the Engine rooms and all accommodations.

The plan shall consist of:

- bottles arranged in an appropriate room in the main deck
- one pump (capacity 2.5 m³/h – 150bar) in engine room
- a tank of fresh water with sufficient capacity in engine room.

The delivery shall be carried out through a distribution net directly into Engine rooms and in accommodation spaces with acoustic and visual alarm arranged in the wheelhouse and in Engine rooms. The foag room shall be fitted with equipment for bottles weighting.

In the foag space all remote controls will be installed, for closing all engine room ventilation ducts and to intercept fuel lines.

The system will be operated either locally or remotely from the wheelhouse.

The alarms will comply with Classification Society requirements.



6.10 Portable Fire Extinguishers

The ship will be provided with portable fire extinguishers the number, size and type of which will comply with Classification Society requirements and the EU Administration.

6.11 Hot and Cold Fresh Water System

Fresh water will be contained in two lateral tanks it will be provided with level gauges with floating indicators for the alarm of minimum level, inspection manholes, and ventilation pipe, refilling station.

Only one circuit shall be provided for drinking and washing service; it shall include:

- One electrically driven self priming centrifugal pumps each capable of 1.5 m³/h and 15 m head provided with suitable expansion tank of 200 lts for supply the users through a main manifold in copper. The branches connecting each user to the main manifold will be in flexible pipes.

The plant shall feed the following users:

- toilet and galley sinks, taps of which will be of the self closing type;
- toilet flushing system;
- the wheelhouse window wipers;
- a hose connection in each engines room;
- One boilers of 150 litres each will also be installed in dd/gg room

6.12 Sewage and Grey Water System

To be provided treatment, storage and discharging sewage system, in full compliance with the rules currently in force regarding outboard discharge of sewage and grey waters.

The system will be of the vacuum type and will consist of:

- a toilet made of china, the flushing will be fresh water from the fresh water system on the ship;
- vacuum pump,

The connection between the toilets and the pump will be by means of pipes specially suited for this service.

The suction capacity of the pumps will allow easy fitting of the pipes with a counter slope and with many curves and deviations.

The black waters will be then sent to a water treatment unit, equipped with a recovery tank capable to treat approx. 0.5 m³/h.

Once treated, the black waters could also be discharged into the harbour waters.



The possibility to discharge ashore will be provided as well.

The system will be fully automatic and all necessary alarms and signals will appear on the ship's monitoring system.

Grey waters to be discharge directly, due to gravity, overboard through the ship's drainage system.

Piping will be made of suitable material approved by Class. If HDP (high density polyethylene) will be used, piping from each supply up to points accepted by Class will be from HDP material, DIN standard, self-extinguishing type and connections will be as follows

- a) HDP - HDP through special couplings
- b) HDP - steel pipe through flange.

Penetrations of HDP piping through bulkhead or deck will be through steel pipe of suitable dimensions.

Valves of the pipeline will be wholly in stainless steel. The others will as per current regulations and on condition that their valve and valve seat to be brass or stainless steel- where that is required.

6.13 Compressed air system

One compressor shall be fitted in engine room having a capacity of 20 m³/h at 8 bars for ship service, and for the whistle. Instrument and automatism air to be taken from air system through reduction valves and suitable dehydrating filter equipment.

There will be air supply, through a low-pressure 7 bar network with suitable valves, at the sea chests for cleaning with air blow and also various receptions in the engine-pump room areas for various uses.

All necessary valves, safety arrangements, pressure reductions, automations, water and oil traps where required etc, as needed for the installation.

The piping will be equipped with all necessary manometers and supply indication instruments.

The piping materials and generally all arrangements will be as per Class regulations with a special emphasis on the safety arrangements.

6.14 Air conditioning system and Ventilation

6.14.1 Accommodation Conditioning Plant

One air conditioning plant shall be fitted including two identical and independent air conditioning sets arranged as per general arrangement plan. The plant shall serve the cabins, mess and recreation rooms, wheelhouse.

The plant shall be designed for the following conditions:

Summertime:

- Outside conditions (at shadow): T=40°C ; U=70%



- Sea temperature : T=30°C
- Inside conditions : T=27°C ; U=55% ± 5%

Winter time:

- Outside conditions : T=-5°C ; U=50%
- Inside conditions : T=23°C ; U=60% ± 5%

When the air conditioning plant is operating, part of the air shall re-circulate and part shall be external air (about 10 m³/h per person and about 3 changes/h for each space).

In ventilating condition only external air shall be used.

Each of two conditioning sets shall include one centrifugal ventilator, one plenum, flaps, one cooling battery (copper pipes made with continuous anodised wings), one heating electric battery (copper pipes made with continuous anodised wings), one electric compressor (R-134) with cupronikel 90/10 pipes, stainless steel piping plates and bronze body and caps treated with anti-acid plastic covering.

The two conditioning sets and the two compressors have to assure each 70% of the service with the above mentioned external summer conditions.

The air conditioning station shall have external air intakes fitted with anti-rain grid.

Sea water circulation service shall be granted by central cooling system.

The air circulation shall be carried out by a high-speed simple duct circuit; the temperature regulation, in winter time, shall be obtained by means of two thermal-regulators (arranged on the heating batteries of each conditioning set).

The humidity regulation shall be of automatic type. The temperature regulation as well as the humidity regulation, in summer time, shall be obtained by the automatic regulation device of compressor capacity connected to Freon flow variation on the cooling battery.

The manual control for the regulation of the airflow shall be arranged in each cabin.

The ducts for the ventilation/exhaust and conditioning plant shall be of circular ducts minimum thickness 0.6 mm.

Structural ducts shall be provided, where necessary only, of suitable thickness, possibly insulated.

The conditioning plant ducts shall be insulated with glass wool panels, sheeted with glass wool cloth and fixed by means of glue.

The air delivery of mechanical ventilation to the ventilated spaces shall be carried out by means of circular louvers fitted with closing device.

Diffusers, duly appropriated with the spaces, shall be arranged for the conditioned spaces.

A stainless steel hood, fitted with stainless steel grids, and independent exhausting fan shall be installed in the galley, complete with grease filter and oil drain gutter of easy removable type to consent the normal cleaning operation.

A fire fighting plant for the hood shall be arranged as per regulations.



6.14.2 Mechanical Ventilation

Mechanical ventilation/exhausting plant shall be provided for the following spaces:

- Galley 60 air changes/h
- Food Store 6 air changes/h
- Toilet 25 air changes/h
- Stores 6 air changes/h
- Steering gear 25 air changes/h

Fans shall be axial or centrifugal type.

Mechanical ventilation by means of centrifugal fans with sufficient capacity to remove the machinery generated heat shall be provided for the bosun store and bow thruster room

All the spaces without mechanical ventilation shall be fitted with natural ventilation.



7 ELECTRIC SYSTEM

7.1 GENERAL

7.1.1 Conditions

The electrical installation will be designed, constructed and installed in accordance with section of electrical installation and to comply with regulations and requirements of:

- IEC – International Electric-technical Commission
- Classification society and Flag Administration rules
- International Maritime Organization (I.M.O.)

Electrical systems and equipment will be suitable for service in a salty, misty atmosphere and design for an ambient temperature of 45° C in the engine room (40° C on open deck) and a relative humidity of 60% and in accordance with the rules.

Electrical motors and equipment mounted on open decks will be installed weather proof and sea water tight, with a protection rate of minimum IP 56 and shall be explosion proof type for installation on cargo deck within the dangerous zone as described by Classification Society.

Electric equipment to be placed in ventilated space, where they are not exposed to the risk of mechanical injury and the damage from water, steam, or oil, and where inflammable gases cannot be accumulated.

Where necessarily exposed to such risk, the equipment to be protected from the damage.

If any items in the machinery or hull specification necessitate the installation of electrical equipment not mentioned in this specification, such equipment to be provided by the Builder in accordance with similar equipment mentioned in this section.

The material, construction, etc., of all electrical equipment to be manufacturer's standard and builders' standard unless otherwise specified and to be complied with class requirements.

7.1.2 Power Distribution System

The power distribution system shall be as follows:

Alternator	:	AC 450 V, 3ph
Power	:	AC 450 V, 3ph
Small consumer	:	AC 230 V, 3ph or 1ph
Heater of large capacity	:	AC 450 V, 3ph
Lighting	:	AC 220 V, 3ph
Control & monitoring system	:	AC 230 V, 3ph or 1ph and/or DC



	24 V
Communication equipment and alarm :	AC 230 V, 3ph or 1ph and/or and/or DC 24 V

The system shall be insulated from hull throughout the Barge, i.e. floating neutral, except earth detecting circuits and necessary circuits of electrical equipment which may be earthed.

7.1.3 Standard Frequency

A frequency of 60 Hz shall be applied to the AC power supply system.

7.1.4 Wiring

The wiring shall be of three (3) wire-insulated system for AC three phase circuit, and of 2 wire insulated system for AC single phase circuit and DC circuit. All internal wiring will be terminated to a central connection box or strip. 'AS BUILT' drawings will be updated according final wiring connections. All wiring will run in wire trays or pipes. Wiring in control boxes will run in plastic wire trays with top cover where applicable.

660V rated cables shall be used for the 450V circuit and 250V rated cables for AC 220V and DC 24V circuits.

Cable on exposed deck, between the deckhouse and the upper deck forward areas shall be protected with galvanized steel pipe (SPP) and several expansion joints shall be fitted.

7.1.5 Labels and Markings

Components inside switchboards, consoles, starter boxes etc. shall be marked with labels in accordance with AS BUILT circuit diagrams. All internal wiring shall be provided with plastic pressed-on wiring numbers (wire and terminal pin).

All circuit breakers, control switches, instruments, indication lights, terminal blocks, etc. shall be clearly labeled to identify their purpose and/or function and/or circuit. All labels for fuses shall, in addition, indicate the rating of the fuses. Language shall be in English.

Bus bars and connections of major power equipment shall be clearly marked with tapes, paints, letters or equivalent, and shall be arranged as follows or according the Classification requirements:

7.1.6 Colour Scheme for Electrical Equipment

○ **Colour for Electrical Equipment**

Standard colour scheme of finishing paint on metal surface of electrical equipment shall be as mentioned below. Inner metal surface shall also be finished in manufacturer's standard color. Generally steel enclosures, i.e. switchboards,



consoles, distribution boards, starter boxes etc. shall be dip-coat primed and powder coated .

○ **Colour of Indicating Light**

The color of indicating lights shall be decided considering easy discrimination based on following principle.

Red	Meaning	Danger & abnormal condition
	Application	Alarm for dangerous conditions/Stop
White	Meaning	Normal working condition, general information
	Application	Power source “ON”
Orange	Meaning	Attention
	Application	Space heater “ON”
Green	Meaning	Safety
	Application	Motor running, turning gear disengage, etc.
Yellow	Meaning	Attention
	Application	Stand by

Remarks: The colour indicating lights mentioned above shall not apply for navigation lights, signal lights and CRT unit for engine room alarm and monitoring where the CRT unit is used.

7.1.7 Circuit Breakers

Air circuit breaker

Air circuit breaker (draw-out type) shall be used for protection of the generator.

Air circuit breaker shall be of motor operated type and controlled by a control switch, and additionally a manual-operating handle shall be provided.

The air circuit breaker shall have over current trip device for long time and short time inverse action and shall have magnetic coils for instantaneous trip and under voltage trip.

Generator shall be protected against reverse power with reverse power relay connected to under voltage trip device.

The air circuit breaker shall be capable of maintenance from the front of the main switchboard.

The air circuit breaker shall have enough interrupting capacity against short circuit current.

Moulded case circuit breaker

Moulded case circuit breaker shall be used for protection of the feeder circuit.

Moulded case circuit breaker shall be equipped with thermal over-current and magnetic instantaneous trip device and used for distribution feeders on the switchboard.



All moulded case circuit breakers shall be of plug-in type, so that the breakers may be removed from panel front without touching any energized part.

Moulded case circuit breaker for shore-connection shall have auxiliary contact to inter-lock with air circuit breakers for main generator.

7.2 ELECTRIC POWER GENERATING PLANT

Electrical power aboard the barge will be supplied by :

- two Diesel generators (DG) set, about 720 kWe
- one port/emergency Diesel generators (DG) set, about 40kWe
- One Shore connection 100A, 440V, 3ph,60 Hz- BS:advise
- Batteries of 24 V to providing power to essential equipment.

The running alternator set for each condition and its rating shall be confirmed by the electric load analysis prepared by the Builder and approved by the Owner.

7.2.1 Main Diesel Alternators

See Chapter 9.4.4 and 9.5

7.2.2 Port Diesel Alternators

Number of unit	One
Rated output	40KWe 50KVA (may change due to detail design)
Rated voltage	AC 450 V
Frequency	60 Hz
Number of phase	Three (3)
Power factor	0.8 (lagging)
Rating	Full load continuous
Revolution	1800 RPM(maximum)
Type	Self excited, brushless, complete with AC exciter, rectifiers, and AVR unit
Insulation	Class "H/F"
Enclosure	Totally enclosed type (IP23) with cable gland

7.2.3 Construction, installation and associated apparatuses of alternators

a. Construction and installation

The diesel alternators to be of the cylindrical rotary field type, semi enclosed drip-proof and self ventilated construction. The generators to be star connected



without earthing of neutral point. The alternators will be suitable to be installed with their rotor shafts in the fore and aft direction.

b. Bearing

The bearing of alternators to be of double, bracket type and arranged for self-contained ring lubrication.

c. Alternator protection

Means to be provided to prevent the all effects of flow current circulating between the shaft and the bearing in accordance with the manufacturer's standard.

Two resistance bulb (PT 100 ohm) per each phase (one for working, one for stand-by) to be fitted for detecting stator winding temperature and H.T. alarm displayed in the deck office control panel.

d. Space heater

The alternator to have a single phase sheathed wire type space heater to prevent the condensation of moisture when the generator is not in use. The space heater circuits to be interlocked with the alternators-generator air circuit breakers.

The manual switch for the space heater to be fitted on the main switchboard.

The lamps indicating that the space heaters are energized to be fitted on the main switchboard.

7.2.4 Cooling system

Alternator for auxiliary genset shall be cooled by shaft-mounted fan. The cooling shall be drawn through air filters.

7.3 SWITCHBOARDS

7.3.1 Main Switchboard

The switchboard to be located in the engine room above the main deck.

The switchboard consists of the following panels:

- 1 - Group 440V feeder panel
- 2 - Group starter boards/ motor control centres
- 2 - AC 230 V feeder panel
- 1 - Bus tie panel
- 1 -DC 24 V panel

The lay-out of the front of the switchboard is designed according to the Builder's practice but will be approved by the Owner.

Oil and water pipes are not installed above or adjacent to switchboard. In case such placing is unavoidable, suitable protection is provided in these positions.

Rubber covers in front and behind of main switchboard and also on wall behind of main switchboard.

Construction:

The switchboard is of modern design dead front type, the framework being constructed of profile iron, suitable braced, stiffened and installed in a solid manner



to eliminate vibration. Frontal hinged doors and panels are of sheet metal. All instruments and apparatus are installed easily accessible, free of dangerous proximity to each other to facilitate adjustments and repairs, and clearly identified. Insulated hand rails in front.

For the propulsion see chapter 9.5

7.3.2 Shore Connection Box

One set of shore connection box shall be installed integrated with the switchboard. Connections shall be provided at the bottom of the box for connecting temporary shore cable.

The connection box shall be fitted with:

- 1 – Molded case circuit breaker
- 1 – Phase sequence indicating lamps
- 1 – Phase sequence change-over switch
- 1 – ‘POWER ON’ indicating lamp
- 1 – Kilowatt-hour meter

The circuit breaker shall be interlocked that it will not be possible to connect the shore power to any of the ship’s generators. It will be possible, however, to synchronize the auxiliary generators to the shore power (when voltage and frequency are correct) followed by an automatic trip of the shore power circuit breaker.

A notice shall be provided to give information of the supply system and the procedure for carrying out the connection.

7.4 STORAGE BATTERY, BATTERY SWITCHBOARD AND TRANSFORMER

7.4.1 General Use Battery

One set of storage battery shall be installed in the battery box for navigation equipment, communication equipment, automation equipment and general use.

Particulars of battery shall be as follows:

Capacity:	For 24 hours discharge rate
Rated voltage :	DC 24 V
Type:	Maintenance free, sealed, lead–acid type

Inventory for battery shall be supplied according to the manufacturer’s standard.

7.4.2 Battery Switchboard

One set of dead–front type battery switchboard shall be provided for charging and discharging of battery, and distributing DC 24 V source.

The charging rate shall be sufficient to replace 100% battery capacity within 24 hours, and then unit shall automatically revert to the trickle charge rate.

The board shall be fitted with the following instruments and devices:

- 1 – Voltage adjuster



- 1 – DC voltmeter with a selector switch
- 1 – DC ammeter with a selector switch
- 1 – Source pilot lamp
- 1 – Insulation level meter with earth indicating lamp
- 1 – Push button switch (quick charging or trickle charging)
- Necessary numbers of miniature circuit breaker or fuses

Two batteries sets will be provided for emergency and general use.

The batteries will be fitted in fiberglass boxes and located in engine room with air vent in atmosphere.

7.4.3 Battery Charger System

Two automatic battery inverter/charger shall be provided with suitable capacity. Automatic change-over from normal to trickle charging will be provided as well as an ammeter.

An alarm contact to the engine room alarm and monitoring system to be fitted.

The capacity and type of automatic battery inverter/charge as approved by relevant authority to be set.

The inverter will be provided power to supply monitoring system and emergency lighting.

7.4.4 Transformer

Transformers shall be drip-proof, dry type, natural air cooled and class “B” insulation, and located in dry, clean and well ventilated space free from dripping water and moisture.

Three general use transformers AC, 440/220V/120V, 3 Ph, 60 Hz, of suitable capacity in accordance with electrical balance.

These transformer are each capable for supplying the total 220V distribution system each transformer to be fed via from a selector switch at 220V side. Transformers are of the drip proof, air cooled type, in a sheet steel housing.

7.5 MOTOR AND STARTER

7.5.1 General

The specification described in this section shall be applied to the motors and the starters unless otherwise specified in the other section, however, motors and starters supplied as part of the following equipment shall be constructed in accordance with the manufacturer’s standards:

- Governor
- Instrumentation and control equipment
- Package type air conditioning unit
- Auxiliary machinery such as ventilation fans, workshop machinery, tools, etc.



7.5.2 Motors

Motors shall be of squirrel cage induction type of IEC standard frame designed for AC 440 V, three phase, 60 Hz, except for the small motors which may be AC 230 V single phase or three phase type.

Motors shall be rated for continuous full load duty except motors for deck machinery, cranes, etc.

Motors < 0.4 kW may be rated for single or three phase 230 V 60Hz. Motors >0.4 kW shall be rated for three phase 450 V 60 Hz. Ratings and frame sizes will be selected from the tables of IEC 72-1 and IEC 72-2.

All motors shall be suitable for marine service environment.

All motors shall be enclosed type, external fan cooled (IP 55 enclosure). Vertical motors shall have also drip proof protection

Motors arranged on weather decks shall be totally enclosed type (IP 56)

As far as possible motors shall be supplied by a single Maker (Maker according to Makers List) .

All motors shall be single speed type, except those driving special users if any maximum speed not to exceed 1750 rpm.

The electric motor will be protected by a normal thermal overload relay (normally mounted in starter).

Stator windings shall be treated with insulating varnish to resist oil and water. Motors shall be designed and constructed into class "F" insulation.

Motors shall be provided with water-proof terminal box of cast iron or steel plate construction with gland and removable cover.

The terminal box shall contain suitable size of solderless terminals secured on an insulating board facilitating connection of the cable.

Motors shall be fitted with duty plates engraved in English with manufacturer's name, serial number, rated kW, RPM and full load.

7.6 **ELECTRIC CABLE AND INSTALLATION**

7.6.1 General

In general, cables installed throughout the barge shall be approved by the Classification Society and of 440 V, 250 V grade insulation to meet the voltage to which they are subjected.

Cables installed throughout the barge shall be constructed in compliance with the requirements of the Classification Society and IEC recommendations. Flame retardant characteristic of cable shall be in accordance with IEC publication 332-1.



The cable supplying one load, in general, shall have a continuous current carrying capacity of the connected load except for short time loads and intermittent loads such as deck machinery, cranes, etc.

The cable supplying two or more loads, in general, may have a current carrying capacity calculated with the application 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 final point shall not exceed 6% of the nominal voltage except for DC circuit shall not exceed 10% of the nominal voltage.

All cables shall be based on 45°C ambient temperature.

Insulated (6Y) or equally graded cables shall be installed. This shall include all thermal fluid plant cables.

In general cables for power, lighting, intercommunication shall be of copper conductor, PYC insulated, PVC sheathed type, European standard IEC 92-353.

For installations sensitive to interference or radiating interference a metal overall screen shall be fitted under the outer sheath (or equal standard protection if available).

Cables in hazardous areas shall be screened.

Cables for intrinsically safe circuits shall be clearly marked and routed separately from other cables.

Cable cores of cables with 1-3 cores shall be colour coded.

Cable cores of multi-core control cables shall be marked with printed on numbers.

Cable cores connected into terminals shall be executed with soldered or pressed-on pins.

Cable cores connected to bolt type terminals shall be executed with pressed-on pins.

Spare cables (12x1.5mm²) and (5x2.5mm²), screened and shielded PYC shall be installed .

7.6.2 Cable Application

In general, the type of cables installed throughout the vessel shall be selected to match their locations or purposes in compliance with the Class and Flag requirements.

Single, double or triple core cable shall be used in general, and multi-core cable shall be used for communication, signaling and control circuit.

In general, flexible cords for portable fixtures shall be provided with an earth continuity conductor which shall be effectively connected to the earth terminal of the receptacles.

7.6.3 Cable's Supporting

In general, cables run in groups shall be supported with hot dip galvanized, ladder type steel hanger or flat bar.



Cable in the engine room and accommodation shall be fixed with galvanized mild steel band with PVC sheath or non-metallic band.

Cable on the exposed deck shall be fixed with stainless steel band with PVC sheath or UV resistant non-metallic bands.

Cable in refrigerated chamber shall be wired along plastic trays and fixed with stainless steel band. To protect cables in pipes from damage, the ends of the pipes shall be fitted with PVC inserts and/or trumpet edges (or equivalent means). Aerial cables to be fitted in galvanized steel pipes.

The cables in the weather deck to be installed in galvanized steel pipe with the expansions and the cable connection boxes as per the builder's practices subject to Owner's approval of the number of expansion/connection boxes during plan approval.

7.6.4 Laying

Where paneling is applied over the hull structure in the deckhouse, concealed wiring shall be carried out as far as practicable.

No unconcealed cables shall run in C.C.R.

Cables in the deckhouse shall run along a dedicated cable locker trunk, with suitable access at every deck.

Cables on weather deck shall be mainly protected with the electric cable steel pipe.

The cables will be installed in galvanized steel pipe if which fitted on the exposed deck.

Where cables is below the floors in E/R, it will be protected with flexible steel cable conduit as cable conduit as per the build's practice.

Where cable is exposed to some mechanical damage, it shall be protected with steel plate, galvanized steel pipe, flexible cable conduit or other equivalent means.

Cables beneath the gratings of engine room floor deck or other similar areas shall be protected with flexible conduits or flat bar where cable damages could occur.

Cable along the foremast shall be protected with galvanized steel pipe or painted steel plate up to 2.5 meters high on the main deck.

7.6.5 Cable Penetration

Where cable penetrates water-tight deck or bulkhead, water-tight cable gland or equivalent water-tight means shall be used.

Where cable penetrates non water-tight deck, coaming, or cable pipe without cable gland shall be used for protection of the cable.

Where cable penetrates fire-resistant or fire retarding deck or bulkhead, cable gland or coaming shall be used for protection of the cable filled with incombustible compound where necessary.

Special attention shall be given to the Rule requirements regarding cable free section area of the penetration.

Suitable plastic covers shall be fitted where cables pass through accommodation panels against abrasion. Cable entry in boxes shall be from below.



7.7 LIGHTING DISTRIBUTION AND EQUIPMENT

7.7.1 General

The lighting system throughout the ship to be designed so as to that adequate lighting levels are obtained according to the use and work conditions of any specific area.

The vessel shall be illuminated with fluorescent lamps or incandescent lamps designed for location and intended service.

Weather deck shall be illuminated with high pressure sodium or halogen floodlights.

The lamps shall be fed from the AC 220 V normal supply system unless otherwise specified or required.

In general, the type of lighting fixtures and fittings shall be applied depending upon their location.

General lighting system to be fed from the ship service transformers via step - down transformers, and to illuminate throughout the vessel in normal condition.

Emergency and emergency transient lighting system to be fed from the DC24 switchboard.

7.7.2 Illumination Level

The number of luminaries shall be sufficient to ensure an efficient illumination.

Limits specified by comfort rules and regulations (classes T3-T5) shall be considered as the absolute minimum requirements.

The illumination level will be agreed with the following table and will be verified on board to Owner's satisfaction.

In general, rooms and spaces shall be effectively illuminated according to the following standard.

7.7.3 Deck's Lighting

External normal and external illumination of Deckhouse shall be by watertight luminaries, suitably located on superstructure boundary bulkheads.

The aft part of main deck external illumination shall be by floodlights.

In general above luminaries shall be fed from both normal and emergency lighting circuits or from more circuits. Circuits shall be controlled directly from switches arranged into distribution panels.

Proposed luminaries and appliances shall be as per maker list or equivalent Owner approved.

7.7.4 Switch

Switches used for lighting branch circuit shall be of double pole type and the material of body shall be synthetic resin.



Switches shall be of flush mounting type except where inapplicable, and those in other spaces shall be of surface mounting type.

Switches for bed lights shall be two-way type.

For engine room lights and passage lights, breakers on deck distribution boards shall be used as switches.

Switches shall be watertight as per requirements.

7.7.5 Socket plugs

In general, socket plugs shall be of three pole DIN or equivalent type, one pole of which shall be used as an earthing connection for metal frames of portable appliances.

Socket outlets in engine room, deck and workshop areas shall be 3-pole (earthed) 230 V 60 Hz, 16 Amps, CEE-17 type or equivalent.

Socket plugs for personal computer power supply, shall be fed via a central UPS in the deck office.

7.7.6 Navigation Light

Arrangement and number of navigation and signal lights shall satisfy the Rules and Regulations.

The system shall consist of two navigation light water-proof sets, one in service and one in stand-by, and shall be provided as follows:

- 1 – Masthead light
- 1 – Stern light
- 1 – Port side light
- 1 – Starboard side light

Navigation lights shall be controlled from the navigation light indicating panel.

7.8 ELECTRICAL DRAINAGE AND HULL EARTENING

All cargo and sea water piping shall be connected by means of steel connection on flanges in order to assure the electric continuity as per Regulations.

All the plants shall be earthened with the ship structure. In way of manifolds amidships, connections for hull earthening shall be provided.

7.9 FIRE DETECTION SYSTEM

Fire detection system shall be provided with one central panel in the wheelhouse .

Fire alarm with indication of all fire zones to be set.

Fire indication and failure of detector shall be indicated by corresponding loop lamps on the central panel.

Smoke detectors and/or thermal detectors shall be fitted in the engine room, engine casing, deckhouse space according to the Class approved drawing.

Fire detectors in engine room shall be tested during dock trials with both ventilators running at high speed.



The power for the fire detection system shall be fed from the emergency switchboard. It shall be fed from the DC 24V battery power supply as a back-up.

The power supply failure and system abnormal shall be signaled on the central panel.

7.10 PUBLIC ADDRESS AND MUSIC

The ship will be provided with a console located in the wheelhouse for address and music transmission where the following equipment will be installed:

- syntonizer;
- CD, MP3 Player;
- all the amplifiers and ancillary equipment.

The music and the sound track of the movie will arrive to the loudspeakers fitted all over the ship.

The same equipment will be used for crew mess and general alarm.

7.11 NAVIGATION SYSTEM

7.11.1 Radars

One S-band radar will be installed with the following characteristics:

- a 15-in colour display;
- one unit to be 6 kW power X-band radar with common aerial ;
- coloured screen and true motion capability.
- the range will be for 45 n.m.
- the radar will be installed on the wheelhouse area while the transponder-aerial unit will be a single unit mounted on the mast.

7.11.2 Other navigational aids

- One magnetic compass.
- One DGPS and one GPS
- One echo-sounder coloured 12 stages 60W ability of 600 fathoms.
- One meteo-fax.
- One integrated navigation console which will basically consist of:
 - One coloured chart video plotter where the nautical charts of the area, the route indication (by signals from GPS, speedometer, gyro etc.) will be shown and with charts of EU seas or equivalent
- Barometer wall mounted at least 15 cm.
- One Clinometers (enclosed air bubble type) with similar one in the Engine Room.
- One marine clock wall mounted of at least 15cm. diameter.
- Auxiliary magnetic compass of approved type.
- One electro-magnetic speed log - tachometer.
- Autopilot system, which will have the ability to cooperate with gyrocompass and the magnetic compass.
- Repeaters of speed and wind direction with direct signal from wind-meter, wind-indicator mounted on the mast.



- Satellite communication system with ability of position registration (coordinates-bearing).
- One AIDS system
- One searchlights, of sufficient candelas with remote control from wheelhouse;
- One bulkhead mounted Aneroid Barometer, 152 mm diameter;
- One Aldis type Signalling lamp (24v);
- One bulkhead mounted Clinometer;
- One bulkhead mounted Thermometer

7.11.3 Radio Station

The system will be provided with in the wheelhouse console designed in order to meet the communication system requirements for the vessel's navigation areas.

The following equipment will be provided:

- one HF SSB radio;
- one duplex VHF radio;
- one receiver on emergency frequency 2182 kHz;
- one simplex VHF radio;
- one Navtex system;



8 INTERNAL ACCOMMODATION

8.1 Furniture

Interior joinery work shall be soundly constructed, of simple contemporary design, utilizing laminates and plastic products as appropriate. All plywood use shall conform to good marine standards and giving particular attention to the protection of the back and end grain. All solid timber used shall be of hardwood, carefully selected, well seasoned, free from knots, saps and other defects. All furniture to be built-in and fastened to the deck floor, wherever possible, and well preserved. All unpainted and unvarnished timber shall be protected with wood preservative. All fastenings and hardware are to be/ of marine type and non- corrosive.

Structural fire protection will be according to Rules.

All materials used for space decoration, noise-absorbing materials, will be of the self-extinguishing type, with smoke emission and attitude to flame propagation according to Rules.

All materials will be selected pursuing the minimum weight criteria and give the highest possible onboard comfort.

8.2 Accommodations Lay out

According to what shown on the general arrangement plans, the accommodation area will be sufficient for the vessel needs.

The vessel should be developed as below:

- a) Lower Deck - Double Bottom Deck
- b) Main Deck - fully open Main Deck
- c) Upper Deck - Bridge Deck, fully open tugboat type

The communication between the Bridge Deck and the Main Deck will be through one internal ladder and 2 external one on each side.

The communication between D.B. Deck and the Main Deck will be through 1 direct ladder.

Detailed list of all items to be made corresponding to General Arrangement Plans and in accordance with the Rules Requirement

The accommodation layout shall consist of:

- 1 cabin for Captain and Navigating Officer:
- 2 cabins for scientists:

It will also include:

- 1 Mess room
- 1 Galley

The storage spaces of the boat will be:



- Storage space for food (refrigerator for fresh food, store-room for dry)
- Storage space with spares for engines
- Nautical equipment storage space (paints, ropes, maintenance equipment, etc.)

All the internal spaces and alleyways which will be developed based on the design and constructional needs, must have real free breadth ≥ 80 cm and respective height ≥ 200 cm. This height should be regarded as minimum requirement for all spaces.

Curtains, crew mattresses, bed spreads, sofas sheathing, tables and chairs, etc. will be chosen in accordance with the Rules Requirements.

8.2.1 Cabins of Captain and Navigating Officer

The cabin shall at least fitted as follows:

- Two superposed built-in single tier berths, with drawers, underneath lower berth;
- Private toilet, shower and washroom;
- Wall mounted berth lights;
- Built – in lockers;
- Fluorescent lightings with fittings

8.2.2 Cabins of scientist

Each one of the cabins shall at least fitted as follows:

- Two sets of superposed built-in single tier berths, with drawers, underneath lower berth;
- Wall mounted berth lights;
- Built – in lockers;
- Fluorescent lightings with fittings

8.2.3 Berths

All accommodation berths shall be of wooden construction, built-in, having inside dimensions of at least 1.80 meters long and 0.70 meters wide, with drawers underneath and fitted board. Each shall be equipped with a 100.0 mm thick rubber foam mattress covered with bed sheet, two rubber foam pillows.

8.2.4 Cabin Lockers

All cabin lockers shall be wooden construction, built in, adequate dimensions, hinged opening with mirror on inside, complete with shelves, hanging space, hanger rod, coat hooks and life jacket stowage on top.

8.2.5 Dining room

The vessel will have only one dining room. The dining room will be able to serve 8 persons, with appropriate turnover.

One long table with formica laminated-top and pedestal bolted to deck floor.



Built-in L-shaped settee with vinyl fabric upholstery, foam rubber cushions and draws underneath;

At the inside space of the sofas there will be storage places for personal life-saving equipment.

The dining room should be capable of being used as a Meeting Room too.

8.2.6 Galley

The galley will be in a specially arranged area with all necessary equipment: galley with 4 fire places, electrical oven with grill, 1 thermal chamber, refrigerator, deep freezer, stainless sink with two basins, metallic shelves, storage area for food and equipment, etc. Over the cook an exhaust will be mounted.

The panels, the shelves and the drawer of the galley will be lined with stainless steel plating while the floor will be covered with anti-slip type tiles and should be installed with suitable drainage in various points with inspect able pipettes.

In the galley also will be foreseen a storage area for dry food (food store).

8.2.7 Toilet, shower and washroom

Toilet cabinet shall be fitted with washbasin, with pedestal WC vacuum type, shower recess, with mirror on hinged opening, clips, and soundly mounted to the wall,

a) Washbasin

The washbasin shall be of vitreous china or of other approved material fitted with a rubber stopper and keep chain, a cold fresh water screw-down tap and soundly mounted to the wall.

b) Shower

Shower shall have stainless and adjustable shower heads and with a cold fresh waters screw down tap. Shall have grab rails, soap dish, curtain rail.

Floor will be sheathed with ceramic tiles of anti-slip type, drains will be provided to allow an easy cleaning.

8.3 Wheelhouse

The wheelhouse shall be fitted with navigation equipment, communication equipment, and control equipment as follows:

- Variable Orientable Thruster (V.O.T.) joysticks.
- Main engine control: Suitable control system for the main engines combined with simple machinery instrumentation and alarms for monitoring and control of the main engines.
- Non electrical equipment
- Electrical equipment
- Navigation equipment
- Communication equipment



9 MACHINERY AND PROPULSION EQUIPMENT

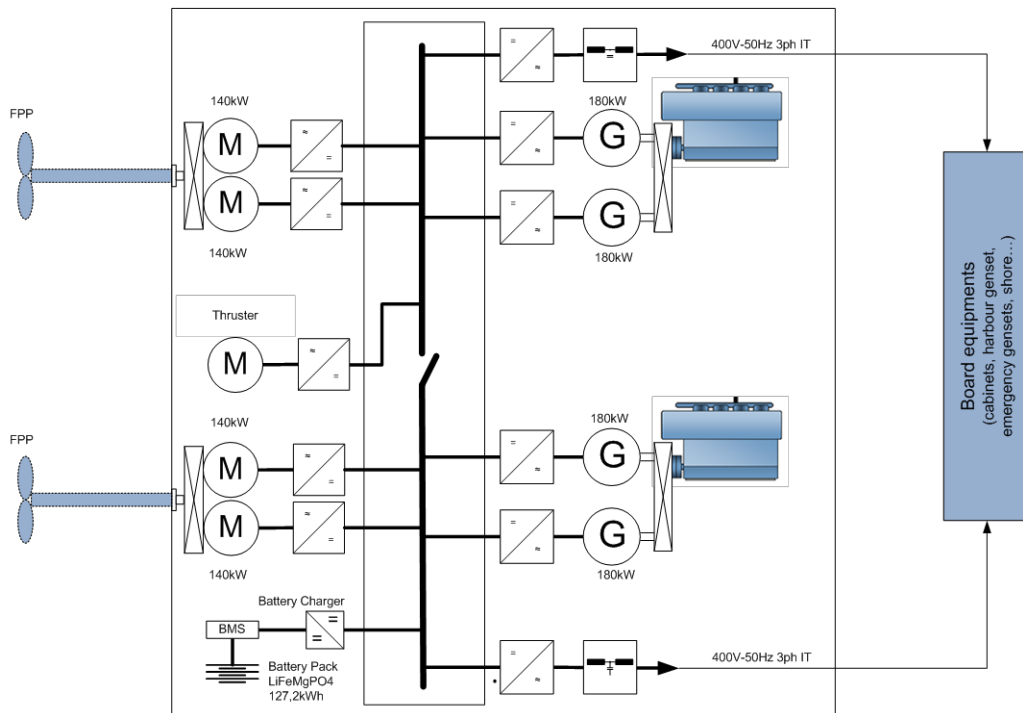
9.1 General

The engine room will be placed in the aft part of the ship where the main dual fuel diesel generators (gensets), the port generator, the propulsion equipment, the pumps and other machinery will be installed

The vessel to be fitted with two Variable, Orientable Thrusters, (V.O.T) electric driven and electrical hybrid system propulsion.

The main characteristics of the system can be summarized and described below.

1. Prime mover through an electric aggregate, composed by paired permanent magnet synchronous motors, liquid cooled, to drive the Variable Orientable Thrusters
2. DC Main switchboard, with floating voltage between 500V and 750V in order to provide the requested power, equipped with safety tie-break aimed to give the maximum availability of the system, even if this will be at reduced power/performances.
3. Diesel gen-sets at variable speed and frequency, in order to adapt the diesel speed and the load to the power requested. The speed regulation will take into account the optimal working points of the diesel engines in terms of efficiency and specific fuel consumption. The frequency converters will convert the AC generated power to DC power to be injected into the main switchboard. The overall power management system will act therefore on the diesel engine speed and on the number of active gensets.
4. Two Frequency converter for the power supply of the ship services (400VAC, three-phase IT network, 50Hz). Two Active filter will be also included in order to fulfill the class requirements in terms of THD.
5. Two electric motors with related frequency converter directly connected to the DC Bus, able to drive the bow- and stern-thruster (dimensioning provided by the supplier of the thrusters).
6. Lithium Batteries of adequate capacity, able to cover the power requested by the hotel load of the ship during night or anchor. The batteries are not supposed to be used during propulsion. The recharge of the batteries will happen through a current-control algorithm.



9.2 Engine Room

On the Engine Room the following main equipment will be fitted:

- 1) Two diesel generators aggregates, each one of the two 2 generation aggregates, including:
 - 2 off permanent magnet synchronous machines type 1FV5168, 180kW @ 3000 rpm
 - 1 off summation gearbox, ratio 1:1,66
 - 1 off diesel engine, 368kW four-stroke, single-acting, non-reversible, medium speed, turbocharged type marine dual fuel engines
- 2) Two Variable, Orientable Thrusters, (V.O.T), connected through a reduction gear to the electric motors including:
 - 2 off permanent magnet synchronous machines type 1FV5168, 180kW @ 3000 rpm
 - 1 off summation gearbox, ratio 1:1,66 o 1 off skid and lube pumps
- 3) n°. 1 permanent magnet synchronous motors, type 1FV5168, used 700Nm@1500rpm, to drive the mechanical bow thruster (this last not included in the scope).
- 4) n°. 11 frequency converters, each 250kVA, liquid cooled
- 5) n°. 1 Power Pack LiFeMgPO4, 96 modules, 32 modules in series, 3 parallel, type UEV 18XP, 127,2 kWh, 614,4V nominal System Discharge Voltage, including Battery Management System and Battery Charger 120kW.



6) Signal cables, Siemens standard, limited to 600m in total (about 20m. max. between cabinets and machines).

7) Cabinets:

- n°. 1 Propulsion control unit, redundant, double CPU, touch panel.
- n°. 1 DC bus Cabinet
- n°. 2 Active Filter toward the ship network (AC, max. 30kVA each),
- n°. 2 Cabinets for the Frequency Converters
- n°. 1 Cabinet, air cooled, for battery charger and precharge

8) The auxiliary machinery in engine room will be driven by electric motor.

9) Switchboard, starters, etc., necessary to operate the above-mentioned equipment.

10) The engines to be operated on marine diesel oil or fuel gas.

The access to the engine room will be from the main deck through the relative stair; Light switches will be fitted nearby the entrances.

Particular care will be taken to ease as much as possible maintenance, substitution, repairing of machinery.

9.3 Design condition

- Sea water temperature	32°C
- Ambient temperature in E/R	45°C
- L.T. cooling F.W. temp.	36°C
- Relative humidity	60 percent
- Barometric pressure	0.1 MPa
-	

9.4 Electric generating plant

The main electric generating plant to be consisted of two (2) main diesel generator sets.

9.4.1 Main generator's engine

Each main generator will be 4 stroke, non-reversible, turbocharged, medium speed, and inter-cooled dual fuel engine with direct injection of liquid fuel and indirect injection of gas fuel. The engine to be arranged for running on gas mode or in marine diesel mode. The engine will be IMO Tier III type both with gas fuel and marine diesel oil.

The engine to be connected to the generator through a flexible coupling,



Maximum continuous rating	368 kWm
RPM at max continuous output	1800
Number of	6L
Cylinder bore	130 mm
Stroke	160mm

9.4.2 Gas fuel specification

For continuous operating in gas operating mode the gas used must have the following characteristics:

- Lower heating value 28 MJ/m³N
- Methane number(MN) min : 80 – 90
- Methane (CH₄) min :70% of volume
- Gas inlet temperature :0 – 60 °C

9.4.3 Liquid fuel specification

The fuel specification are based on the ISO 8217:2010(E) standard.

Distillate fuel grades are ISO-F-DMX, DMA, DMZ, DMB all referred to as marine diesel fuel.

The engine will be installed for dual fuel operation meaning the engine can be run either in gas or diesel operation mode. The operation mode can be changed while the engine is running, within certain limits, without interruption of power generation.

The engine to be arranged for operation with fuel oil and with fuel oil consumption of about 203 gr/KWh, with flow tolerance of +8% and temperature tolerance 15°C at 100% of MCR with a fuel of 42,700 KJ/Kg during shop trial without engine driven pumps at ISO condition 3046-1 and fulfilling IMO NO_x emission limitations Tier II.

The engine to be arranged for operation with gas and fuel gas consumption of about 9110 KJ/KWh with flow tolerance +5% and temperature tolerance 10°C at 100% of MCR with a fuel gas of LHV 49620 KJ/Kg during shop trial without engine driven pumps at ISO condition 3046-1 and fulfilling IMO NO_x emission limitations Tier II.

The generator's engines installation and all systems related to them will be designed and constructed according to the requirements of generator's builder.

9.4.4 Generators

Four shafts generators permanent magnet synchronous machines type 1FV5168, 180kW @ 3000 rpm with the following characteristics:

Manufacturer	Siemens
Shaft power	180 kW
Rated voltage	max: 750 V, 3 phase
Rated current	265 A max 360 A
Rated speed	3000 rpm
Rotation	CCW & CW



Duty Class	S1 (continuous)
Cooling	liquid, 50% fresh water 50% glycol
Cooling medium temperature	max. 55°C
Type of construction	IM B9 (horizontal)
Type of protection	IP 65
Surface sound-pressure level	max. 75db(A)
Insulation class	F
Temperature rise	F
Ambient temperature:	-30°C- 50°C
Bearings	ball

9.4.5 Construction features

The synchronous machines are designed according to the mechanical and electrical requirements of the propulsion application and correspond to the IGBT drive technology of the MONO Inverters. The machines are designed and tested in accordance with the requirements of the standards VDE and IEC.

9.4.6 Terminals

Separate terminal boxes will be provided on the ND end for power cables and auxiliary/signal wiring.

The terminal boxes are wide enough for cable bending and connection. Terminal boxes will be fitted with a drilled cable entrance plate.

9.4.7 Miscellaneous

The generators are used and primarily designed for installation in electric powered vehicles. Core and winding assembly are equipped with temperature sensors integrated into the stator winding for measuring the temperature response, as well as for regulation and preventing the generator from overheating.

Siemens machines are supplied with lifting eyebolts. Motors and Generators are maintenance free during lifetime. It is recommended after 20.000 hours or at least 5 years to replace the bearings.

9.4.8 Emergency/port diesel generator

One (1) port diesel generator set to be provided, the output of generator set to be abt. 40 kW₃ at 1800 r/min.



Above mentioned diesel engine and generator to be installed on a common bedplate and resiliently mounted on the hull foundation respectively.

However the output is to be specially considered in connection with the final electric load analysis.

-Type	: Squirrel - Cage
-Protection	: IP23
-Insulation class	: F

9.4.9 Cooling system

The engine cooling system will be a single circuit system.

The following main components will be included:

- fresh water pumps, two pcs gear driven
- thermostat valve, 3-way, 32°C for heat exchanger circuit
- one sea water pump, gear driven
- heat exchanger, plate type for 32°C sea water temperature, 32°C nominal (38°C max.) water temperature to engine
- expansion tank, shunt system
- flexible connections

The sea water for the engines will be supplied by two sea chests.

The salt water, after cooling the engines, will be discharged partially directly outboard on ship's sides via suitable outlets protected by valves, partially will be sent to gearboxes cooler.

One sea water and fresh water e/pumps with sufficient capacity will be provided as stand-by for the engines.

9.4.10 Fuel system

The fuel system will be for MDO. The following main components will be included:

- direct injection system with individual unit injectors
- fuel filter, duplex type, with service indicator
- fuel strainer, duplex type
- fuel transfer pump, gear driven
- water separator
- flexible connections

9.4.11 Fuel gas system

The fuel gas system is arranged for natural gas as main fuel.

The gas fuel oil system will be designed to inject into the engine natural gas as fuel at low pressure.

The gas is ignited by injecting a small amount of pilot diesel fuel(MDF).

Gas and pilot fuel injection are solenoid operated and electronically controlled common rail system.

The engine is always started on MDF in gas mode.



Before the gas is supplied to the engine it passed through a GAS Valve Unit(GVU).

The GVU includes a gas pressure control valve and series of block and bleed valves to ensure reliable and safe operation on gas.

The unit include a manual shutt-off valve, inverting connection, filter, fuel gas pressure control, ventilating valves, pressure transmitters/gauges, a gas temperature transmitter and control cabinet.

The GVU valve will installed on main deck.

Two insulated LNG deck tanks will be installed on main deck capacity each to contain 2m3 with all necessary equipment to convert LNG in gas.

9.4.12 Lube oil system

The lube oil system will be included the following main components:

- lube oil pump, gear driven
- lube oil cooler, tube type, fresh water cooled, off engine
- lube oil filter, duplex type
- centrifugal filters
- front and rear oil pan drain
- electric pre-lube pump, off engine

9.4.13 Air intake and exhaust systems

The following main components will be included:

- twin turbochargers, engine front mounted, with compressor bypass
- charge air cooler, fresh water cooled
- air intake silencer, turbo mounted.
- exhaust manifold, dry, with soft wrap, thermal protection
- flexible exhaust connections
- cylinder pressure gauge valves

Exhaust pipes will be in stainless steel, suitably insulated, and will discharge on funnel.

Expansion bellows will be provided to allow the thermal expansion of the pipes.

Each engine exhaust will be provided with a silencer capable of 15 dB attenuation.

9.4.14 Monitoring, alarm and safety control system

A control and monitoring system will be provided. The control function will be represented by the capability of the system to shut down the engine if it operating outside the predetermined set-point parameter.

The monitoring function of the system will be represented by the system's ability to inform the operator about current operating temperatures and pressures of the engine.

Signal for alarms and shutdowns will be provided according to Rules.

The control panel will include the following gauges:

- engine RPM



- start air pressure
- engine hours
- temperature sensors
- pressure sensors
- cylinder pressure relief valve
- crankcase explosion relief valve
- oil mist detector.
- Starting system
- The following main equipment will be included:
- air starting motor
- pressure reducing valve
- starting controls

9.5 Propulsion electrical motors

Each one of the Variable Orientable Thrusters (V.O.T.) will be coupled directly with two electrical motors horizontal type with frequency converter.

The propulsion motors are permanent-magnet three phase 6 pole synchronous machines with water-cooling. According to IEC regulations

The Motors are designed for PWM converter operation.

The characteristics of each one of the electrical motor will be:

Manufacturer	Siemens
Shaft power	140 kW
Rated voltage	max: 750 V, 3 phase
Rated current	265 A max 360 A
Rated speed	3000 rpm
Rotation	CCW & CW
Duty Class	S1 (continuous)
Cooling	liquid, 50% fresh water 50% glycol
Cooling medium temperature	max. 55°C
Type of construction	IM B9 (horizontal)
Type of protection	IP 65
Surface sound-pressure level	max. 75db(A)
Insulation class	F
Temperature rise	F
Ambient temperature:	-30°C- 50°C
Bearings	ball



9.6 Propulsion Converter

The ELFA PWM converter is a water-cooled fuse-less converter. In this fuse-less converter, the thermal capability of the semiconductors is chosen such the converter is still ready for operation after a short circuit, without changing any fuses.

The system is capable for 4-quadrant operation for driving and braking in both directions as an option with a chopper and braking resistor (included if mentioned in technical data).

The inverter on the motor side will provide the motor with a Pulse Wide Modulated (PWM) output voltage, which will result in a sinusoidal output current. The PWM inverter comprises IGBT modules and provides one three phase systems and a single phase system for auxiliary systems (get home, batteries, shore supply, aux generator).

9.6.1 Technical data

Type	ELFA MONO Inverter A5E00468614 PWM converter with voltage-source DC link
Manufacturer	Siemens
Power	250 kVA
Rated voltage DC:	750 V DC
Operating voltage:	300 V – 750 V
Rated current Inverter:	250A
Rated power inverter (650V):	200 kVA
Max. current Inverter (10s):	350 A
Max. power (750V, 350A):	320 kVA
Switching frequency inverter:	2 – 6 kHz
Rated Current:	1 x 150A (@ 6 kHz)
Chopper or DCDC:	1 x 250a (@ 0 kHz)

9.7 SISHIP EcoProp system cabinets

The cabinets to be free standing, front operated, arranged with access doors in front side. The access doors to be hinged, cable entry from bottom. All cabinets will be painted with standard coating RAL 7032.



The cabinets are equipped with standardised electrical and mechanical components and are correctly dimensioned both thermally and mechanically.

9.7.1 Control Cabinet

The system will be equipped with one redundant control cabinet, equipped with:

- 1 pc of S7 PLC Controller to perform simple operation of the system
- Analog and digital I/O's for connection of all system related external peripherals.
- Motor Controls for system related consumers
- Touch Panel for display all relevant data and access to several system functions.

9.7.2 Distribution Cabinet

The system will be equipped with one distribution cabinet, equipped with an un-insulated hard drawn, high conductivity copper busbar (for approx. 750VDC) as powers distribution backbone of the inverter system.

9.7.3 Filter Cabinet (AC-Power Connection)

The system will be equipped with two filter mounted in one cabinets, for generation of one ACpower-connection circuit, each 400VAC, 3 phase, IT without N, with max. 40 kVA,.

9.7.4 Inverter Cabinet

The frequency converters (here called also inverters) will be contained in two cabinets. Here below the proposed configuration.

9.7.5 Transport and storage

The cabinets must always be lifted according to maker's recommendation. The mounting of the cabinets into the ship will be the responsibility of the purchaser. If the cabinets are not to be put into operation immediately, they should be stored in a dry room protected from dust.

9.8 Battery pack

The battery modules are described in the datasheet here below, type UEV-18XP

In order to reach the requested capacity/voltage, 32 modules will be connected in series (42,4kWh >600VDC). Three series in parallel (127,2kWh)



9.9 Functionality SISHIP EcoProp

9.9.1 Operating modes

The selection of the operating mode will be done through the Levers system.

The system will manage the speed set-point of the propulsion electric motors.

The keyboards and panels will give to the operator an overview about the status of the system and will allow the selection of the desired operating mode.

Further details will be visualised on:

- The ship automation system
- The touch panel of the Siemens Ecoprop system, normally installed on the door of the propulsion control cabinet.
- The display of the Levers central units.

The startup of the system will be done at dead ship, enabling the Ecoprop system.

The 1st genset will be switched on, so that the 400VAC-50Hz ship electric network will be available. The status Anchor will be automatically selected.

In Electric Mode, the electric motors will provide mechanical power to the shaft-lines. The propulsion electric motors will be managed traditionally with the levers above mentioned. The clutch of the gearbox will remain always closed, and the inversion of rotation of the shaft-lines will be done inverting the rotational speed of the electric motors.

9.9.2 Ship network supply

The ship network will be supplied by two frequency converters and related filters.

The converters will provide two lines 40kVA each, 400V 50Hz, IT network, and will not work in parallel.

In some specific cases (to be evaluated) an isolation transformer could be advisable.

9.9.3 Shore connection

The switch-over from gensets to shore connection will be integrated in the ship AC distribution cabinet (not in the Siemens scope).

9.10 Bridge Control Station (BCS)

- V.O.T. pitch indicator.
- V.O.T. RPM indicator.
- Responsibility change over buttons, buzzer and indicators.



- Joystick for backup system pitch control.
- Dimming of panel instrument light, including push buttons and indicators
- Lamp test pushbutton.
- ECS responsibility indication button.
- Fixed speed button.
- 100% Load indication.
- Clutch in / out control buttons with indication

9.11 Miscellaneous

The ER flooring will be made in anti-skid aluminum panels, easily removable to inspect the bottom.

Suitable hatches will be placed on the main deck, to allow embarkation/disembarkation of main gearboxes and DD/GG.

The hatches will be bolted on the main deck.

Wherever possible, lifting eyes will be attached to the ship structure inside the ER to ease handling of heavy equipment.

Special attention will be paid in selecting sound absorbing materials to keep the local level of noise as low as possible and to reduce to minimum noise propagation through the structure.

Extraction will be natural, through suitable ducts fitted with water traps, while air ventilation will be forced, by means of fans of suitable capacity, so as the mean temperature in this space will not exceed the external temperature by more than 15 °C.

Especially for the Engine and Pump room area four (4) axial or centrifugal fans will be installed for supply and exhaust (2 fwd and 2 aft) which will be mounted on main deck. The air exhaust will be also performed through air vent openings, which will be installed on main deck.

The delivery of the air supply should be at least 50% bigger from the one required for the “breathing” of the diesel engines running in order to calculate the heat losses due to loss of radiation of the engines. The air supply pipes will be such arranged as to evenly distribute the amount of the supplied air.

In any case the efficiency of the supply/exhaust air system will not be less than the one required by the Class regulations for various areas.

9.12 Propulsion

9.12.1 General

The propulsion installation of this proposal consists of two new conceptual vertical axis propulsion systems with orbital blades, called Variable Orientable Thruster (V.O.T.). this system is constituted by a pair of contra-rotating impellers, which provide directional thrust to 360°, allowing in each case a centered thrust, avoiding parasitic components.

The direction of the thrust is obtained through a synchronized orientation of the blades on both impellers, directing the thrust in the full 360° without acting on the angular velocity and on the direction of rotation of the two crowns.



V.O.T. is a new propulsion system based on a double coaxial impeller with vertical moving blades; this fluid-dynamic machine allows getting both propulsion and steering for ships and boats from the same mechanical device.

This system is proved suitable for congested areas and inland waterways, possessing a limited height of the blades outside the hull, a complete absence of rudders, and the ability to perform maneuvers to 360°. Its use in open sea activities is suggested as well, for its high efficiency and maneuver capabilities, so as to be used in dynamic positioning operations.

- V.O.T. system
- Shaft line
- Pitch servo unit at the forward end of the gear wheel shaft
- Shaft line accessories
- Hydraulic power equipment
- Remote control, combicontrol with load control

9.12.2 V.O.T. characteristics

- V.O.T. blades external diameter : 1200 mm
- V.O.T. blades external diameter : 800 mm
- number of external blades : 4
- number of internal blades : 5
- height of blades : 400 mm
- direction of rotation : controrotating

9.12.3 Material and workmanship of propeller

- material of blades : NiAl bronze
- blade manufacturing accuracy : ISO 484 (1981) class 1
- blade surface finish : class 1

9.12.4 Pitch servo unit

The pitch servo unit consists of an oil distribution box acting to V.O.T. to control the synchronized orientation of the blades. Low-pressure air-driven pump with quick-release coupling for emergency pitch setting and assembly operations

Into the unit is fitted a transmitter box with two pitch transmitters, furthermore a mechanically operated indicator for achieved pitch

The pitch servo unit is provided with a connection for emergency pitch setting by a separate pump; if the hydraulic equipment is out of order, with this pump the pitch can be set in a suitable ahead position (take home device) one pump is supplied per ship set only. The pitch servo unit will be driven by one hydraulic power pack

All electrical components will be wired up to a terminal box. On the box a pitch indicator is provided for local manual control



9.12.5 Remote control system

All the units will be installed in wheelhouse.

- PCU - Propulsion Control Unit
 - BCS - Bridge Control Station
 - HMI - Human Machine Interface
- Control stations are manoeuvre stations.
Control units are cabinets.

9.12.6 General

The system is a 24 VDC PLC based propulsion control system for engine speed and pitch control. In addition to the main control loop a separate backup control system for the pitch control is delivered. A separate pitch indication loop is also implemented in the system.

The control system requires two main 24 VDC supplies to the PCU cabinet. Switching of the two 24 VDC is done in the PCU cabinet, in case of a power failure. The second power source must be battery backed.

9.12.7 Engine and V.O.T. load control

Engine and propulsion system (V.O.T.) load is controlled using the fuel rack position on the engine and the engine speed, measured with separate pickups, as its most important parameters. There is an adjustable MCR engine load curve within the speed range preventing the engine to be (continuously) overloaded.

9.12.8 Load acceptance program

The load / speed increasing program for the main engine in the systems ensures a controlled uploading according to the engine manufacturers load acceptance curve.

9.12.9 Alarm signals to alarm central

All alarm signals from Systems will be hardwired signals taken from the cabinet. Signals are relay outputs with a common.

Standard alarm signals from PCU cabinet are:

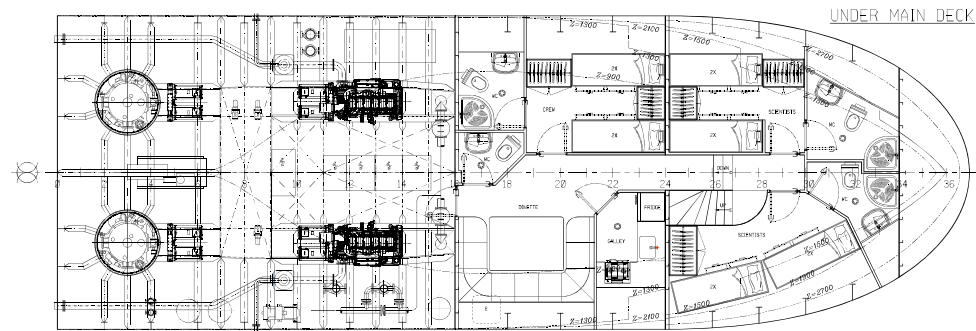
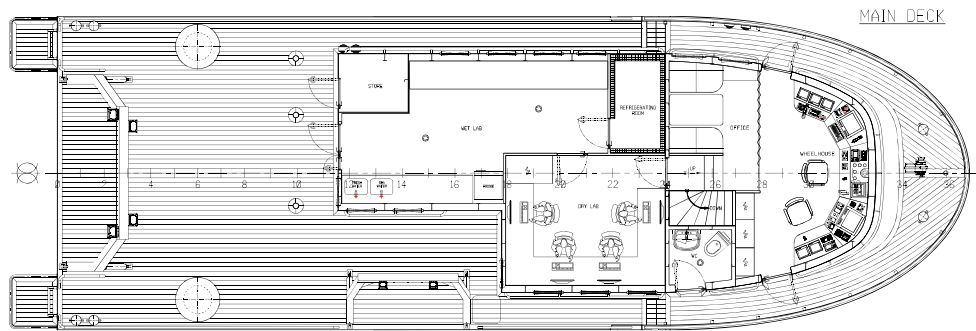
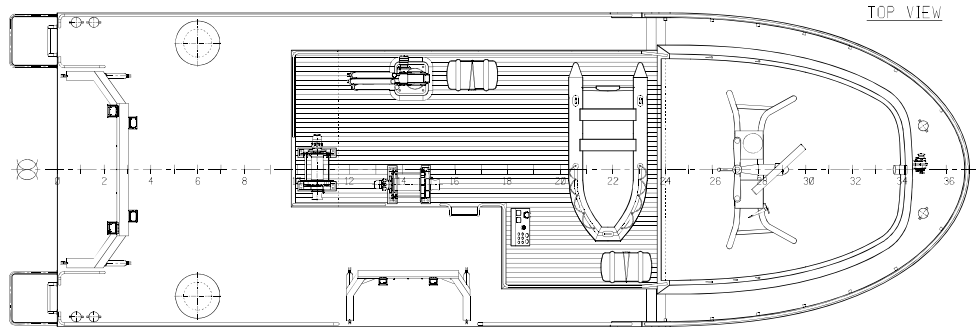
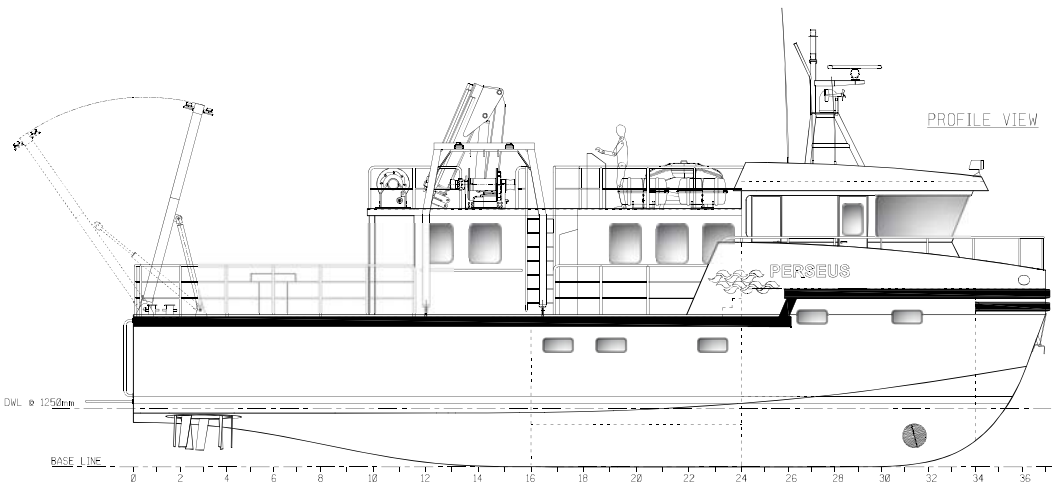
- Propulsion control major alarm
- Propulsion control minor alarm
- Standby E Pump started



10 ANNEX

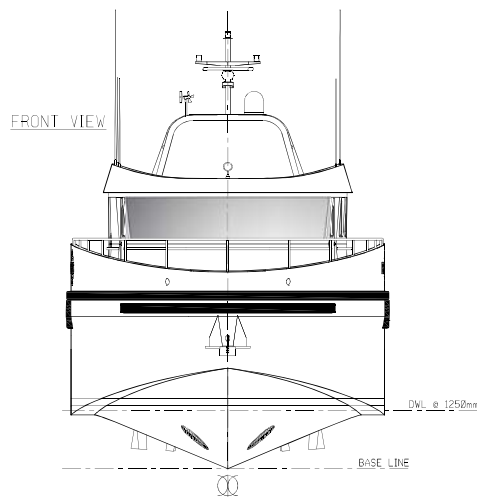
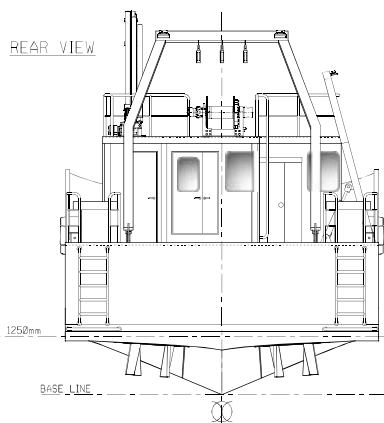
The documents in this Annex are integral part of the PERSEUS small research vessel design concept.

- General Arrangement
- Midship section and typical transversal sections
- Horizontal and Longitudinal section
- External Shell
- Capacity Plan
- Engine Room Arrangement
- Body Lines Plan
- Design Hydrostatics
- Hydrostatic table
- Cross curves of stability
- Preliminary Displacement study and Light Weight estimate
- Resistance Prediction
- Propulsion Prediction

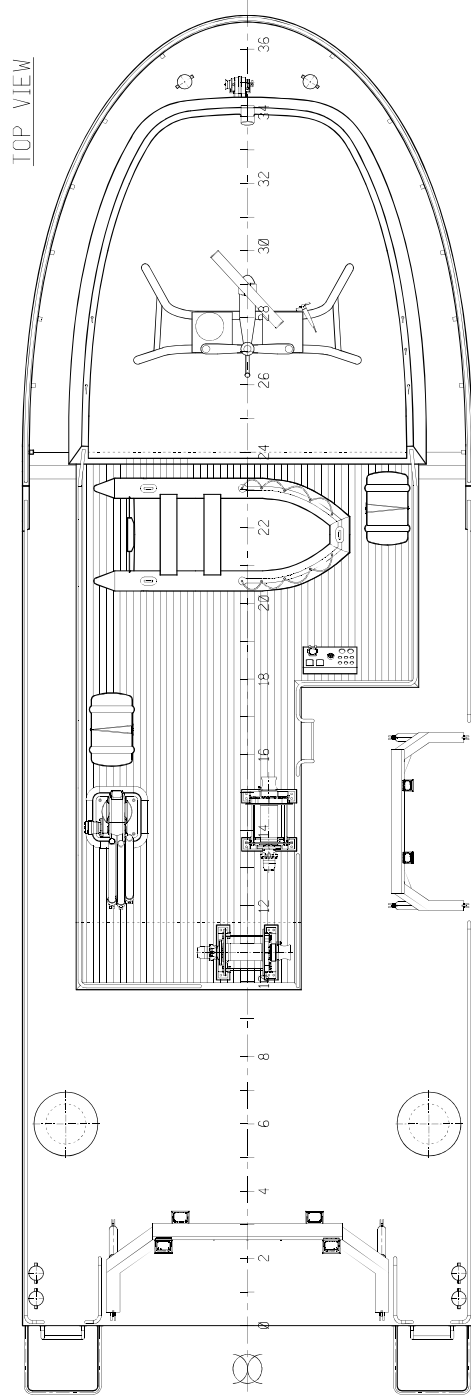
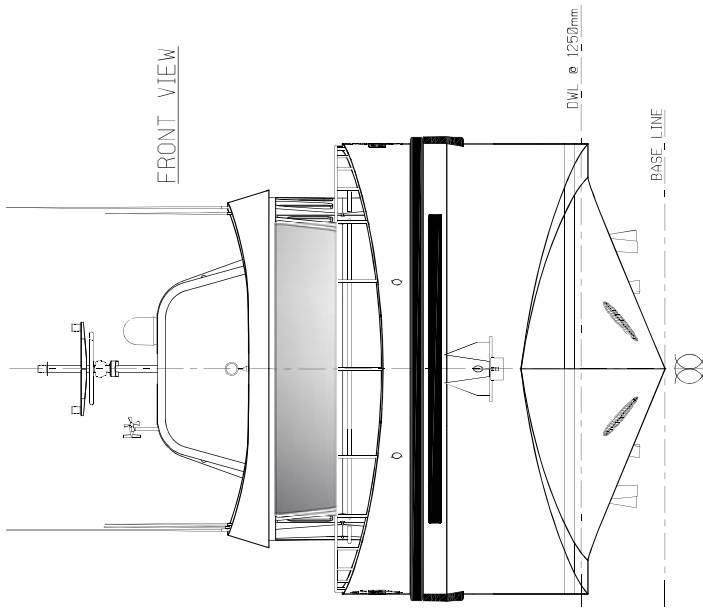
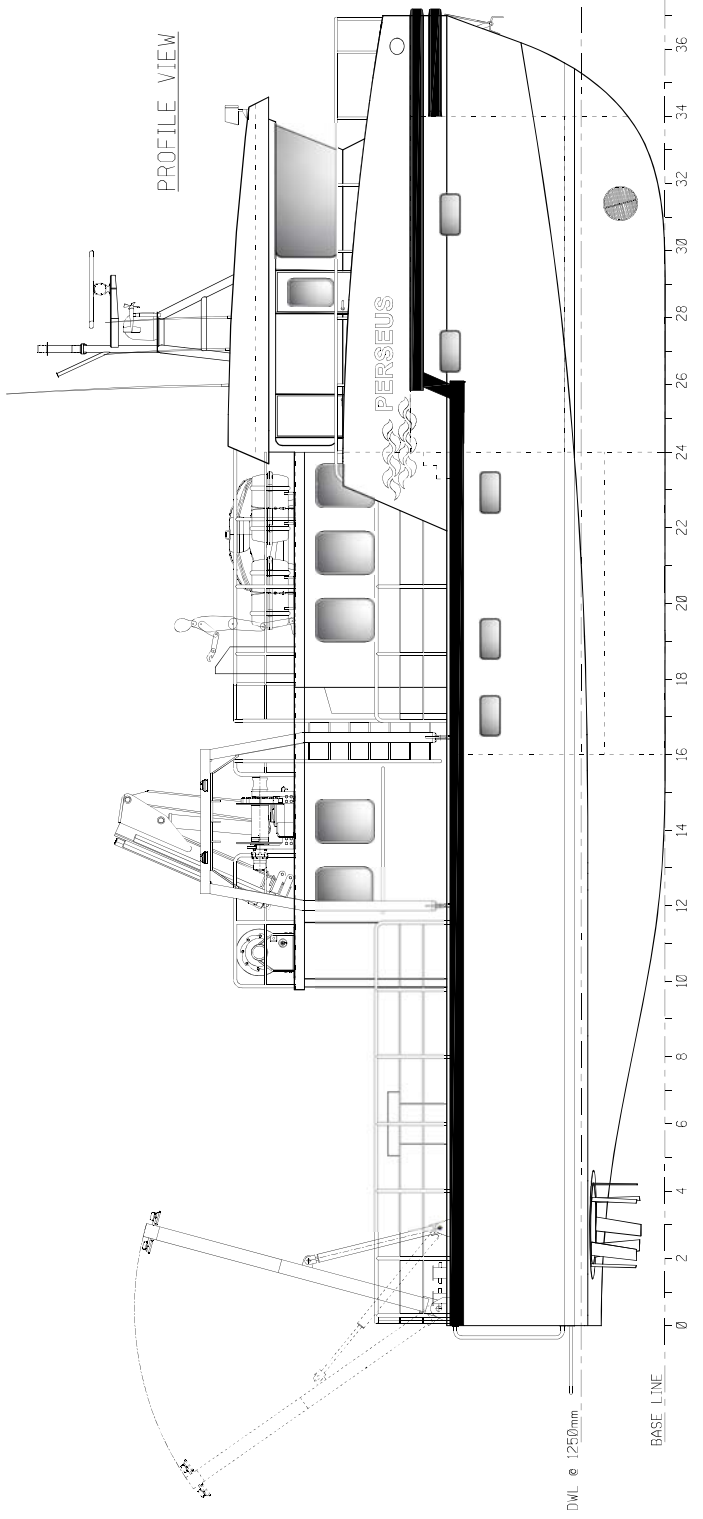


MAIN CHARACTERISTICS:

LOA: 19,5 m
 B: 6,7 m
 D: 3,2 m
 T: 1,25 m
 Speed: 16 knots
 Crew: 4
 Scientists: 4+4




N°	DATE	OPERAZIONE	MODIFICHE/ALTERATION	DESCRIZIONE	PRIMA/SCALE	DATE	
					SCALE	DATE	
					1:50	MAY '14	
<p>COSNAV ENGINEERING S.r.l. Via dei Coronati 421 34133 - 34019 Tel: +39043-629176/63410 Telefax: +39043-633933</p>						<p>P. 363 DIS. N° 00-0001-00 SHEET 1/1</p>	
<p>INNOVATIVE RESEARCH VESSEL GENERAL ARRANGEMENT</p>							
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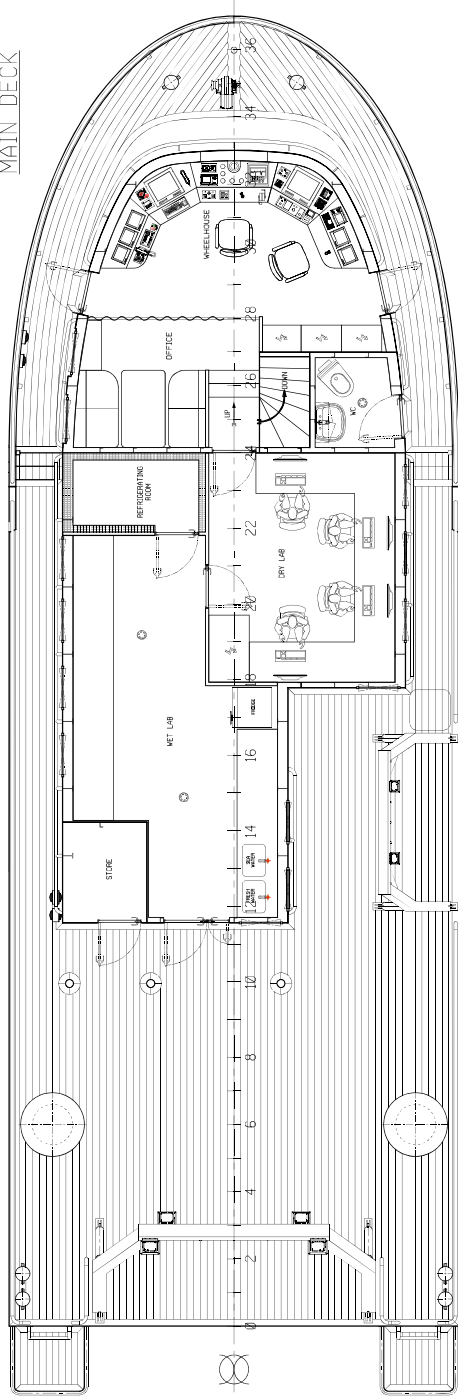
LOA: 19,5 m
 B: 6,7 m
 D: 3,2 m
 T: 1,25 m
 Speed: 16 knots
 Crew: 4
 Scientists: 4+4

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			DATE
			SCALE
			1:50
			DATE
			MAY '14
			P. 363
 COSNAV ENGINEERING S.r.l. Via del Coroneo 1/21 20138 Milano - Italy TEL. +39042-634176/638470 E-MAIL: cosnav@cosnav.com TELEFAX: +39042-633733		DIS. N°	
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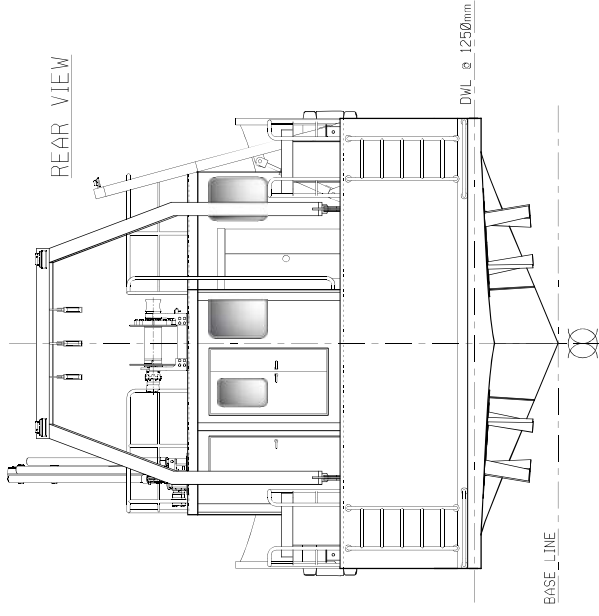
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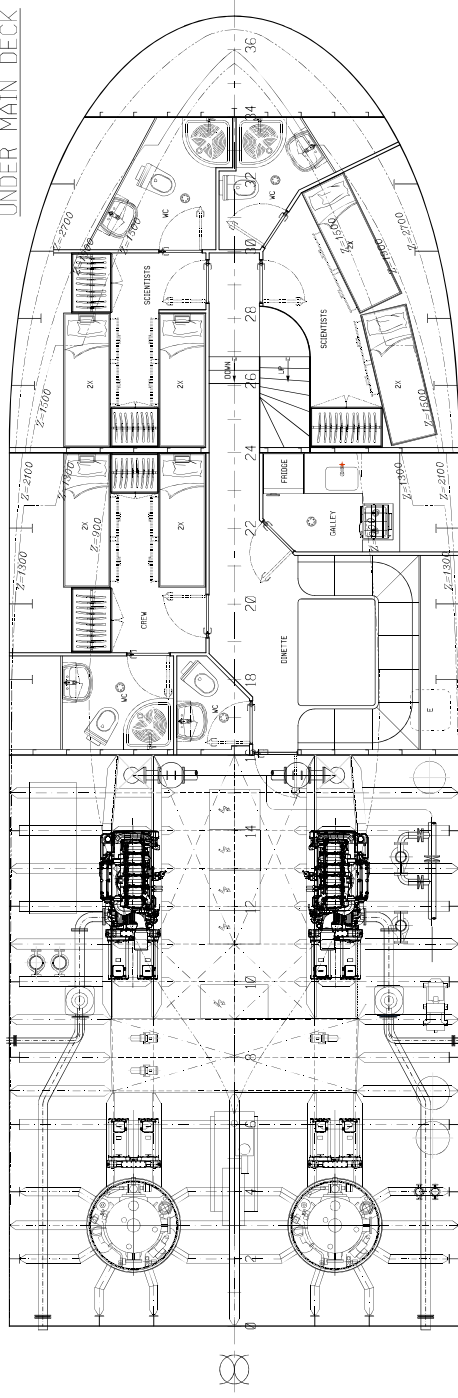
MAIN DECK



REAR VIEW



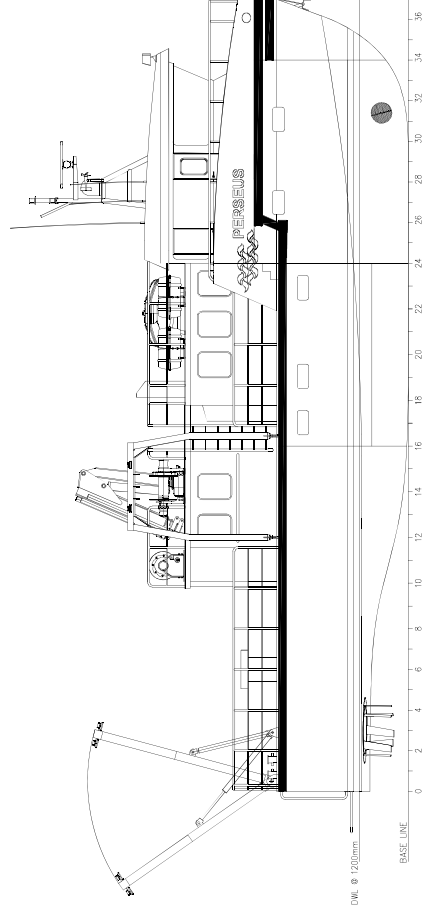
UNDER MAIN DECK



RINA ★ RESEARCH SHIP – RESTRICTED NAVIGATION INTERNATIONAL (COASTAL AREA)
 ★ AUT – UMS; ★ AUT – PORT; MANOVR

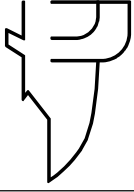
MAIN CHARACTERISTICS

LENGHT OVER ALL	=	19.500	m
LENGHT AT WATERLINE	=	18.607	m
LENGHT FOR SCANTLINGS	=	39.650	m
BREADTH	=	6.70	m
DEPTH MOULDED (AT SIDE ON MIDSHIP SEC.)	=	3.20	m
DRAUGHT	=	1.25	m
SPEED	=	16	Knots
ENGINE POWER	=	2x368	kW



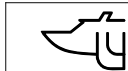
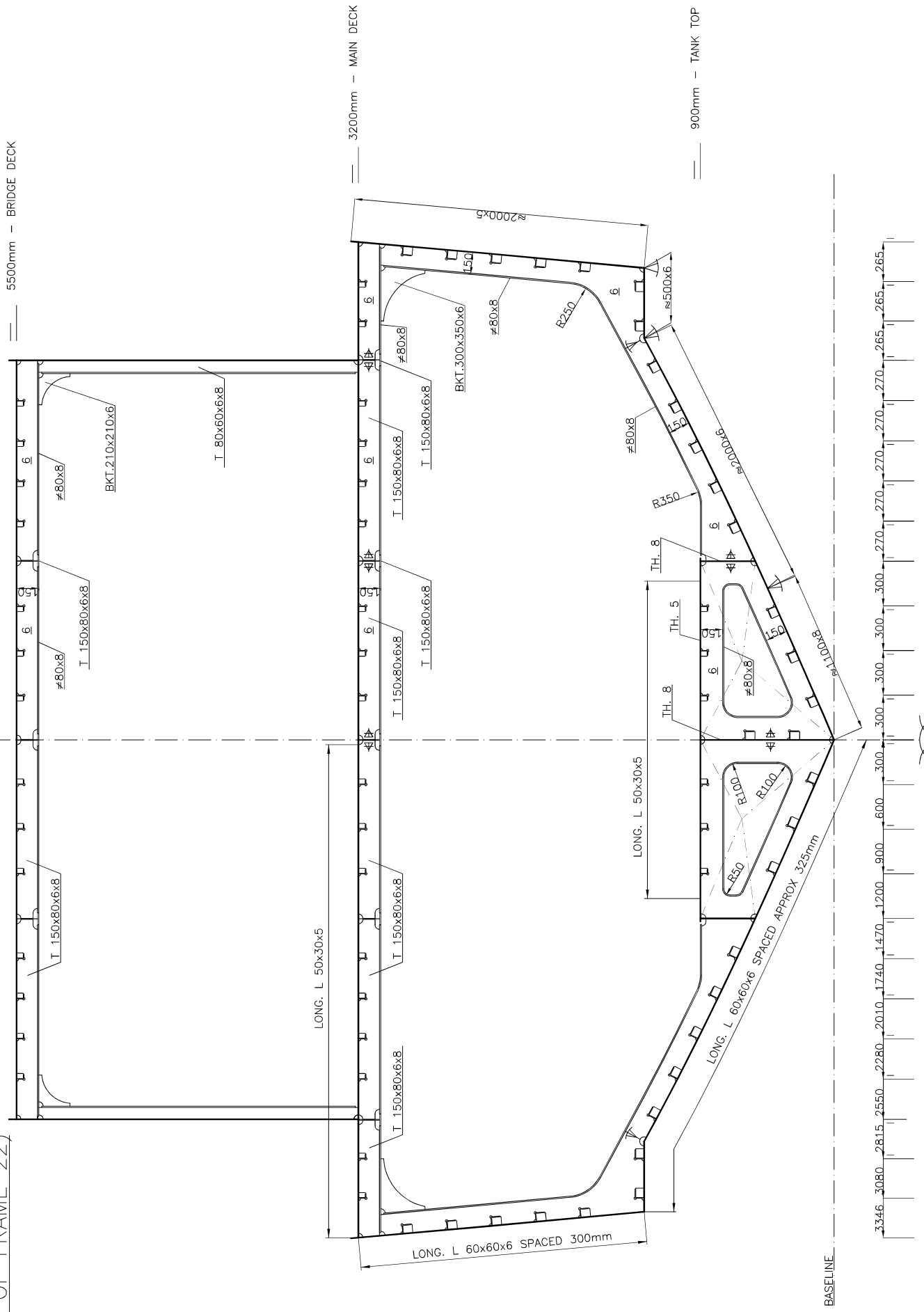
MATERIALS

SIMBOLS	CHARACTERISTICS
WITHOUT INDICATIONS	ALUMINIUM ALLOY, YELD STRESS $R_{pe2} > 125$ N/mm ²

N°	DATE	DESCRIZIONE MODIFICHE/ALTERATION	DESCRIPTORS	FIRMA/SIGN.	
			SCALE	DATE	
COSNAV ENGINEERING S.r.l. Via del Coroneo N° 21 34133 TRIESTE TEL: +39-040-639176/939470 E-MAIL: cosnav@cosnav.com TELEFAX: +39-040-633793			1:25	DEC. '15	
INNOVATIVE RESEARCH VESSEL "PERSEUS" MIDSHIP AND TYPICAL TRANSV. SECTIONS			P.363		
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			SHEET		1/5
			DEL.		

MIDSHIP SECTION (WEB)

(IN WAY OF FRAME 22)



COSNAV ENGINEERING S.R.L.

INNOVATIVE RESEARCH VESSEL "PERSEUS"
MIDSHIP AND TYPICAL TRANSV. SEC.

P.363

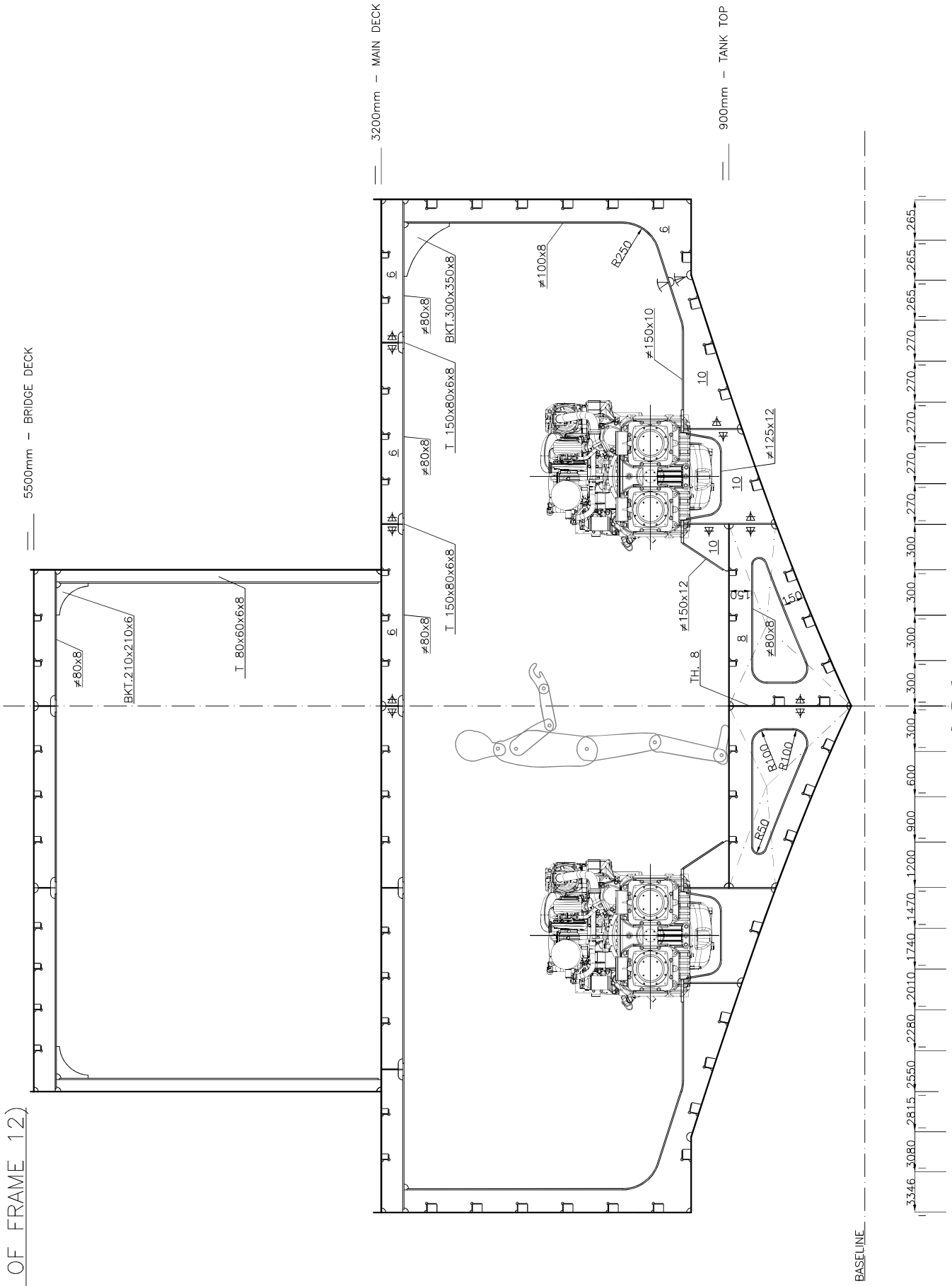
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SHEET N. 2/5

GEN-SET FOUNDATIONS

(IN WAY OF FRAME 12)



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P.363

DRW.N. 00-0002-00

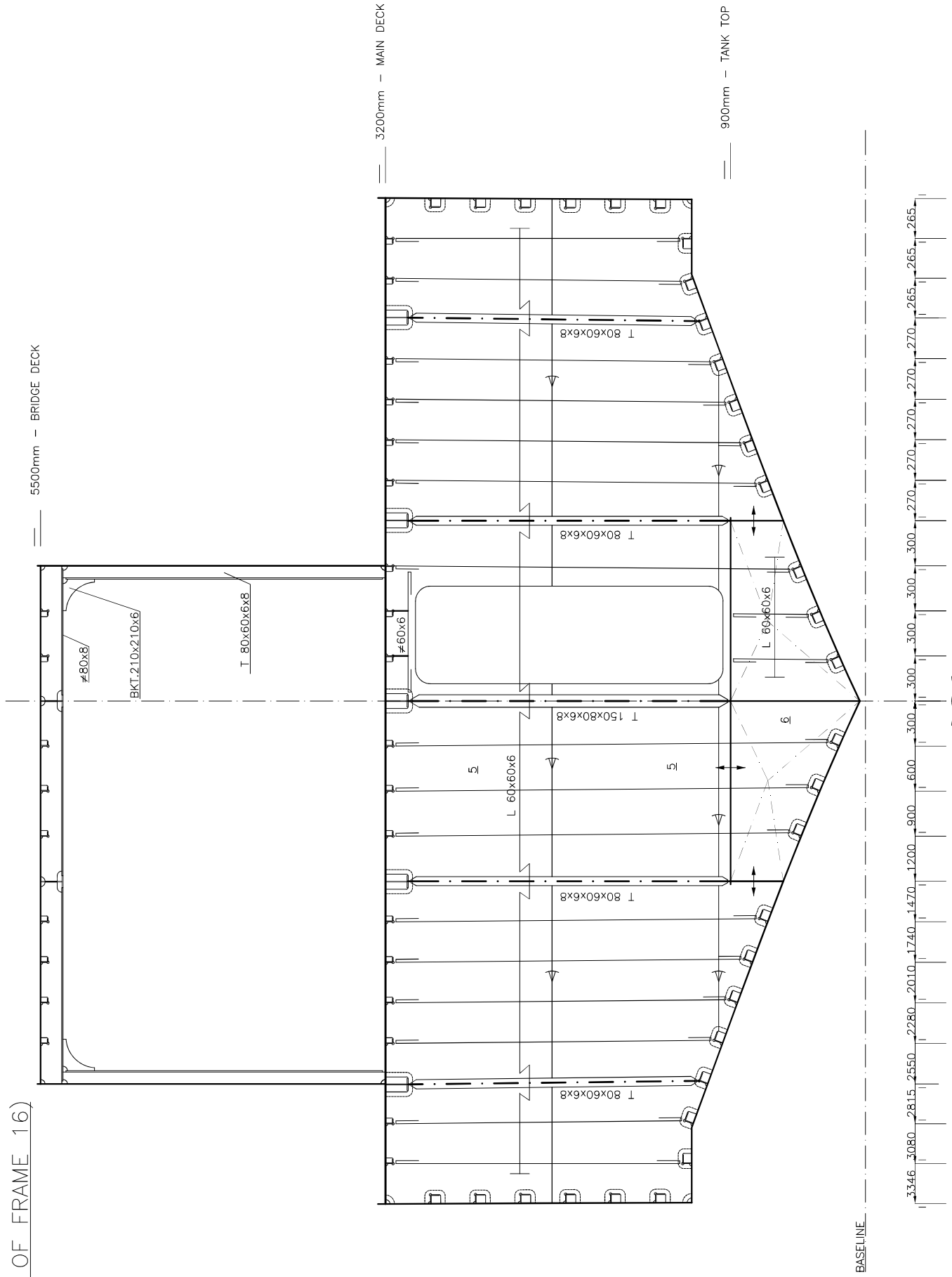
INNOVATIVE RESEARCH VESSEL "PERSEUS"
MIDSHIP AND TYPICAL TRANSV. SEC.


SCALE 1:25

SHEET N. 3/5

WATERTIGHT BULKHEAD

(IN WAY OF FRAME 16)

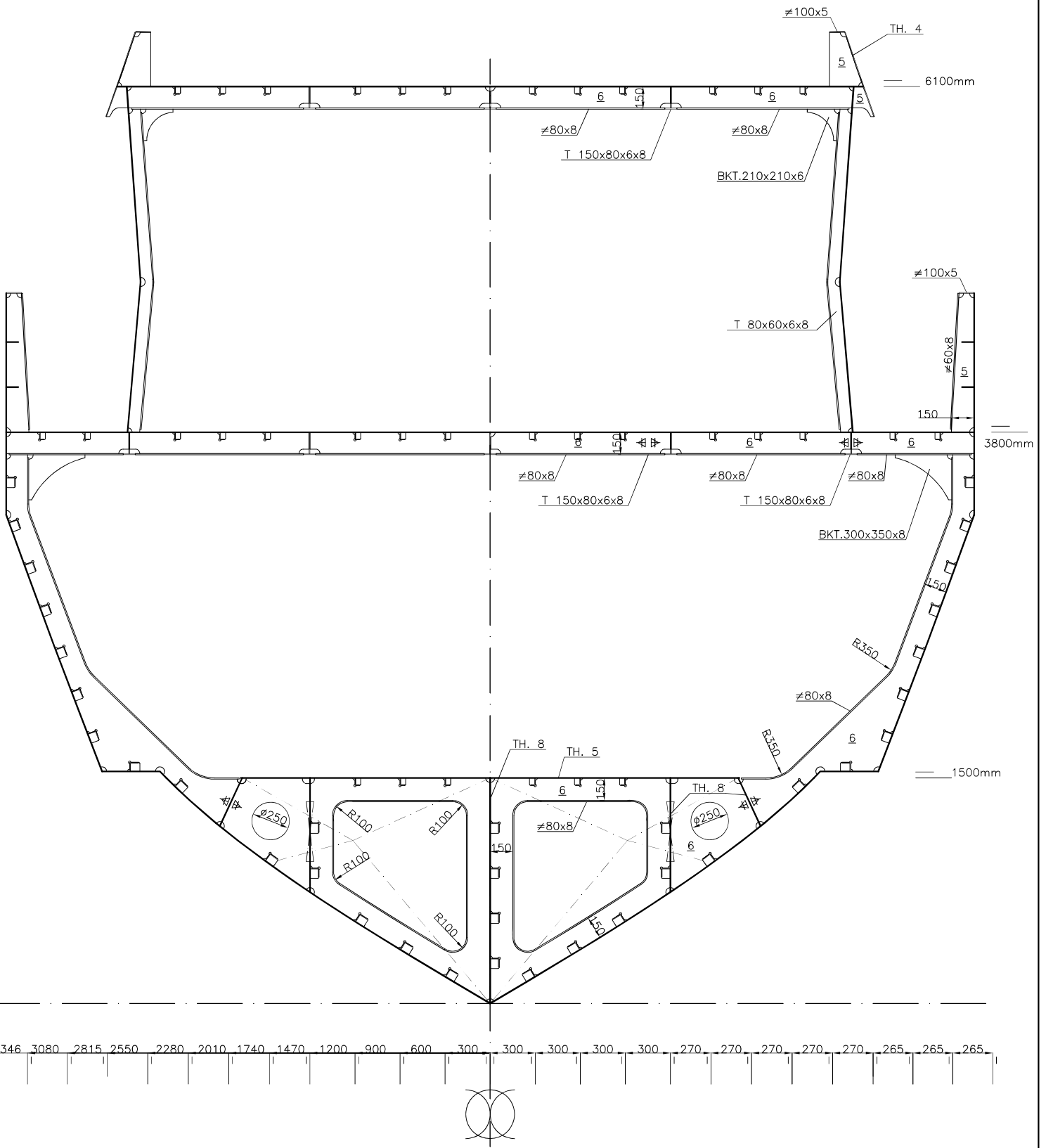


 COSNAV ENGINEERING S.R.L.	P.363
	DRW.N. 00-0002-00
	SCALE 1:25
	SHEET N. 4/5

INNOVATIVE RESEARCH VESSEL "PERSEUS"
MIDSHIP AND TYPICAL TRANSV. SEC.

TYPICAL FORE SECTION

(IN WAY OF FRAME 28)



3346 3080 2815 2550 2280 2010 1740 1470 1200 900 600 300 300 300 300 300 270 270 270 270 270 265 265 265



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INNOVATIVE RESEARCH VESSEL "PERSEUS"
MIDSHIP AND TYPICAL TRANSV. SEC.

P.363

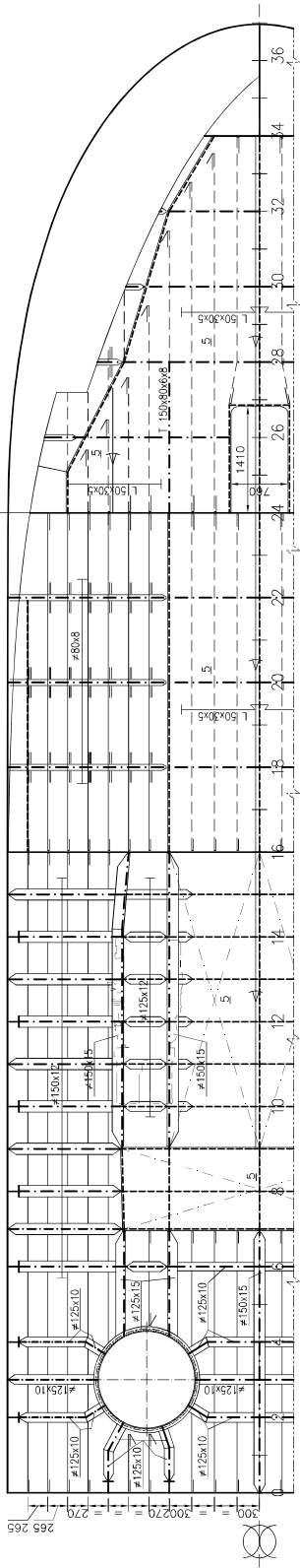
DRW.N. 00-0002-00

SCALE 1:25

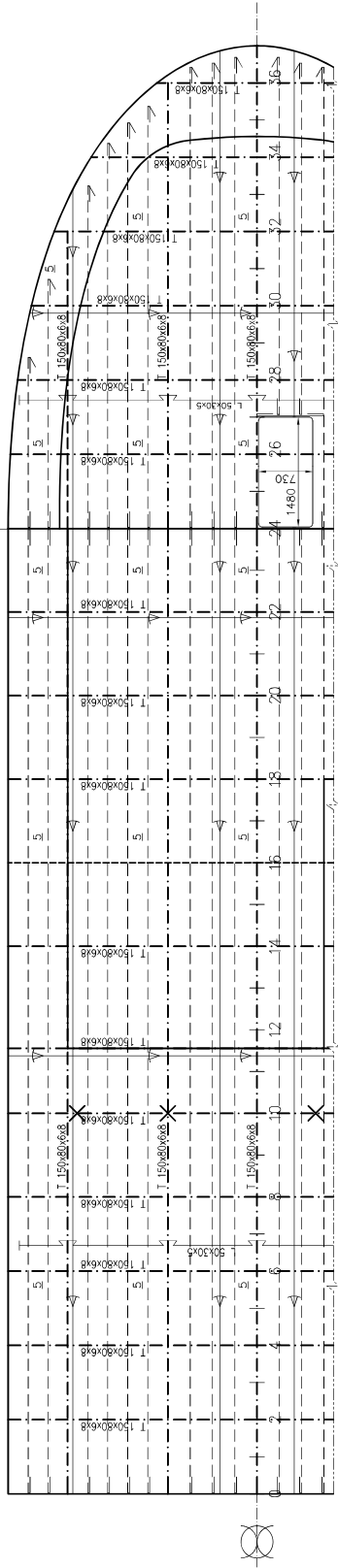
SHEET N. 5/5

HORIZONTAL SECTION 900 mm FROM B.L.

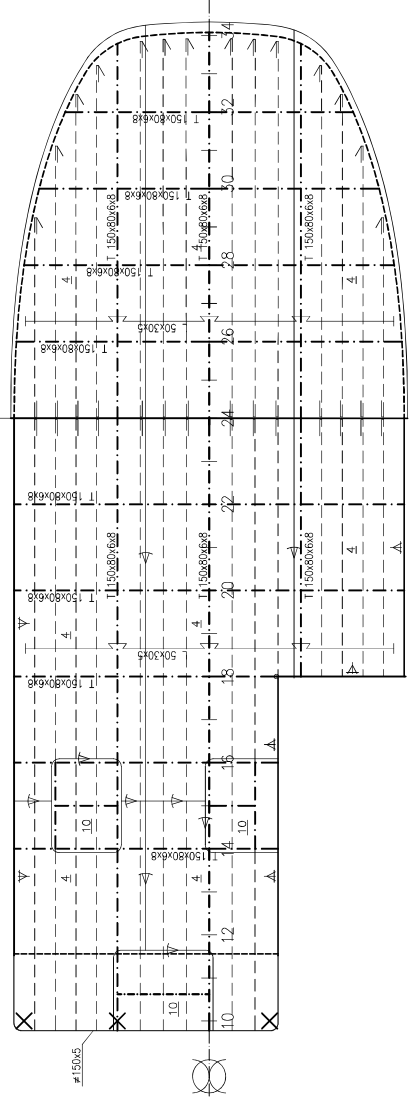
HORIZONTAL SECTION 1500 mm FROM B.L.




MAIN DECK AT 3200 mm FROM B.L. FWD. DECK AT 3800 mm FROM B.L.



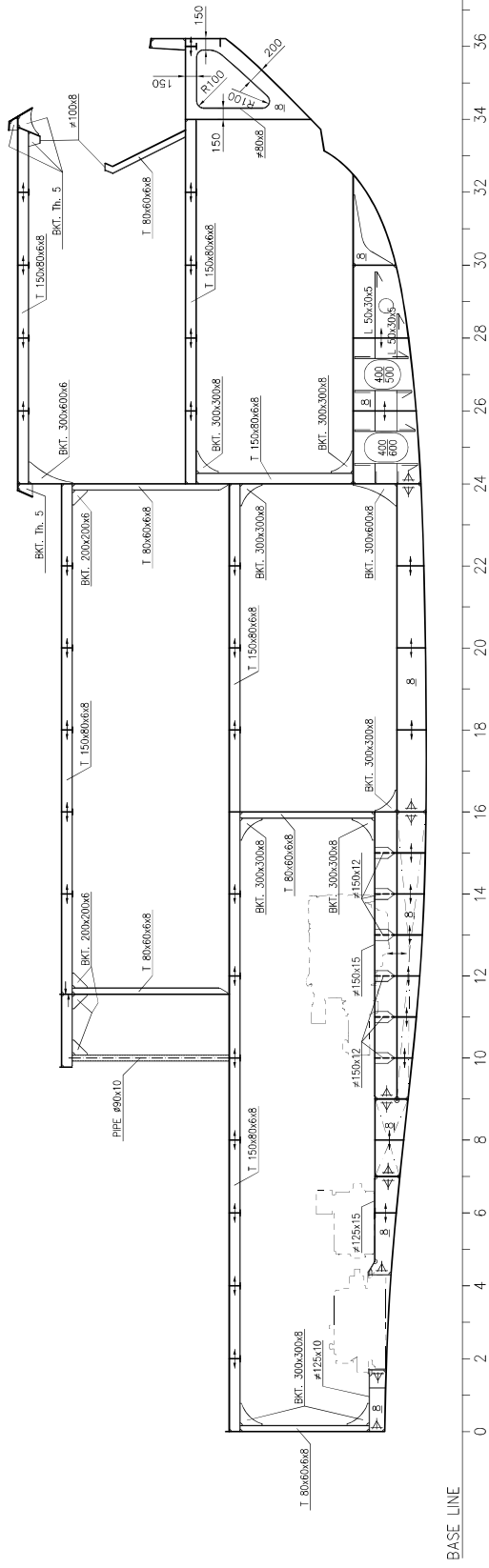
BRIDGE DECK AT 5500 mm FROM B.L. FWD. BRIDGE DECK AT 6100 mm FROM B.L.



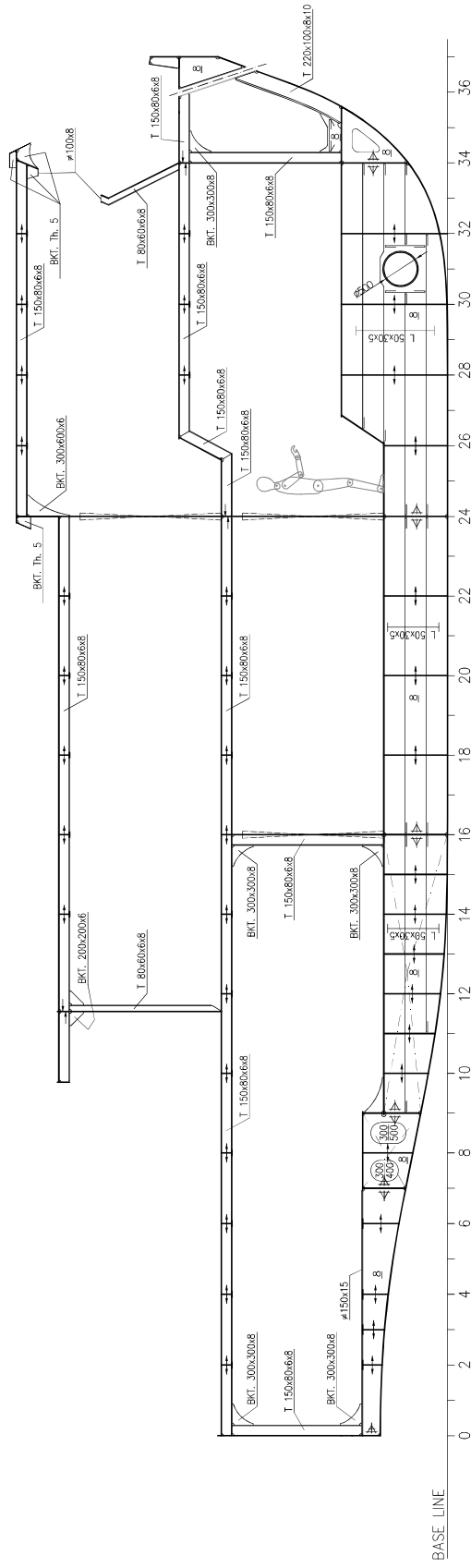
MATERIAL : ALUMINIUM ALLOY, YIELD STRESS $R_{m2} > 125 \text{ N/mm}^2$

N°	DATE	DESCRIZIONE MODIFICHE/ALTERATION DESCRIPTIONS	FRAMA/SIGN.	
			SCALE	DATE
			1:50	DEC. '15
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INNOVATIVE RESEARCH VESSEL "PERSEUS" HORIZONTAL AND LONGITUDINAL SECTIONS			DIS. N° 00-0003-00	
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ESEC.: COSNAV			DEL.	
DIS. : G.B.			VISTO : C.C.	
SHEET			1/2	

LONGITUDINAL SECTION Y=1200 mm

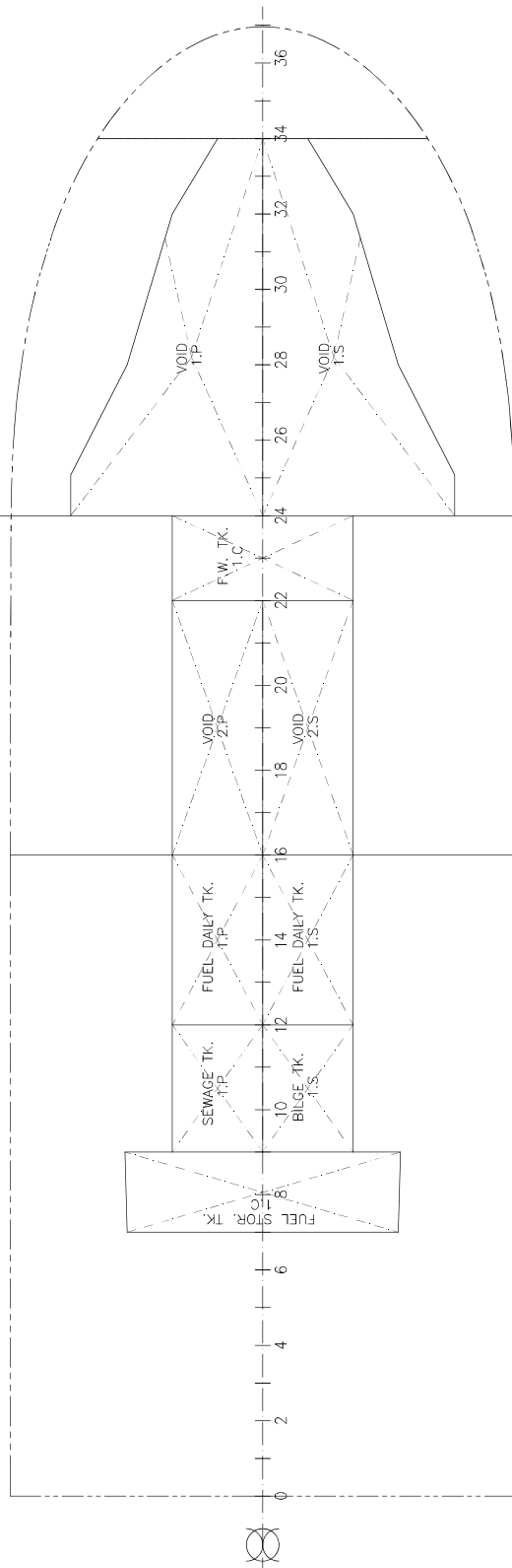


LONGITUDINAL CENTRELINE SECTION



TANK TOP 900/1200 mm FROM B.L.

TANK TOP 1500 mm FROM B.L.

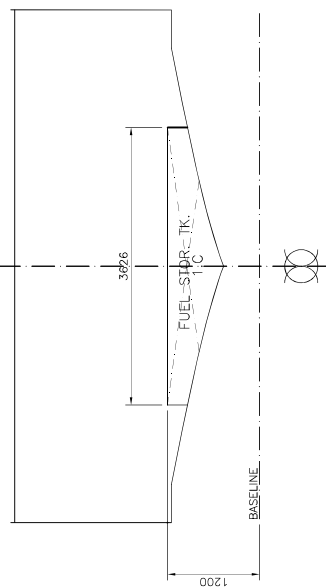


N.	FRMIN	FRMAX	CAPACITY 100% m³	CAPACITY 98% m³	CENTER OF GRAVITY	
					LCG	TCC
FUEL						
DAILY TK. 1.P	12	16	1.7	1.7	7.402	-0.517
DAILY TK. 1.S	12	16	1.7	1.7	7.402	0.517
STOR. TK. 1.C	7	9	1.8	1.8	4.057	0.000
STOR. TK. 1.C	7	9	1.8	1.8	4.057	0.000
SUBTOTAL			5.2	5.1	6.224	0.000
					6.224	0.000

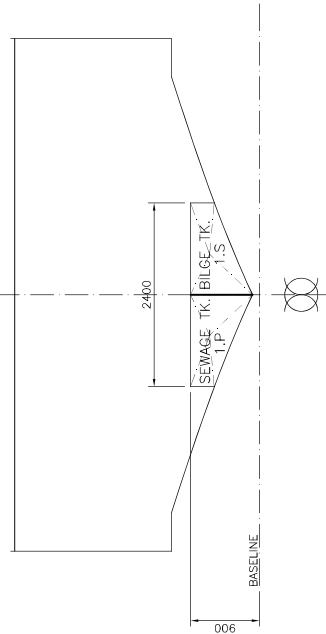
N.	FRMIN	FRMAX	CAPACITY 100% m³	CAPACITY 98% m³	CENTER OF GRAVITY	
					LCG	TCC
OTHER						
SEWAGE TK. 1.P	9	12	0.9	0.9	5.474	-0.500
BILGE TK. 1.S	9	12	0.9	0.9	5.474	0.500
F.W. TK. 1.C	22	24	1.7	1.7	12.435	0.000
F.W. TK. 1.C	22	24	1.7	1.7	12.435	0.000
SUBTOTAL			3.5	3.4	8.855	0.000
					8.855	0.000

N.	FRMIN	FRMAX	CAPACITY 100% m³	CAPACITY 98% m³	CENTER OF GRAVITY	
					LCG	TCC
VOID SPACE						
VOID SPACE 1.P	24	34	7.4	7.3	15.004	-0.717
VOID SPACE 1.S	24	37	7.4	7.3	15.004	0.717
VOID SPACE 2.P	16	22	2.6	2.5	10.183	-0.521
VOID SPACE 2.P	16	22	2.6	2.5	10.183	0.521
SUBTOTAL			20.0	19.6	13.751	0.000
					13.751	0.000

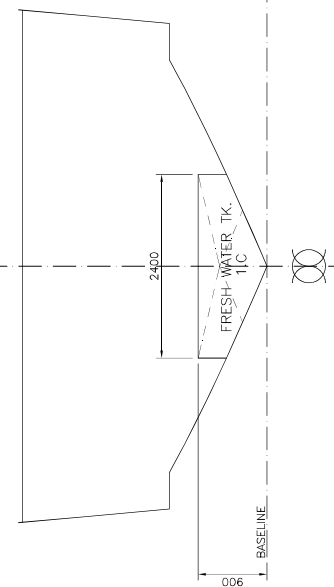
FRAME 08



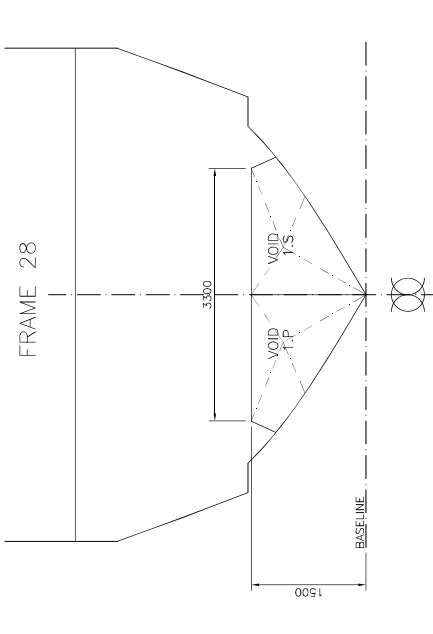
FRAME 12




FRAME 22

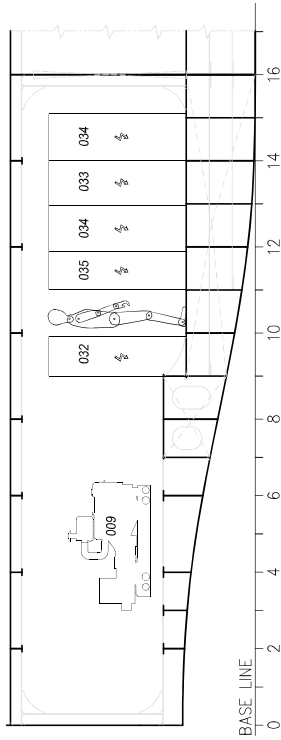


FRAME 28

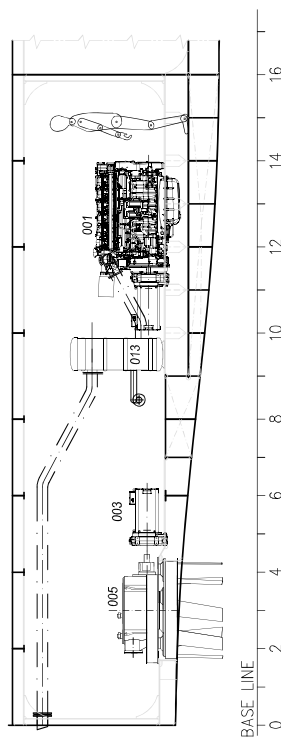


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 COSNAV ENGINEERING S.r.l. Via del Carone N° 21 34133 TRIESTE TEL: +39-040-639176/939470 E-MAIL: cosnav@cosnav.com TELEFAX: +39-040-633793			SCALE 1:50 DATE DEC. '15
INNOVATIVE RESEARCH VESSEL "PERSEUS" CAPACITY PLAN			P.363 DIS. N° 00-0005-00 SHEET 1/1 BEL.
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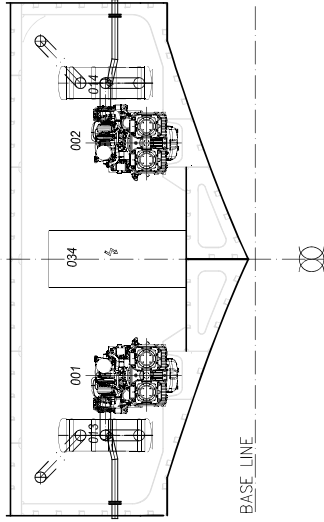
LONGITUDINAL CENTRELINE SECTION



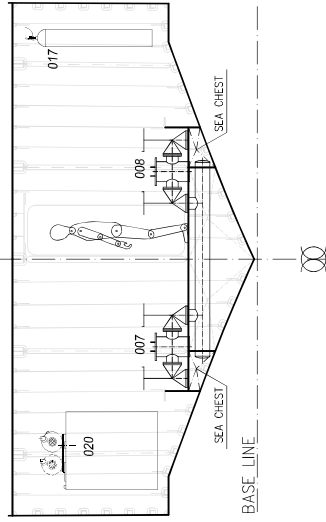
LONGITUDINAL SECTION Y=1200 mm



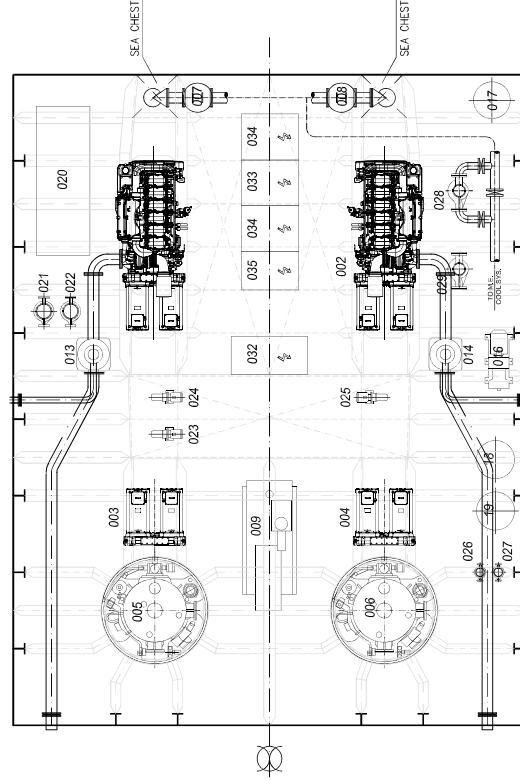
FRAME 12



FRAME 16




TOP VIEW



013	MAIN GENSET SILENCER - PORT
014	MAIN GENSET SILENCER - STBD
015	EM./PORT DIESEL GENERATOR SILENCER
016	AIR COMPRESSOR - SPERRE HL277 20m³/h - 8bar
017	AIR VESSEL RECEIVER 150l - 8bar
018	FRESH WATER ELECTRICAL HEATER 150l
019	WATER HYDROPHORE 300l
020	SEWAGE TREATMENT UNIT - I.S.I.R. BIOEPURO B15 - 1.5m³/day
021	BALLAST, BILGE AND FIRE PUMP 25m³/h - 20+60mt
022	BALLAST, BILGE AND FIRE PUMP 25m³/h - 20+60mt
023	FUEL OIL TRANSFERT PUMP (SCREW TYPE) 2.5m³/h - 25mt
024	LUBE OIL TRANSFERT PUMP (SCREW TYPE) 1.5m³/h - 25mt
025	SLUDGE PUMP (SCREW TYPE) 1.5m³/h - 25mt
026	FRESH WATER PUMP 1.5m³/h - 15mt
027	FRESH WATER PUMP 1.5m³/h - 15mt
028	M.E. SEA WATER STAND-BY PUMP 150m³/h - 20mt
029	MAIN ENGINE FRESH WATER STAND-BY PUMP
030	FOG SYSTEM PUMP 6.5m³/h - 150bar
031	FIRE EMERGENCY PUMP 25m³/h - 60mt
032	CONTROL CABINET
033	DISTRIBUTION CABINET
034	INVERTER CABINET
035	FILTERS CABINET

MACHINERIES LIST

001	MAIN GENSET - SCANIA D113 082M, 6L TIER3 - PORT 388kW - 2100rpm - with generators and reduction gear
002	MAIN GENSET - SCANIA D113 082M, 6L TIER3 - STBD 2480kW - 2100rpm - with generators and reduction gear
003	PROPULSION MACHINES 1FV5168, 140kW@300rpm - PORT
004	PROPULSION MACHINES 1FV5168, 140kW@300rpm - STBD
005	VARIABLE ORIENTABLE THRUSTER (V.O.T.) - PORT
006	VARIABLE ORIENTABLE THRUSTER (V.O.T.) - STBD
007	M.E. SEA CHEST FILTER - ND 125 - PORT
008	M.E. SEA CHEST FILTER - ND 125 - STBD
009	EMERGENCY/PORT DIESEL GENERATOR - AIFOIVECO G.E.80U45M08 32kW - 40kVA - 50Hz - 1500r.p.m.
010	FOAG SYSTEM
011	HELICOIDAL FAN - EVE 700 - PORT 15.000m³/h - 4.5kW
012	HELICOIDAL FAN - EVE 700 - PORT 15.000m³/h - 4.5kW



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P.363

DIS. N° 00-0006-00

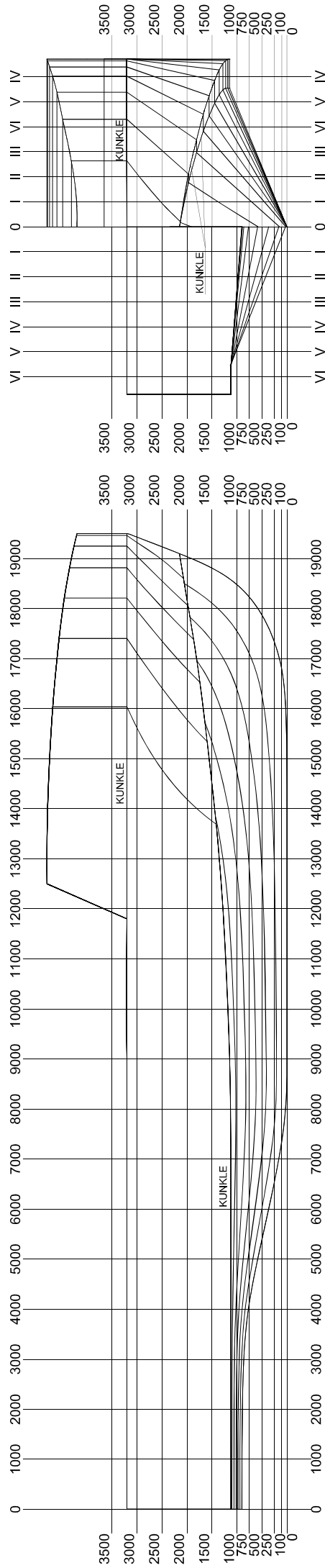
SHEET 1/1

INNOVATIVE RESEARCH VESSEL "PERSEUS"
ENGINE ROOM ARRANGEMENT

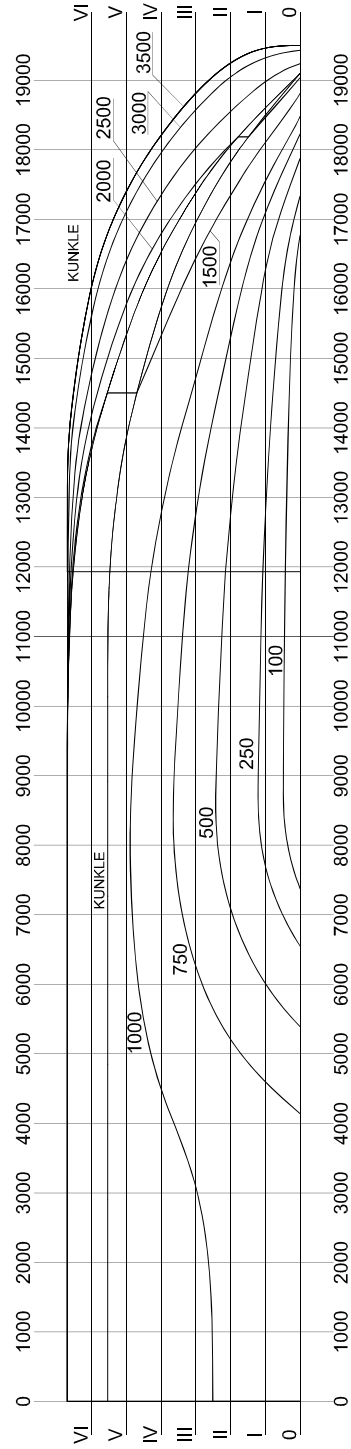
DEL. VISTO : C.C.

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LONGITUDINAL VIEW



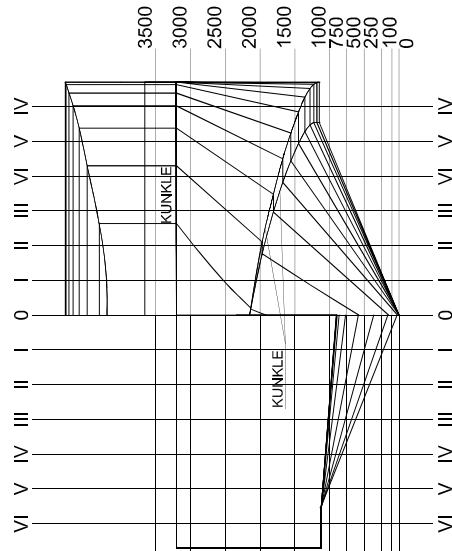
HORIZONTAL VIEW



MAIN DIMENSION

LENGTH OVER ALL	19.50 m	abt.
BREADTH	6.70 m	abt.
DEPTH TO MAIN DECK	3.20 m	abt.
DESIGN DRAFT	1.25 m	abt.

BODY LINES



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INNOVATIVE RESEARCH VESSEL "PERSEUS"
 BODY LINES PLAN

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 ESEG.: COSNAV DIS.: C.C.C. VISTO.: C.C. DEL:

DATE	DESCRIZIONE MODIFICHE/ALTERATION DESCRIPTIONS	SCALE	DATE
		1:50	OCT,15

P. 363
 DIS. N° 00-0007-00
 SHEET 1/1

Design hydrostatics report

P363 PERSEUS

Designer	COSNAVENGINEERING		
Created by			
Comment			
Filename	P363-04 a.fbm		
Design length	19,500 (m)	Midship location	9,750 (m)
Length over all	19,500 (m)	Relative water density	1,0250
Design beam	6,700 (m)	Mean shell thickness	0,0000 (m)
Maximum beam	6,700 (m)	Appendage coefficient	1,0000
Design draft	1,350 (m)		

Volume properties		Waterplane properties	
Moulded volume	55,617 (m ³)	Length on waterline	18,728 (m)
Total displaced volume	55,617 (m ³)	Beam on waterline	6,700 (m)
Displacement	57,008 (tonnes)	Entrance angle	28,402 (Degr.)
Block coefficient	0,3153	Waterplane area	103,84 (m ²)
Prismatic coefficient	0,6419	Waterplane coefficient	0,7948
Vert. prismatic coefficient	0,3967	Waterplane center of floatation	7,891 (m)
Wetted surface area	119,96 (m ²)	Transversemoment of inertia	342,94 (m ⁴)
Longitudinal center of buoyancy	8,891 (m)	Longitudinal moment of inertia	2300,7 (m ⁴)
Longitudinal center of buoyancy	-4,588 %		
Vertical center of buoyancy	0,979 (m)		

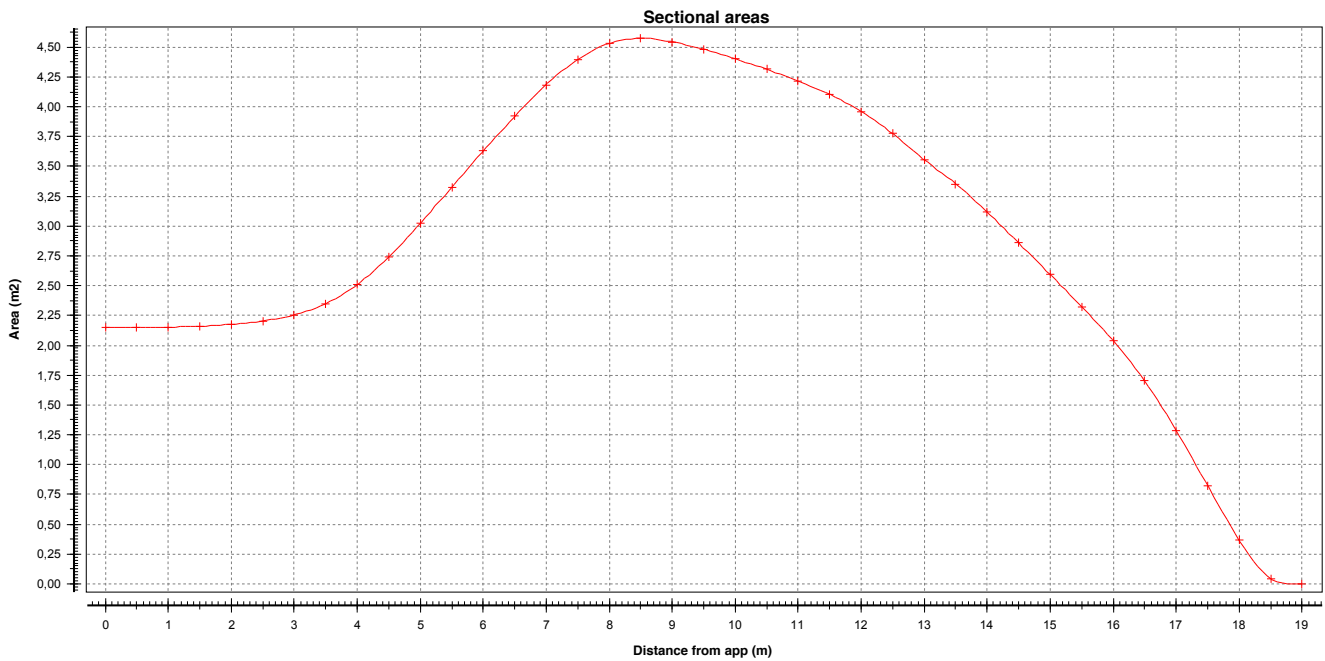
Midship properties		Initial stability	
Midship section area	4,443 (m ²)	Transversemetacentric height	7,145 (m)
Midship coefficient	0,4913	Longitudinal metacentric height	42,346 (m)

Lateral plane	
Lateral area	19,191 (m ²)
Longitudinal center of effort	10,549 (m)
Vertical center of effort	0,769 (m)

The following layer properties are calculated for both sides of the ship

Location	Area (m ²)	Thickness (m)	Weight (tonnes)	VCG (m)	LCG (m)	TCG (m)
bott01	104,29	0,000	0,000	0,806	9,113	0,000 (CL)
side01	95,850	0,000	0,000	2,072	9,239	0,000 (CL)
side02	24,421	0,000	0,000	3,895	16,014	0,000 (CL)
deck01	67,000	0,000	0,000	3,200	5,000	0,000 (CL)
deck02	37,991	0,000	0,000	4,675	15,512	0,000 (CL)
transom	14,545	0,000	0,000	2,113	0,000	0,000 (CL)
sca	23,761	0,000	0,000	3,596	11,516	0,000 (CL)
Total	367,86		0,000	0,000	0,000	0,000 (CL)

Sectional areas									
Location	Area	Location	Area	Location	Area	Location	Area	Location	Area
(m)	(m ²)	(m)	(m ²)	(m)	(m ²)	(m)	(m ²)	(m)	(m ²)
0,000	2,150	4,000	2,508	8,000	4,531	12,000	3,959	16,000	2,037
0,500	2,151	4,500	2,741	8,500	4,575	12,500	3,775	16,500	1,702
1,000	2,153	5,000	3,023	9,000	4,544	13,000	3,558	17,000	1,286
1,500	2,161	5,500	3,326	9,500	4,482	13,500	3,353	17,500	0,822
2,000	2,176	6,000	3,629	10,000	4,402	14,000	3,115	18,000	0,369
2,500	2,205	6,500	3,921	10,500	4,314	14,500	2,858	18,500	0,044
3,000	2,256	7,000	4,185	11,000	4,217	15,000	2,594	19,000	0,000
3,500	2,349	7,500	4,397	11,500	4,103	15,500	2,324		



NOTE1: Draft (and all other vertical heights) is measured above base Z=
 NOTE2: All calculated coefficients based on project length, draft and beam.

Hydrostatics

Trim: 0,000 (m)

Draft	Volume	Displ FW	Displ.	LCB	VCB	TCB	Aw	LCF	S	KMt	KMI	MCT	TpCm
(m)	(m ³)	(tonnes)	(tonnes)	(m)	(m)	(m)	(m ²)	(m)	(m ²)	(m)	(m)	(t*m/cm)	(t/cm)
0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,00	0,000	0,00	0,000	0,00	0,000	0,000
0,010	0,001	0,001	0,001	11,542	0,007	0,000	0,28	11,560	0,31	0,037	746,80	0,001	0,003
0,020	0,006	0,006	0,006	11,567	0,013	0,000	0,59	11,584	0,65	0,073	418,80	0,001	0,006
0,030	0,013	0,013	0,013	11,579	0,020	0,000	0,91	11,591	1,01	0,109	300,64	0,002	0,009
0,040	0,024	0,024	0,024	11,584	0,027	0,000	1,24	11,590	1,38	0,145	238,24	0,003	0,013
0,050	0,038	0,038	0,039	11,585	0,034	0,000	1,57	11,585	1,76	0,181	199,20	0,004	0,016
0,060	0,055	0,055	0,057	11,584	0,041	0,000	1,92	11,578	2,15	0,216	172,27	0,005	0,020
0,070	0,076	0,076	0,078	11,581	0,047	0,000	2,27	11,569	2,55	0,252	152,51	0,006	0,023
0,080	0,101	0,101	0,103	11,576	0,054	0,000	2,63	11,559	2,95	0,287	137,30	0,007	0,027
0,090	0,129	0,129	0,132	11,572	0,061	0,000	2,99	11,549	3,36	0,323	125,22	0,008	0,031
0,100	0,161	0,161	0,165	11,567	0,068	0,000	3,36	11,538	3,78	0,359	115,36	0,010	0,034
0,110	0,196	0,196	0,201	11,562	0,074	0,000	3,73	11,526	4,20	0,394	107,18	0,011	0,038
0,120	0,235	0,235	0,241	11,555	0,081	0,000	4,11	11,514	4,62	0,430	100,28	0,012	0,042
0,130	0,278	0,278	0,285	11,548	0,088	0,000	4,49	11,502	5,06	0,466	94,38	0,014	0,046
0,140	0,325	0,325	0,333	11,541	0,095	0,000	4,88	11,490	5,49	0,501	89,26	0,015	0,050
0,150	0,376	0,376	0,385	11,533	0,102	0,000	5,27	11,478	5,93	0,537	84,77	0,017	0,054
0,160	0,431	0,431	0,442	11,525	0,108	0,000	5,66	11,465	6,38	0,573	80,80	0,018	0,058
0,170	0,489	0,489	0,502	11,517	0,115	0,000	6,06	11,453	6,83	0,609	77,27	0,020	0,062
0,180	0,552	0,552	0,566	11,509	0,122	0,000	6,46	11,440	7,28	0,644	74,11	0,021	0,066
0,190	0,619	0,619	0,634	11,501	0,129	0,000	6,87	11,427	7,74	0,680	71,25	0,023	0,070
0,200	0,689	0,689	0,707	11,493	0,136	0,000	7,28	11,415	8,20	0,716	68,67	0,025	0,075
0,210	0,764	0,764	0,783	11,485	0,142	0,000	7,69	11,402	8,67	0,752	66,32	0,027	0,079
0,220	0,843	0,843	0,864	11,477	0,149	0,000	8,10	11,389	9,14	0,788	64,17	0,028	0,083
0,230	0,926	0,926	0,950	11,468	0,156	0,000	8,52	11,376	9,61	0,824	62,21	0,030	0,087
0,240	1,014	1,014	1,039	11,460	0,163	0,000	8,95	11,362	10,09	0,860	60,39	0,032	0,092
0,250	1,105	1,105	1,133	11,451	0,170	0,000	9,38	11,349	10,58	0,897	58,72	0,034	0,096
0,260	1,201	1,201	1,231	11,442	0,176	0,000	9,81	11,336	11,06	0,933	57,17	0,036	0,101
0,270	1,301	1,301	1,334	11,434	0,183	0,000	10,24	11,322	11,55	0,969	55,74	0,038	0,105
0,280	1,406	1,406	1,441	11,425	0,190	0,000	10,68	11,309	12,05	1,005	54,40	0,040	0,109
0,290	1,515	1,515	1,553	11,416	0,197	0,000	11,12	11,295	12,55	1,042	53,15	0,042	0,114
0,300	1,629	1,629	1,669	11,407	0,204	0,000	11,56	11,281	13,05	1,078	51,98	0,044	0,119
0,310	1,746	1,746	1,790	11,398	0,211	0,000	12,01	11,268	13,56	1,115	50,89	0,047	0,123
0,320	1,869	1,869	1,916	11,389	0,217	0,000	12,46	11,254	14,07	1,151	49,87	0,049	0,128
0,330	1,996	1,996	2,046	11,380	0,224	0,000	12,92	11,240	14,59	1,188	48,90	0,051	0,132
0,340	2,127	2,127	2,181	11,371	0,231	0,000	13,38	11,225	15,11	1,225	48,00	0,053	0,137
0,350	2,263	2,263	2,320	11,362	0,238	0,000	13,84	11,211	15,63	1,262	47,14	0,056	0,142
0,360	2,404	2,404	2,464	11,353	0,245	0,000	14,31	11,197	16,16	1,299	46,34	0,058	0,147
0,370	2,550	2,550	2,613	11,343	0,252	0,000	14,78	11,182	16,69	1,336	45,58	0,061	0,151
0,380	2,700	2,700	2,767	11,334	0,259	0,000	15,25	11,168	17,23	1,373	44,86	0,063	0,156

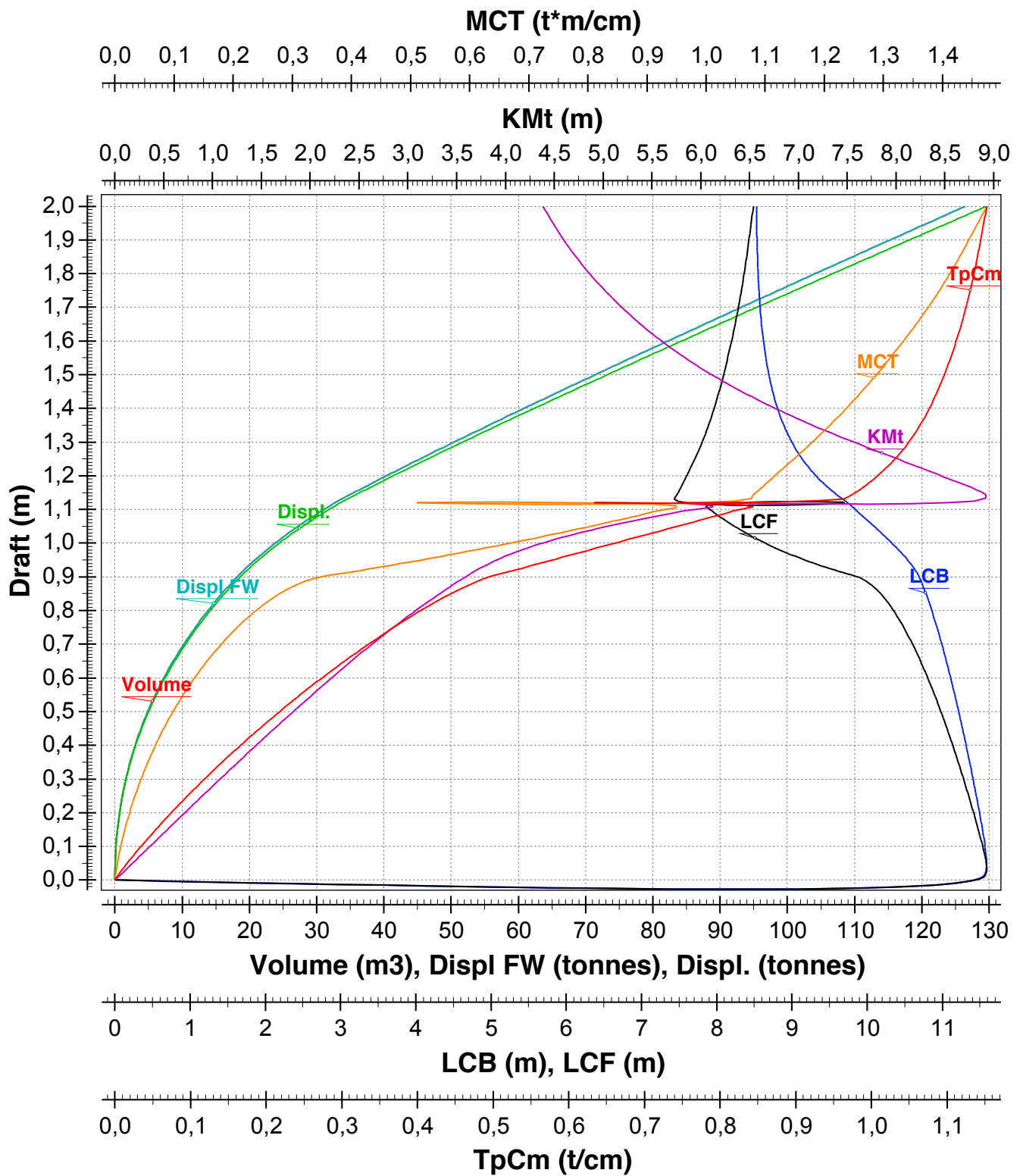
Draft	Volume	DisplFW	Displ.	LCB	VCB	TCB	Aw	LCF	S	KMt	KMI	MCT	TpCm
(m)	(m ³)	(tonnes)	(tonnes)	(m)	(m)	(m)	(m ²)	(m)	(m ²)	(m)	(m)	(t*m/cm)	(t/cm)
0,390	2,855	2,855	2,926	11,325	0,265	0,000	15,73	11,153	17,77	1,410	44,18	0,066	0,161
0,400	3,015	3,015	3,090	11,315	0,272	0,000	16,21	11,138	18,31	1,447	43,53	0,069	0,166
0,410	3,179	3,179	3,259	11,305	0,279	0,000	16,70	11,123	18,86	1,484	42,92	0,071	0,171
0,420	3,349	3,349	3,432	11,296	0,286	0,000	17,19	11,108	19,41	1,522	42,34	0,074	0,176
0,430	3,523	3,523	3,611	11,286	0,293	0,000	17,68	11,092	19,97	1,559	41,79	0,077	0,181
0,440	3,702	3,702	3,795	11,276	0,300	0,000	18,18	11,077	20,53	1,597	41,26	0,080	0,186
0,450	3,887	3,887	3,984	11,267	0,307	0,000	18,68	11,061	21,10	1,635	40,76	0,083	0,191
0,460	4,076	4,076	4,178	11,257	0,314	0,000	19,18	11,046	21,67	1,673	40,29	0,086	0,197
0,470	4,270	4,270	4,377	11,247	0,320	0,000	19,69	11,030	22,24	1,711	39,84	0,089	0,202
0,480	4,470	4,470	4,582	11,237	0,327	0,000	20,20	11,014	22,82	1,749	39,41	0,092	0,207
0,490	4,675	4,675	4,791	11,226	0,334	0,000	20,72	10,997	23,41	1,787	39,00	0,095	0,212
0,500	4,884	4,884	5,007	11,216	0,341	0,000	21,24	10,981	24,00	1,826	38,61	0,098	0,218
0,510	5,100	5,100	5,227	11,206	0,348	0,000	21,77	10,964	24,59	1,864	38,23	0,102	0,223
0,520	5,320	5,320	5,453	11,196	0,355	0,000	22,30	10,947	25,19	1,903	37,88	0,105	0,229
0,530	5,546	5,546	5,684	11,185	0,362	0,000	22,83	10,931	25,79	1,942	37,54	0,108	0,234
0,540	5,777	5,777	5,921	11,175	0,369	0,000	23,37	10,913	26,40	1,981	37,22	0,112	0,240
0,550	6,013	6,013	6,163	11,164	0,376	0,000	23,92	10,896	27,01	2,020	36,92	0,115	0,245
0,560	6,255	6,255	6,411	11,153	0,383	0,000	24,46	10,878	27,63	2,059	36,62	0,119	0,251
0,570	6,502	6,502	6,665	11,142	0,390	0,000	25,02	10,860	28,25	2,099	36,35	0,123	0,256
0,580	6,756	6,756	6,924	11,132	0,397	0,000	25,57	10,842	28,88	2,139	36,08	0,127	0,262
0,590	7,014	7,014	7,189	11,121	0,404	0,000	26,14	10,824	29,51	2,178	35,83	0,131	0,268
0,600	7,278	7,278	7,460	11,109	0,410	0,000	26,70	10,806	30,15	2,219	35,60	0,135	0,274
0,610	7,548	7,548	7,737	11,098	0,417	0,000	27,28	10,787	30,79	2,259	35,37	0,139	0,280
0,620	7,824	7,824	8,020	11,087	0,424	0,000	27,86	10,768	31,44	2,299	35,16	0,143	0,286
0,630	8,106	8,106	8,308	11,075	0,431	0,000	28,44	10,748	32,10	2,340	34,96	0,147	0,292
0,640	8,393	8,393	8,603	11,064	0,438	0,000	29,03	10,729	32,76	2,381	34,77	0,151	0,298
0,650	8,686	8,686	8,903	11,052	0,445	0,000	29,62	10,709	33,43	2,422	34,59	0,156	0,304
0,660	8,986	8,986	9,210	11,040	0,452	0,000	30,23	10,688	34,10	2,464	34,42	0,160	0,310
0,670	9,291	9,291	9,523	11,028	0,459	0,000	30,83	10,668	34,78	2,506	34,27	0,165	0,316
0,680	9,602	9,602	9,842	11,016	0,466	0,000	31,45	10,647	35,47	2,548	34,12	0,170	0,322
0,690	9,920	9,920	10,168	11,004	0,473	0,000	32,07	10,625	36,16	2,590	33,99	0,175	0,329
0,700	10,244	10,244	10,500	10,992	0,480	0,000	32,69	10,603	36,86	2,633	33,87	0,180	0,335
0,710	10,574	10,574	10,838	10,979	0,487	0,000	33,33	10,581	37,57	2,676	33,76	0,185	0,342
0,720	10,911	10,911	11,183	10,967	0,494	0,000	33,97	10,558	38,29	2,719	33,66	0,190	0,348
0,730	11,254	11,254	11,535	10,954	0,501	0,000	34,62	10,535	39,01	2,763	33,58	0,196	0,355
0,740	11,603	11,603	11,893	10,941	0,508	0,000	35,28	10,511	39,75	2,807	33,50	0,201	0,362
0,750	11,959	11,959	12,258	10,928	0,515	0,000	35,95	10,486	40,49	2,851	33,44	0,207	0,368
0,760	12,322	12,322	12,630	10,914	0,523	0,000	36,63	10,461	41,25	2,896	33,40	0,213	0,375
0,770	12,692	12,692	13,009	10,901	0,530	0,000	37,32	10,435	42,01	2,941	33,36	0,219	0,382
0,780	13,069	13,069	13,396	10,887	0,537	0,000	38,01	10,408	42,79	2,987	33,35	0,225	0,390
0,790	13,453	13,453	13,789	10,873	0,544	0,000	38,73	10,380	43,57	3,033	33,35	0,232	0,397
0,800	13,844	13,844	14,190	10,858	0,551	0,000	39,45	10,350	44,38	3,080	33,38	0,239	0,404

Draft	Volume	DisplFW	Displ.	LCB	VCB	TCB	Aw	LCF	S	KMt	KMI	MCT	TpCm
(m)	(m ³)	(tonnes)	(tonnes)	(m)	(m)	(m)	(m ²)	(m)	(m ²)	(m)	(m)	(t*m/cm)	(t/cm)
0,810	14,242	14,242	14,598	10,844	0,558	0,000	40,19	10,320	45,19	3,128	33,42	0,246	0,412
0,820	14,648	14,648	15,014	10,829	0,565	0,000	40,95	10,288	46,03	3,176	33,49	0,254	0,420
0,830	15,061	15,061	15,438	10,813	0,572	0,000	41,72	10,254	46,88	3,224	33,59	0,261	0,428
0,840	15,482	15,482	15,869	10,798	0,579	0,000	42,52	10,218	47,75	3,274	33,73	0,270	0,436
0,850	15,912	15,912	16,309	10,782	0,587	0,000	43,34	10,179	48,66	3,324	33,92	0,279	0,444
0,860	16,349	16,349	16,758	10,765	0,594	0,000	44,20	10,136	49,59	3,375	34,17	0,289	0,453
0,870	16,796	16,796	17,216	10,747	0,601	0,000	45,10	10,089	50,57	3,427	34,50	0,299	0,462
0,880	17,252	17,252	17,683	10,729	0,608	0,000	46,05	10,034	51,61	3,481	34,96	0,312	0,472
0,890	17,718	17,718	18,160	10,710	0,615	0,000	47,10	9,968	52,73	3,535	35,64	0,326	0,483
0,900	18,194	18,194	18,649	10,690	0,623	0,000	48,32	9,875	54,03	3,591	36,89	0,347	0,495
0,910	18,686	18,686	19,153	10,666	0,630	0,000	49,93	9,716	55,73	3,648	39,67	0,383	0,512
0,920	19,193	19,193	19,673	10,639	0,638	0,000	51,55	9,567	57,43	3,708	42,15	0,419	0,528
0,930	19,717	19,717	20,210	10,608	0,645	0,000	53,16	9,427	59,13	3,772	44,36	0,453	0,545
0,940	20,257	20,257	20,763	10,575	0,653	0,000	54,77	9,295	60,83	3,839	46,32	0,486	0,561
0,950	20,813	20,813	21,333	10,539	0,661	0,000	56,39	9,171	62,54	3,912	48,06	0,519	0,578
0,960	21,385	21,385	21,919	10,501	0,669	0,000	58,00	9,054	64,25	3,991	49,60	0,550	0,595
0,970	21,973	21,973	22,522	10,461	0,677	0,000	59,62	8,943	65,96	4,077	50,95	0,581	0,611
0,980	22,577	22,577	23,142	10,419	0,685	0,000	61,23	8,838	67,68	4,169	52,14	0,611	0,628
0,990	23,198	23,198	23,778	10,375	0,693	0,000	62,84	8,739	69,40	4,270	53,17	0,640	0,644
1,000	23,834	23,834	24,430	10,330	0,701	0,000	64,46	8,644	71,12	4,377	54,06	0,669	0,661
1,010	24,487	24,487	25,099	10,284	0,709	0,000	66,07	8,554	72,84	4,494	54,83	0,697	0,677
1,020	25,156	25,156	25,785	10,237	0,717	0,000	67,69	8,469	74,57	4,618	55,48	0,724	0,694
1,030	25,841	25,841	26,487	10,189	0,725	0,000	69,30	8,387	76,30	4,751	56,03	0,751	0,710
1,040	26,542	26,542	27,206	10,140	0,733	0,000	70,92	8,309	78,03	4,893	56,48	0,778	0,727
1,050	27,260	27,260	27,941	10,091	0,742	0,000	72,53	8,235	79,77	5,043	56,85	0,804	0,743
1,060	27,993	27,993	28,693	10,041	0,750	0,000	74,15	8,164	81,50	5,203	57,13	0,830	0,760
1,070	28,743	28,743	29,461	9,992	0,758	0,000	75,76	8,096	83,24	5,371	57,35	0,855	0,777
1,080	29,509	29,509	30,246	9,941	0,766	0,000	77,38	8,030	84,99	5,548	57,51	0,880	0,793
1,090	30,291	30,291	31,048	9,891	0,774	0,000	78,99	7,968	86,73	5,733	57,60	0,905	0,810
1,100	31,089	31,089	31,866	9,841	0,783	0,000	80,61	7,908	88,48	5,928	57,64	0,929	0,826
1,110	31,903	31,903	32,700	9,791	0,791	0,000	82,22	7,850	90,23	6,130	57,64	0,953	0,843
1,120	32,733	32,733	33,551	9,741	0,799	0,000	83,83	7,794	92,01	6,341	57,64	0,977	0,860
1,130	33,600	33,600	34,501	9,691	0,808	0,000	85,44	7,740	93,81	6,558	57,64	1,001	0,877
1,140	34,602	34,602	35,467	9,641	0,817	0,000	87,05	7,688	95,61	6,781	57,64	1,025	0,894
1,150	35,554	35,554	36,443	9,591	0,826	0,000	88,66	7,638	97,41	7,009	57,64	1,049	0,911
1,160	36,512	36,512	37,425	9,541	0,834	0,000	90,27	7,589	99,21	7,242	57,64	1,073	0,928
1,170	37,477	37,477	38,414	9,491	0,843	0,000	91,88	7,542	101,01	7,480	57,64	1,097	0,945
1,180	38,448	38,448	39,409	9,441	0,851	0,000	93,49	7,496	102,81	7,722	57,64	1,121	0,962
1,190	39,423	39,423	40,409	9,391	0,860	0,000	95,10	7,452	104,61	7,969	57,64	1,145	0,979
1,200	40,405	40,405	41,415	9,341	0,868	0,000	96,71	7,409	106,41	8,220	57,64	1,169	0,996
1,210	41,391	41,391	42,425	9,291	0,876	0,000	98,32	7,368	108,21	8,474	57,64	1,193	1,013
1,220	42,382	42,382	43,441	9,241	0,884	0,000	99,93	7,328	110,01	8,731	57,64	1,217	1,030
1,230	43,377	43,377	44,462	9,191	0,892	0,000	101,54	7,289	111,81	8,991	57,64	1,241	1,047

Draft	Volume	DisplFW	Displ.	LCB	VCB	TCB	Aw	LCF	S	KMt	KMI	MCT	TpCm
(m)	(m ³)	(tonnes)	(tonnes)	(m)	(m)	(m)	(m ²)	(m)	(m ²)	(m)	(m)	(t*m/cm)	(t/cm)
1,240	44,377	44,377	45,487	9,168	0,899	0,000	100,22	7,690	112,30	8,105	49,86	1,142	1,027
1,250	45,382	45,382	46,516	9,135	0,907	0,000	100,63	7,711	113,07	8,015	49,05	1,148	1,031
1,260	46,390	46,390	47,550	9,105	0,914	0,000	101,03	7,731	113,82	7,925	48,27	1,155	1,036
1,270	47,402	47,402	48,587	9,076	0,922	0,000	101,40	7,751	114,55	7,835	47,53	1,161	1,039
1,280	48,418	48,418	49,628	9,048	0,929	0,000	101,75	7,770	115,27	7,745	46,80	1,167	1,043
1,290	49,437	49,437	50,673	9,022	0,937	0,000	102,09	7,789	115,97	7,656	46,10	1,174	1,046
1,300	50,460	50,460	51,721	8,997	0,944	0,000	102,41	7,807	116,66	7,567	45,42	1,180	1,050
1,310	51,485	51,485	52,772	8,974	0,951	0,000	102,72	7,825	117,34	7,480	44,77	1,186	1,053
1,320	52,514	52,514	53,827	8,951	0,958	0,000	103,02	7,842	118,01	7,394	44,13	1,192	1,056
1,330	53,546	53,546	54,884	8,930	0,965	0,000	103,30	7,858	118,67	7,310	43,52	1,198	1,059
1,340	54,580	54,580	55,945	8,910	0,972	0,000	103,58	7,875	119,32	7,227	42,92	1,204	1,062
1,350	55,617	55,617	57,008	8,891	0,979	0,000	103,84	7,891	119,96	7,145	42,35	1,209	1,064
1,360	56,657	56,657	58,073	8,872	0,986	0,000	104,10	7,906	120,60	7,066	41,79	1,215	1,067
1,370	57,699	57,699	59,142	8,855	0,993	0,000	104,35	7,922	121,23	6,988	41,24	1,221	1,070
1,380	58,744	58,744	60,213	8,839	1,000	0,000	104,59	7,937	121,85	6,911	40,71	1,226	1,072
1,390	59,791	59,791	61,286	8,823	1,007	0,000	104,83	7,951	122,47	6,837	40,20	1,232	1,074
1,400	60,840	60,840	62,361	8,808	1,013	0,000	105,05	7,965	123,08	6,763	39,70	1,237	1,077
1,410	61,892	61,892	63,439	8,794	1,020	0,000	105,27	7,979	123,69	6,691	39,22	1,243	1,079
1,420	62,946	62,946	64,519	8,780	1,027	0,000	105,48	7,993	124,29	6,621	38,74	1,248	1,081
1,430	64,002	64,002	65,602	8,768	1,033	0,000	105,68	8,006	124,88	6,552	38,28	1,253	1,083
1,440	65,060	65,060	66,686	8,755	1,040	0,000	105,88	8,019	125,47	6,485	37,83	1,258	1,085
1,450	66,119	66,119	67,772	8,744	1,046	0,000	106,08	8,032	126,06	6,419	37,40	1,263	1,087
1,460	67,181	67,181	68,861	8,732	1,053	0,000	106,27	8,044	126,64	6,355	36,97	1,268	1,089
1,470	68,245	68,245	69,951	8,722	1,059	0,000	106,45	8,056	127,22	6,292	36,56	1,273	1,091
1,480	69,310	69,310	71,043	8,712	1,065	0,000	106,63	8,068	127,80	6,231	36,15	1,278	1,093
1,490	70,377	70,377	72,137	8,702	1,072	0,000	106,81	8,080	128,37	6,171	35,76	1,283	1,095
1,500	71,446	71,446	73,232	8,693	1,078	0,000	106,98	8,091	128,94	6,113	35,37	1,288	1,097
1,510	72,517	72,517	74,330	8,684	1,084	0,000	107,15	8,103	129,51	6,056	35,00	1,293	1,098
1,520	73,589	73,589	75,429	8,676	1,091	0,000	107,31	8,114	130,07	6,000	34,63	1,298	1,100
1,530	74,663	74,663	76,530	8,668	1,097	0,000	107,47	8,125	130,64	5,946	34,28	1,302	1,102
1,540	75,739	75,739	77,632	8,660	1,103	0,000	107,63	8,136	131,20	5,893	33,93	1,307	1,103
1,550	76,816	76,816	78,736	8,653	1,109	0,000	107,78	8,147	131,75	5,841	33,59	1,311	1,105
1,560	77,894	77,894	79,842	8,646	1,116	0,000	107,94	8,157	132,31	5,790	33,26	1,316	1,106
1,570	78,974	78,974	80,949	8,639	1,122	0,000	108,08	8,168	132,86	5,741	32,93	1,321	1,108
1,580	80,056	80,056	82,057	8,633	1,128	0,000	108,23	8,178	133,41	5,693	32,62	1,325	1,109
1,590	81,139	81,139	83,167	8,627	1,134	0,000	108,37	8,188	133,96	5,646	32,31	1,330	1,111
1,600	82,223	82,223	84,279	8,621	1,140	0,000	108,51	8,198	134,51	5,599	32,00	1,334	1,112
1,610	83,309	83,309	85,392	8,616	1,146	0,000	108,65	8,207	135,06	5,554	31,71	1,338	1,114
1,620	84,396	84,396	86,506	8,610	1,152	0,000	108,79	8,217	135,60	5,510	31,42	1,343	1,115
1,630	85,485	85,485	87,622	8,605	1,158	0,000	108,92	8,226	136,14	5,467	31,13	1,347	1,116
1,640	86,575	86,575	88,739	8,601	1,164	0,000	109,05	8,236	136,68	5,425	30,86	1,351	1,118
1,650	87,666	87,666	89,858	8,596	1,170	0,000	109,18	8,245	137,22	5,384	30,58	1,355	1,119

Draft	Volume	DisplFW	Displ.	LCB	VCB	TCB	Aw	LCF	S	KMt	KMI	MCT	TpCm
(m)	(m ³)	(tonnes)	(tonnes)	(m)	(m)	(m)	(m ²)	(m)	(m ²)	(m)	(m)	(t*m/cm)	(t/cm)
1,660	88,758	88,758	90,977	8,592	1,176	0,000	109,30	8,254	137,75	5,344	30,32	1,360	1,120
1,670	89,852	89,852	92,098	8,588	1,182	0,000	109,42	8,263	138,29	5,304	30,06	1,364	1,122
1,680	90,947	90,947	93,221	8,584	1,188	0,000	109,54	8,272	138,82	5,266	29,80	1,368	1,123
1,690	92,043	92,043	94,344	8,580	1,194	0,000	109,66	8,280	139,35	5,228	29,55	1,372	1,124
1,700	93,140	93,140	95,469	8,577	1,200	0,000	109,78	8,289	139,88	5,191	29,30	1,376	1,125
1,710	94,239	94,239	96,594	8,574	1,206	0,000	109,89	8,297	140,41	5,155	29,06	1,380	1,126
1,720	95,338	95,338	97,721	8,570	1,212	0,000	110,00	8,305	140,93	5,119	28,82	1,384	1,128
1,730	96,439	96,439	98,849	8,567	1,217	0,000	110,11	8,313	141,45	5,085	28,59	1,387	1,129
1,740	97,540	97,540	99,979	8,565	1,223	0,000	110,21	8,321	141,97	5,051	28,36	1,391	1,130
1,750	98,643	98,643	101,109	8,562	1,229	0,000	110,32	8,328	142,49	5,018	28,13	1,395	1,131
1,760	99,747	99,747	102,240	8,559	1,235	0,000	110,42	8,336	143,01	4,985	27,91	1,398	1,132
1,770	100,851	100,851	103,372	8,557	1,241	0,000	110,52	8,343	143,53	4,953	27,69	1,402	1,133
1,780	101,957	101,957	104,506	8,555	1,247	0,000	110,61	8,350	144,04	4,922	27,47	1,406	1,134
1,790	103,063	103,063	105,640	8,553	1,252	0,000	110,71	8,357	144,55	4,892	27,26	1,409	1,135
1,800	104,171	104,171	106,775	8,551	1,258	0,000	110,80	8,364	145,06	4,862	27,05	1,412	1,136
1,810	105,279	105,279	107,911	8,549	1,264	0,000	110,89	8,371	145,57	4,833	26,85	1,416	1,137
1,820	106,389	106,389	109,049	8,547	1,270	0,000	110,98	8,378	146,08	4,804	26,65	1,419	1,138
1,830	107,499	107,499	110,187	8,545	1,275	0,000	111,07	8,384	146,58	4,777	26,45	1,422	1,138
1,840	108,610	108,610	111,326	8,543	1,281	0,000	111,16	8,391	147,09	4,749	26,25	1,426	1,139
1,850	109,722	109,722	112,465	8,542	1,287	0,000	111,24	8,397	147,59	4,722	26,06	1,429	1,140
1,860	110,835	110,835	113,606	8,541	1,292	0,000	111,33	8,404	148,10	4,696	25,87	1,432	1,141
1,870	111,949	111,949	114,748	8,539	1,298	0,000	111,41	8,410	148,60	4,671	25,69	1,435	1,142
1,880	113,064	113,064	115,890	8,538	1,304	0,000	111,50	8,416	149,10	4,646	25,51	1,438	1,143
1,890	114,179	114,179	117,033	8,537	1,310	0,000	111,58	8,422	149,61	4,621	25,33	1,441	1,144
1,900	115,295	115,295	118,178	8,536	1,315	0,000	111,66	8,429	150,11	4,597	25,15	1,445	1,145
1,910	116,412	116,412	119,323	8,535	1,321	0,000	111,74	8,435	150,61	4,574	24,98	1,448	1,145
1,920	117,530	117,530	120,468	8,534	1,326	0,000	111,83	8,441	151,11	4,551	24,81	1,451	1,146
1,930	118,649	118,649	121,615	8,533	1,332	0,000	111,91	8,447	151,61	4,529	24,64	1,454	1,147
1,940	119,768	119,768	122,762	8,532	1,338	0,000	111,99	8,453	152,11	4,507	24,48	1,457	1,148
1,950	120,889	120,889	123,911	8,531	1,343	0,000	112,07	8,459	152,61	4,485	24,32	1,460	1,149
1,960	122,010	122,010	125,060	8,531	1,349	0,000	112,14	8,465	153,10	4,464	24,16	1,463	1,149
1,970	123,131	123,131	126,210	8,530	1,355	0,000	112,22	8,471	153,60	4,444	24,00	1,466	1,150
1,980	124,254	124,254	127,360	8,530	1,360	0,000	112,30	8,476	154,10	4,424	23,85	1,469	1,151
1,990	125,377	125,377	128,512	8,529	1,366	0,000	112,38	8,482	154,60	4,404	23,70	1,472	1,152
2,000	126,502	126,502	129,664	8,529	1,371	0,000	112,46	8,488	155,09	4,385	23,55	1,475	1,153

Curves of form



NOTE 1: Draft (and all other vertical heights) is measured above base $Z=0,000$

NOTE 2: All calculated coefficients based on project length, draft and beam.

Nomenclature

Draft	<i>Moulded draft, measured from baseline</i>
Volume	<i>Total displaced volume</i>
Displ FW	<i>Displacement fresh water</i>
Displ.	<i>Displacement</i>
LCB	<i>Longitudinal center of buoyancy, measured from the aft perpendicular at $X=0.0$</i>
VCB	<i>Vertical center of buoyancy</i>
TCB	<i>Transverse center of buoyancy</i>
Aw	<i>Waterplane area</i>
LCF	<i>Waterplane center of floatation, measured from the aft perpendicular at $X=0.0$</i>
S	<i>Wetted surface area</i>
KMt	<i>Transverse metacentric height</i>
KMI	<i>Longitudinal metacentric height</i>
MCT	<i>Moment to change trim one unit</i>
TpCm	<i>Weight to change the immersion with one unit</i>

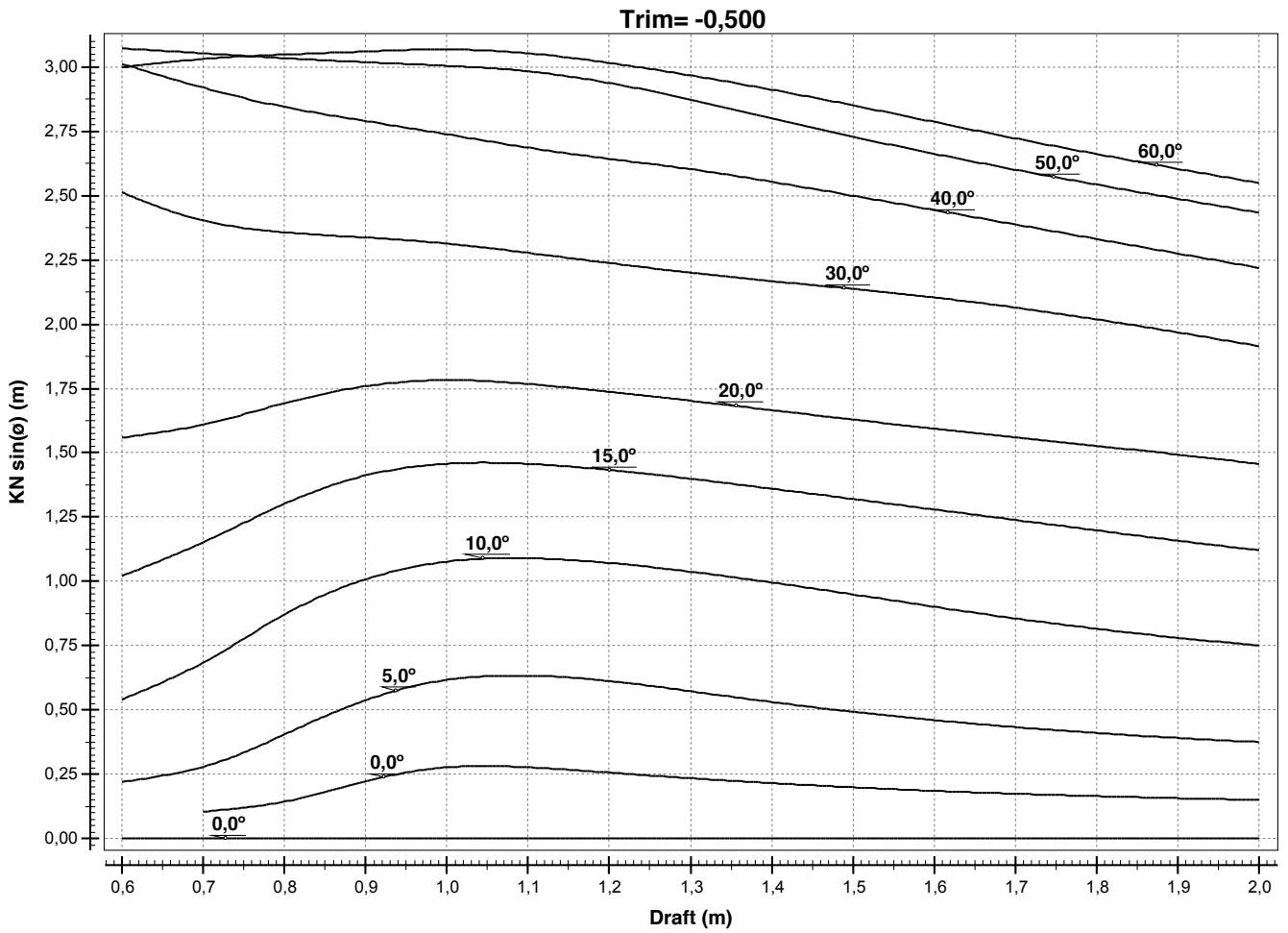
Crosscurves

Heel to: Port side

Trim settings: Free to trim

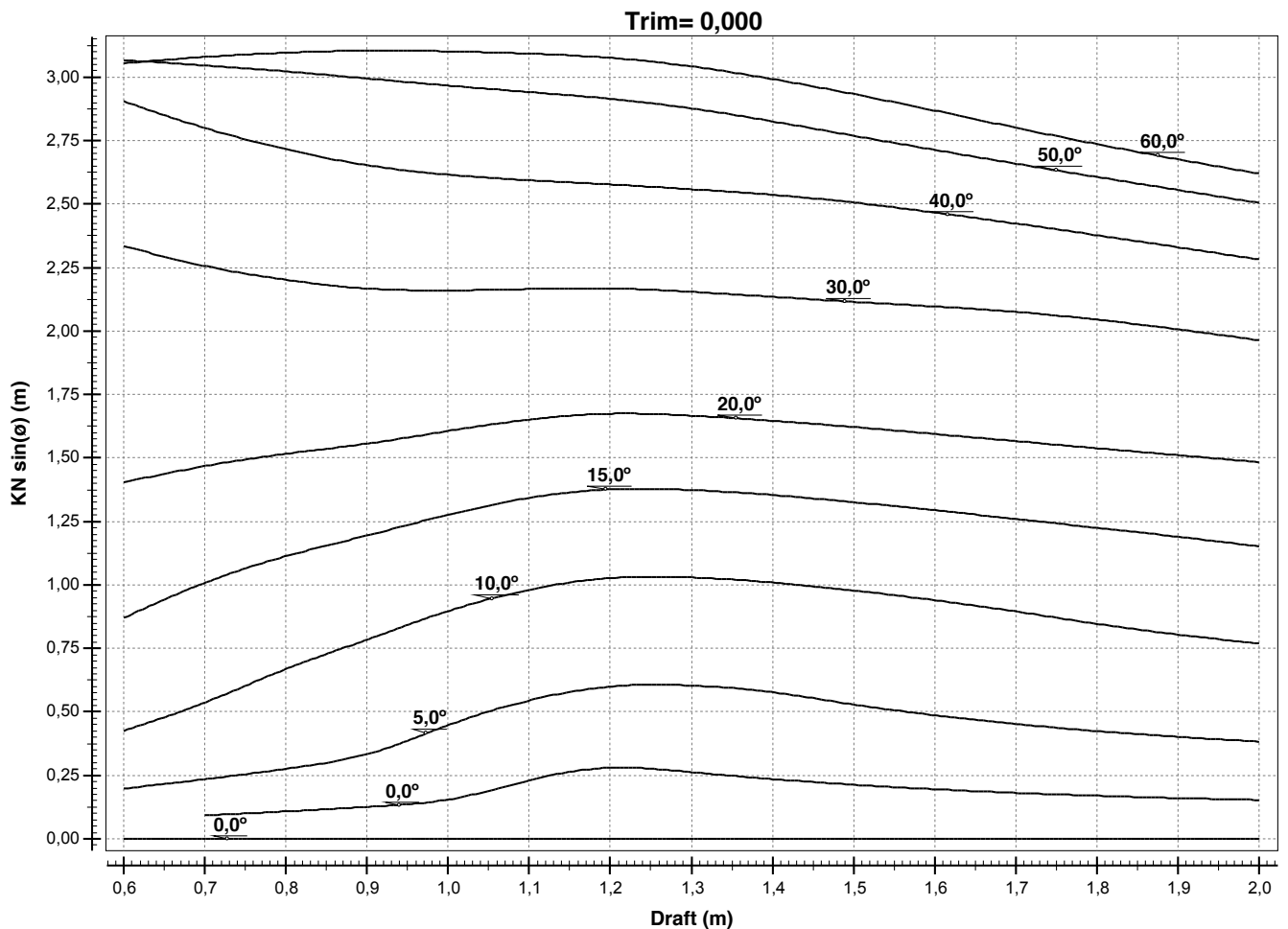
Trim= -0,500

Draft	0,0°	0,0°	5,0°	10,0°	15,0°	20,0°	30,0°	40,0°	50,0°	60,0°
0,600	0,000	<->	0,219	0,540	1,021	1,558	2,513	3,013	3,073	2,999
0,700	0,000	0,104	0,279	0,685	1,152	1,610	2,403	2,920	3,054	3,032
0,800	0,000	0,143	0,404	0,871	1,302	1,693	2,358	2,845	3,035	3,049
0,900	0,000	0,222	0,538	1,008	1,412	1,759	2,337	2,790	3,020	3,061
1,000	0,000	0,277	0,616	1,077	1,458	1,783	2,314	2,739	3,005	3,069
1,100	0,000	0,276	0,633	1,090	1,457	1,768	2,278	2,687	2,984	3,054
1,200	0,000	0,256	0,612	1,071	1,433	1,737	2,238	2,643	2,938	3,017
1,300	0,000	0,234	0,572	1,037	1,399	1,702	2,200	2,603	2,874	2,968
1,400	0,000	0,215	0,530	0,996	1,360	1,666	2,168	2,554	2,801	2,913
1,500	0,000	0,199	0,493	0,949	1,320	1,629	2,138	2,500	2,730	2,852
1,600	0,000	0,185	0,460	0,901	1,279	1,594	2,104	2,444	2,663	2,787
1,700	0,000	0,173	0,433	0,856	1,239	1,560	2,065	2,388	2,601	2,723
1,800	0,000	0,164	0,410	0,815	1,198	1,527	2,019	2,332	2,543	2,662
1,900	0,000	0,156	0,391	0,780	1,158	1,493	1,968	2,276	2,488	2,605
2,000	0,000	0,150	0,375	0,750	1,121	1,456	1,915	2,220	2,434	2,550



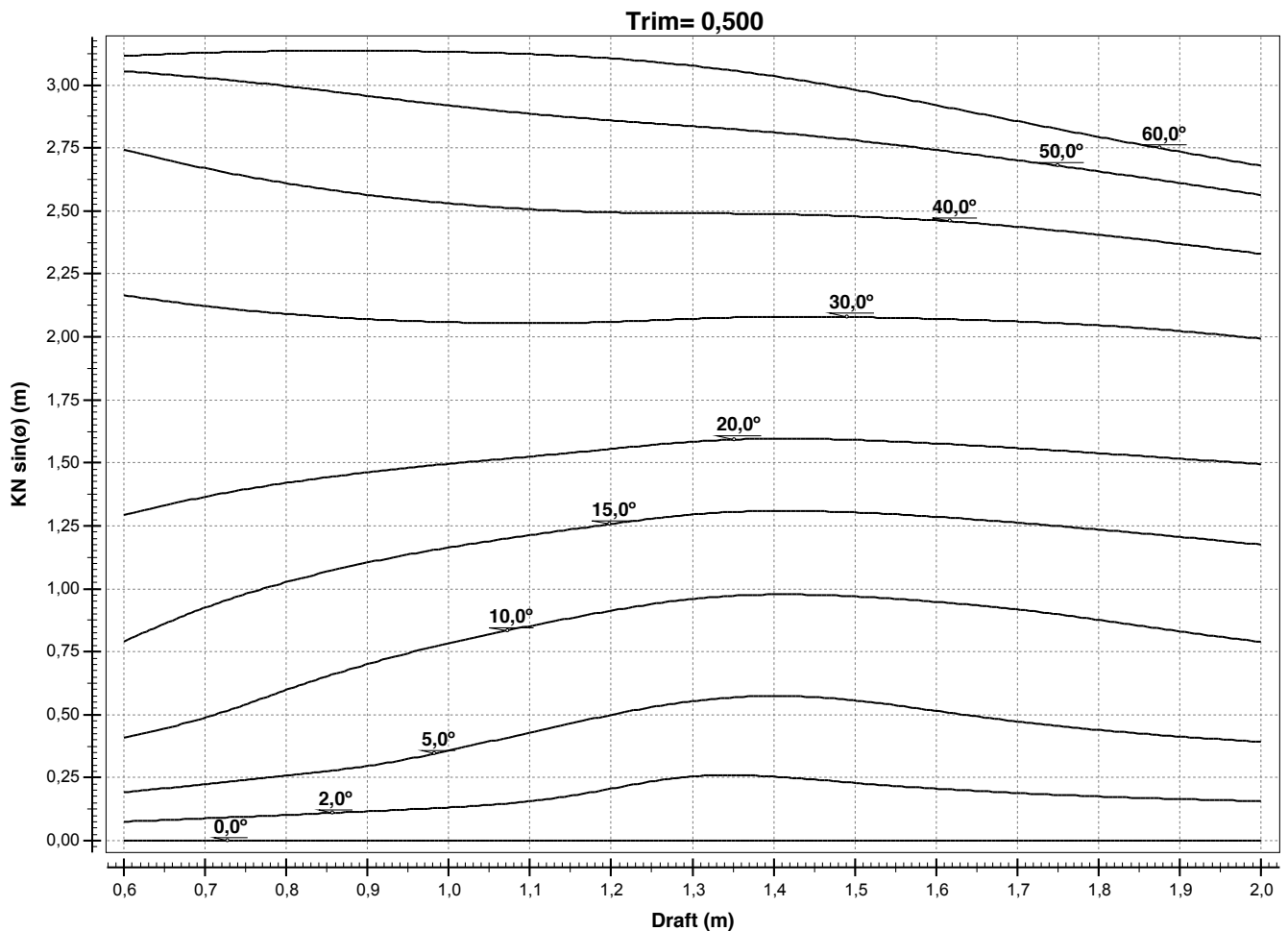
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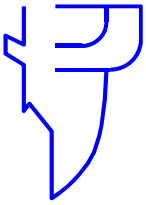
Draft	0,0°	0,0°	5,0°	10,0°	15,0°	20,0°	30,0°	40,0°	50,0°	60,0°
0,600	0,000	<->	0,198	0,426	0,870	1,405	2,334	2,905	3,067	3,054
0,700	0,000	0,092	0,235	0,537	1,009	1,468	2,256	2,799	3,046	3,080
0,800	0,000	0,108	0,276	0,669	1,113	1,517	2,202	2,716	3,022	3,096
0,900	0,000	0,126	0,333	0,785	1,195	1,557	2,167	2,653	2,995	3,104
1,000	0,000	0,155	0,448	0,897	1,277	1,606	2,160	2,616	2,967	3,102
1,100	0,000	0,231	0,545	0,982	1,343	1,651	2,165	2,594	2,941	3,093
1,200	0,000	0,280	0,600	1,027	1,376	1,675	2,167	2,577	2,915	3,076
1,300	0,000	0,262	0,603	1,030	1,374	1,667	2,154	2,558	2,877	3,042
1,400	0,000	0,235	0,577	1,010	1,354	1,647	2,135	2,537	2,826	2,993
1,500	0,000	0,213	0,529	0,978	1,326	1,622	2,115	2,506	2,769	2,933
1,600	0,000	0,195	0,487	0,940	1,294	1,595	2,097	2,467	2,713	2,868
1,700	0,000	0,181	0,453	0,896	1,260	1,566	2,076	2,423	2,659	2,801
1,800	0,000	0,170	0,425	0,847	1,225	1,538	2,045	2,378	2,607	2,736
1,900	0,000	0,161	0,402	0,805	1,190	1,511	2,007	2,330	2,556	2,676
2,000	0,000	0,153	0,383	0,769	1,152	1,484	1,964	2,282	2,505	2,620



Trim= 0,500

Draft	0,0°	2,0°	5,0°	10,0°	15,0°	20,0°	30,0°	40,0°	50,0°	60,0°
0,600	0,000	0,075	0,192	0,409	0,791	1,294	2,165	2,744	3,055	3,116
0,700	0,000	0,088	0,225	0,488	0,925	1,366	2,123	2,669	3,028	3,128
0,800	0,000	0,102	0,259	0,599	1,026	1,420	2,091	2,610	2,996	3,135
0,900	0,000	0,116	0,296	0,701	1,104	1,463	2,070	2,564	2,957	3,136
1,000	0,000	0,132	0,358	0,784	1,164	1,496	2,058	2,530	2,919	3,132
1,100	0,000	0,156	0,429	0,852	1,212	1,525	2,054	2,507	2,886	3,122
1,200	0,000	0,206	0,499	0,913	1,257	1,555	2,060	2,494	2,859	3,105
1,300	0,000	0,255	0,554	0,959	1,295	1,584	2,072	2,491	2,836	3,076
1,400	0,000	0,255	0,574	0,977	1,309	1,596	2,080	2,488	2,812	3,035
1,500	0,000	0,229	0,557	0,970	1,303	1,591	2,078	2,478	2,781	2,981
1,600	0,000	0,206	0,515	0,948	1,286	1,577	2,071	2,462	2,743	2,920
1,700	0,000	0,189	0,473	0,918	1,262	1,559	2,061	2,437	2,701	2,857
1,800	0,000	0,176	0,440	0,877	1,235	1,538	2,046	2,405	2,657	2,795
1,900	0,000	0,165	0,413	0,831	1,206	1,517	2,023	2,369	2,611	2,735
2,000	0,000	0,157	0,393	0,789	1,176	1,494	1,993	2,330	2,564	2,680





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PROJECT N° 363- INNOVATIVE RESEARCH VESSEL

**PRELIMINARY DISPLACEMENT STUDY
 LIGHT WEIGHT ESTIMATE**

LENGHT OVER ALL..... m 19,50
 LENGHT BETW. PB... m 18,65
 BEAM MOULDED m 6,70
 DEPTH (AT SIDE OF MIDSHIP SECT.) m 3,20
 DESIGN DROUGHT m 1,25
 SCANTLING DRAUGHT m 1,5
 ENGINE POWER..... 2x368KW
 DD/GG..... -
 SPEED..... 12.0 knots
 CREW..... 4+8

CHAPTER	OBJECT	WEIGHT (T)
1	TOTAL CHAPTER 1	12,50
2	TOTAL CHAPTER 2	1,56
3	TOTAL CHAPTER 3	4,41
4	TOTAL CHAPTER 4	1,97
5	TOTAL CHAPTER 5	1,35
6	TOTAL CHAPTER 6	0,56
7	TOTAL CHAPTER 7	3,96
8	TOTAL CHAPTER 8	2,53
9	TOTAL CHAPTER 9	0,29
10	TOTAL CHAPTER 10	0,00
11	TOTAL CHAPTER 11	11,52
12	TOTAL CHAPTER 12	0,19
13	TOTAL CHAPTER 13	0,64
14	TOTAL CHAPTER 14	1,08
15	TOTAL CHAPTER 15	2,28
16		
17		
18		
19		
20		
21		
22	RESERVE	1,00
	LIGHT SHIP	45,83 T



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard Tonn.	Price per unit	Total price	Glomate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
2	DECK COVERING, PAINTING AND INSULATION												
2.1	DECKHOUSE COVERING												
	W/H over deck wood grate		18	20	0,36					8,90	3,20	16,25	5,85
	TOTAL				0,36					27,00	3,20	16,25	5,85
2.2	GRATINGS												
	Plastic showers' grating		1	1,5	0,00					3,20	0,00	19,00	0,03
	GRP gratings (external) 30/30 thickness 38		3	20	0,06					4,50	0,27	15,00	0,90
	wooden gratings for steering		1,2	30	0,04					2,20	0,08	0,00	0,00
	TOTAL				0,10					3,63	0,35	9,52	0,93
2.4	DECK COVERINGS TILING AND SHEATHING												
	SHEATHING												
	Flooring for cabin, dinette, corridors : vinyl tiles 2.5mm thick on a rubber underlay2/4mm thick		50	2,5	0,13					5,00	0,63	13,20	1,65
	Flooring for lab, office, corridors, W/H : vinyl tiles 2.5mm thick on a rubber underlay2/4mm thick		50	2,5	0,13					5,00	0,63	13,20	1,65
	Flooring for gally : ceramic anti-slip tiles on a suitable underlayment		2	25	0,05					1,50	0,08	12,20	0,61
	TOTAL				0,30					4,42	1,33	13,03	3,91



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard Tonn.	Price per unit	Total price	Glomate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
2.4	INSULATING LININGS												
	Insulation supstructures		150	1	0,15					4,69	0,70	11,21	1,68
	Insulation under main deck		135	1	0,14					2,50	0,34	15,50	2,09
	Fire Isolation for galley		20	2	0,04					2,30	0,09	12,50	0,50
	TOTAL				0,33					3,49	1,13	13,15	4,27
2.6	PAINTING												
	Painting for hull, accommodations and internal structures		2000	0,2	0,40					2,65	1,06	9,52	3,81
	TOTAL				0,40					2,65	1,06	9,52	3,81
2.6	CATHODIC PROTECTION												
	Passive cathodic protection												
	Aluminium anodes for propulsion system, sea chests and thruster			60	0,06					0,60	0,04	9,50	0,57
	TOTAL				0,08					0,60	0,01	9,20	0,18
	TOTAL CHAPTER 2				1,56					3,7114	5,80	9,993	15,61



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Cd	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	complessive	m	T x m	m	T x m
3	DECK AUXILIARIES												
3.1	ANCHORING AND MOORING EQUIPMENT												
	Deck Machinery												
3.1.1	Windlass/mooring winch and chain stopper												
	Combined windlass-mooring winch forecastle	pcs	1,0	65,00	0,07					3,80	0,25	18,50	1,20
	Accessories for winch and windlass				0,03					6,15	0,18	20,25	0,61



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
3.1.4	Anchor, Anchor Chain												
	AnchorHHP type												
	Shackle, end link, swivel shackle, link and kender	pcs	1,0	90,00	0,09					3,60	0,32	18,50	1,67
	Stud link chain cables Ø 8.0mm/Steel Q2	pcs	3,0	5,00	0,02					3,60	0,05	18,00	0,27
	Mooring Pholipr. ropes -4pcsx12x20	m.l.	75,0	1,73	0,13					4,80	0,62	18,00	2,34
	Towing Pholipr. ropes -2pcsx12mmx120	m.l.	80,0	0,25	0,02					3,50	0,07	12,00	0,24
		m.l.	240,0	0,25	0,06					3,50	0,21	12,00	0,72
3.1.5	Mooring Fitting												
	Hawses holes and pipes												
	Chocks	pcs	2,0	10,00	0,02					3,60	0,07	18,50	0,37
	Double bollards	pcs	8,0	3,00	0,02					2,35	0,06	12,00	0,29
	Cleats	pcs	8,0	3,50	0,03					2,45	0,07	12,00	0,34
	Foundations				0,15					2,35	0,35	10,50	1,58
					0,15					2,30	0,35	10,50	1,58
	TOTAL				0,78					3,33	2,61	14,31	11,18



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
3.3	LIFE SAVING EQUIPMENT												
	Life raft												
	automatic inflatable life raft 6 persons supports and accessories	pcs	4,0	25,0	0,10 0,05					5,90 5,90	0,59 0,30	10,80 10,80	1,08 0,54
	Life Saving Inventory												
	Life jackets, life buoys, life belt and accessories				0,05					4,50	0,23	10,80	0,54
	TOTAL				0,20					5,55	1,11	10,80	2,16
3.4	MASTS, FLAG PALE												
	W/H mast with fittings		1,0	160,0	0,16					7,50	1,20	15,00	2,40
	Flag pale		1,0	20,0	0,02	2,0	40			4,00	0,08	0,00	0,00
	Foundations+sundries		1,0	20,0	0,02	1,0	20			7,00	0,14	13,00	0,26
	TOTAL				0,20					7,10	1,42	13,30	2,66
3.5	WINDOWS												
	Bridge deck windows electrical heated 12+6mm	m2	3,0	30,0	0,09					5,30	0,48	17,80	1,60
	Bridge deck windows 12mm	m2	3,0	20,0	0,06					5,30	0,32	15,80	0,95
	Main deck windows for lab and off (700x700mm)	pcs	9,0	20,0	0,18					4,60	0,83	11,00	1,98
	Fixed sidelights	pcs	10,0	30,0	0,30					2,50	0,75	13,00	3,90
	TOTAL				0,63					3,77	2,37	13,38	8,43



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
3.6	HATCHCOVERS, PORTABLE PLATES												
	Portable plate 1.0x1.0m for thruster	pcs	1,0	30,0	0,03					3,80	0,11	16,50	0,50
	Port. plate 1.5X2.0m on main deck for eng.s	pcs	1,0	70,0	0,07					2,30	0,16	4,00	0,28
	TOTAL				0,10					2,75	0,28	7,75	0,78
3.7	DOORS												
	Accommodation access GRP doors	pcs	5,0	50,0	0,25					4,50	1,13	11,50	2,88
	Alluminium doors	pcs	1,0	80,0	0,08					2,50	0,20	11,50	0,92
	TOTAL				0,3					4,02	1,33	11,50	3,80
3.8	MAN HOLES - DRAINING PLUGS												
	Man holes 600x400mm	pcs	10,0	3,5	0,04					1,35	0,05	8,50	0,30
	Draining plugs	pcs	10,0	1,2	0,01					0,15	0,00	10,50	0,13
	TOTAL				0,05					1,04	0,05	9,01	0,42



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	complessive	m	T x m	m	T x m
3.9	LADDERS												
3.9.1	Internal stairs												
	Accommodation stairs	pcs	1,0	45,0	0,05					5,00	0,23	14,00	0,63
3.9.2	External ladders												
	Vertical ladder for top bridge deck	pcs	2,0	20,0	0,04					7,50	0,30	14,00	0,56
	Gangway ladder - 4mt		1	50	0,05					2,50	0,13	30,00	1,50
	TOTAL				0,14					4,81	0,7	19,93	2,7
3.10	RAIL AND STANCHION												
	Deck handrails	ml	28,0	3,8	0,11	1,0	105			3,80	0,40	6,20	0,65
	Bridge deck handrails	ml	20	3,8	0,08	1,0	75			6,00	0,45	9,20	0,69
	Handrails inside accomodations			35,0	0,04	3,0	105			3,80	0,13	12,80	0,45
	TOTAL				0,22					4,57	0,98	8,32	1,79



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard Tonn	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
3.11	NAME, DRAUGHT MARKS AND IDENTIFICATION												
	Bells	pcs	1,0	2,5	0,00					5,00	0,01	8,50	0,02
	Owner's signal steel plate cut-out, bolted and painted			20,0	0,02					5,00	0,10	8,50	0,17
	Ship's name, draught marks			20,0	0,02					2,80	0,06	8,50	0,17
	Identification number and other markings			20,0	0,02					2,80	0,06	8,50	0,17
	Labels			10,0	0,01					2,80	0,03	8,50	0,09
	TOTAL				0,07					3,48	0,25	8,50	0,62
3.13	CRANES												
	Provision and E.R. handling crane with hyd. unit	pcs	1,0	1500,00	1,50					8,00	12,00	11,50	17,25
	Foundations for crane	pcs	1,0	100,00	0,10					6,80	0,68	11,50	1,15
	Accessories			100,00	0,10					6,80	0,68	11,50	1,15
	TOTAL				1,70					7,86	13,36	11,50	19,55
	TOTAL CHAPTER 3				4,41					5,5321	24,40	12,26	54,07



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
4	SHIP'S SERVICES AUXILIARIES												
4.1	PUMPS For BILGE, BALLAST & FIRE/WASH.												
	E/pump bilge/ballast/fire/washing services Q=40m ³ /h - H=70mlc	pcs	2	50	0,10					1,15	0,12	7,20	0,72
4.2	BILGE pump												
	E/pump bilge Q=30m ³ /h - H=30mlc	pcs	1	50	0,05					1,15	0,06	7,20	0,36
	Foundations				0,02					1,20	0,02	14,50	0,29
	TOTAL				0,17					1,16	0,20	8,06	1,37
4.4	FRESH WATER AND DISTILLED SERVICE WATER												
	Water hydrophore system 150 lt capacity	pcs	1	60	0,06					1,80	0,11	8,00	0,48
	Fresh water e/pump Q=2m ³ /h - H=35mlc	pcs	2	10	0,02					1,20	0,02	8,00	0,16
	E/pump for hot water circulation service Q=1m ³ /h - H=35mlc	pcs	2	10	0,02					1,20	0,02	8,00	0,16
	Electric Water heater 100 lt stainless steel AISI 316 foundations	pcs	1	20	0,02					1,80	0,04	8,00	0,16
	TOTAL				0,17					1,48	0,25	8,00	1,36
4.6	SEWAGE TREATMENT												
	Sewage treatment system	pcs	1	300	0,30					1,60	0,48	8,00	2,40
	Stainless steel garbage disposer	pcs	1	10	0,01					1,80	0,02	8,00	0,08
	TOTAL				0,31					1,61	0,50	8,00	2,48



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
4.7	FIRE EXTINGUISHING SYSTEMS AND FIRE DETECTION SYSTEM												
4.7.1	CO2 Fire Fighting System												
	CO2 System for E.R.	pcs	1	150	0,15					6,00	0,90	10,20	1,53
	Foundations			50	0,05					6,00	0,30	10,20	0,51
4.7.2	Sea water Fire Fighting System												
	Internal baskets for hoses+hoses	pcs	2	15	0,03					1,80	0,05	12,00	0,36
	Internal boxes+ hoses	pcs	2	15	0,03					6,00	0,18	17,50	0,53
	External boxes + hoses	pcs	3	15	0,05					5,00	0,23	9,50	0,43
	Supports and foundations				0,03					4,00	0,12	12,50	0,38
4.7.3	Loose firefighting equipment												
	Fire fighting equipment	pcs	1	30	0,03					3,80	0,11	10,80	0,32
	EEBDs	pcs	5	3	0,02					3,80	0,06	10,80	0,16
	Portable extinguishers - all inclusive			50	0,05					4,50	0,23	16,00	0,80
	Sundries				0,05					12,00	0,60	19,80	0,99
	TOTAL				0,48					5,78	2,78	12,51	6,00
4.7.4	Smoke Detector System and Fixed Gas System												
	Smoke detector system for ER and accommodation with cables and supports	pcs	1	50	0,05					5,00	0,25	16,50	0,83



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Codice	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
4.7.5	High Fog Extinguishing System												
	Equipment			150	0,15					12,00	1,80	19,80	2,97
	Pump			50	0,05					12,00	0,60	19,80	0,99
	Fresh water tank			250	0,25					12,00	3,00	19,80	4,95
	Foundations			100	0,1					10,70	1,07	19,80	1,98
	TOTAL				0,60					11,20	6,72	19,53	11,72
4.8	FUEL OIL TRANSFER												
	Fuel oil transfer IMO type screw pump Q=2.5m ³ /h - H=25m/c	pcs	2	20	0,04					1,20	0,05	15,00	0,60
	TOTAL				0,04					1,20	0,05	15,00	0,60
4.12	LOW PRESSURE AIR COMPRESSORS												
	Electric compressor 50m ³ /h 8bar	pcs	1	50	0,05					1,50	0,08	11,00	0,55
	Ship service air vessel 50 lt 8 bar	pcs	2	40	0,08					1,50	0,12	11,00	0,88
	Air absorption dryer filter	pcs	1	20	0,02					1,50	0,03	11,00	0,22
	Foundations				0,05					1,50	0,08	11,00	0,55
	TOTAL				0,20					1,50	0,30	11,00	2,20
	TOTAL CHAPTER 4				1,97					5,4769	10,79	13,06	25,73



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera Per ton. complessive	L.C.		Pp	
									m	T x m	m	T x m
5	HULL PIPING											
5.1	GENERAL											
5.2/5.3	BILGE AND BALLAST SERVICE											
	Ballast pipes, valves and fittings sundries		150 20	0,15 0,02					1,60 1,60	0,24 0,03	11,00 11,00	1,65 0,22
	TOTAL			0,17					1,60	0,27	11,00	1,87
5.4	DOMESTIC WATER SERVICE SYSTEM											
	Cold/hot fresh water pipes, valves and fittings Supports and clamps Sundries		350 20 20	0,35 0,02 0,02					3,50 3,50 3,50	1,23 0,07 0,07	15,00 15,00 15,00	5,25 0,30 0,30
	TOTAL			0,39					3,50	1,37	15,00	5,85
5.5	FIRE EXTINGUISHING SYSTEM											
	Fire and wash deck pipes, fittings, valves Supports, clamps		100 20	0,10 0,02					3,80 3,80	0,38 0,08	15,00 15,00	1,50 0,30
5.6	High Fog extinguishing system											
	High fog extinguishing system pipes Valves - supports - clamps		80 50	0,08 0,05					3,80 3,80	0,30 0,19	8,00 8,00	0,64 0,40
	TOTAL			0,25					3,80	0,95	11,36	2,84



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
5.7	AIR VENTS AND SOUNDING PIPES												
	Air vent and sounding pipes												
	Air vents + Sounding		75	0,08						3,80	0,29	12,00	0,90
	Sundries		25	0,03						3,80	0,10	12,00	0,30
	Remote level System												
	for WB tanks	pcs	2	5	0,01					0,75	0,01	14,00	0,14
	for MDO tanks	pcs	8	5	0,04					0,75	0,03	6,00	0,24
	for fresh water tanks	pcs	2	5	0,01					0,75	0,01	13,00	0,13
	TOTAL				0,16					2,66	0,43	10,69	1,71
5.8	SCUPPERS AND SANITARY DISCHARGES, SEWAGE												
	Sanitary discharges water on superstructure												
	Scuppers internal and external												
	Sewage pipes on superstructure												
	Sewage pipes in E.R.												
	Valves and fittings												
	Supports and clamps												
	TOTAL				0,17					2,30	0,39	13,00	2,21



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Cd	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera Per ton. compressive	L.C.		Pp	
									m	T x m	m	T x m
5.9	FUEL OIL SYSTEM											
	MDO transfer		100	0,10					2,20	0,22	6,50	0,65
	valves - supports - clamps		50	0,05					2,20	0,11	6,50	0,33
	TOTAL				0,15				2,20	0,33	6,50	0,98
5.10	COMPRESSED AIR SYSTEM FOR HULL SERVICE											
	Compressed air pipes, valves		50	0,05					2,50	0,13	6,00	0,30
	Fittings, supports, clamps		10	0,01					2,50	0,03	6,00	0,06
	TOTAL				0,06				2,50	0,15	6,00	0,36
	TOTAL CHAPTER 5				1,35				2,8763	3,88	11,71	15,82



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard kg	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
	<u>6 - VENTILATION AND AIR CONDITIONING</u>												
	Air conditioning plant		1	270	0,27					4,50	1,22	13,00	3,51
	Pantry exhauster		1	10	0,01					6,75	0,07	17,00	0,17
	W.C. Exhaust		5	5	0,03					4,50	0,11	14,00	0,35
	Venting ducts intreatment room (in linemeter)		1	170	0,17					6,00	1,02	15,00	2,55
	Air intake grating		2	40	0,08					7,00	0,56	14,40	1,15
	TOTAL				0,56					28,75	2,98	13,93	7,73
	TOTAL CHAPTER 6				0,56					5,36	2,98	13,93	7,73



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.6	TRANSFORMER												
	General use transformer AC 440/220V												
	Transformer supplied the total 220V distribution system, three phase 440/220V		1	40	0,04					4,50	0,18	14,00	0,56
	Emergency transformer AC 440/220V												
	Transformer supplied the total 220V emergency distribution system, three phase 440/220V		1	40	0,04					4,50	0,18	14,00	0,56
	TOTAL				0,08					4,50	0,36	14,00	1,12
7.6	STORAGE BATTERY, BATTERY SWITCHBOARD												
	General use battery												
	Storage battery set 24V for main engine starting	pcs	1	160	0,16					3,00	0,48	14,00	2,24
	Storage battery set 24V for navigation, communication and automation equipment, engine starting and general use	pcs	1	160	0,16					3,00	0,48	14,00	2,24
	Battery system for emergency	pcs	1	100	0,10					4,50	0,45	12,00	1,20
	Battery switchboard												
	Dead-front type battery switchboard	pcs	1	50	0,05					4,50	0,23	12,00	0,60
	Battery Charger System												
	Battery charge system	pcs	1	100	0,10					4,50	0,45	12,00	1,20
	TOTAL				0,57					3,66	2,09	13,12	7,48



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.14	LIGHTING INSTALLATION												
7.14.1	General												
7.14.2	Machinery space's Lighting												
	Waterproof lighting fixtures, switches and device			50	0,05					3,70	0,19	12,50	0,63
	Supports, device			25	0,03					3,70	0,09	12,50	0,31
7.8.7	Lighting - Lab. & Accommodation Space												
	Waterproof and common lighting fixtures, switches and device			50	0,05					6,80	0,34	17,50	0,88
	cables, supports, device and lamps			25	0,03					6,80	0,17	17,50	0,44
7.14.4	Deck's Lighting												
	Waterproof lighting fixtures, switches and device		8	10	0,01					5,50	0,06	14,50	0,15
	Supports			10	0,01					8,00	0,08	14,00	0,14
	Special lighting												
	Chart table lamp, instrument lamp and sight glass light			50	0,05					7,00	0,35	16,00	0,80
	Switch												
	Switches for lighting branch circuit, bed lights, ceiling lights, engine room lights, passage lights.			50	0,05					7,00	0,35	15,50	0,78
	TOTAL				0,27					6,01	1,62	15,22	4,11



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								Per ton.	compressive	m	T x m	m	T x m
7.15	PROJECTORS												
	Deck's Lighting												
	300W halogen type for liferaft/launching area		2	10	0,02					9,10	0,18	17,50	0,35
	1000W floodlight on the top of W/H		4	10	0,04					9,10	0,36	16,50	0,66
	Waterproof lighting fixtures, switches and device 1000W floodlight on the mast		2	10	0,02					12,00	0,24	15,00	0,30
	500W on mooring area aft		2	10	0,02					7,30	0,15	9,50	0,19
	Waterproof ALDIS lamp type portable daylight signal light with storage case and dedicated rechargeable battery			10	0,01					9,80	0,10	18,00	0,18
	Waterproof lighting fixtures, switches and device Supports		8	5	0,01					5,50	0,03	14,50	0,07
				150	0,15					8,00	1,20	14,00	2,10
	TOTAL				0,27					8,52	2,26	14,54	3,85
7.16	EMERGENCY LIGHTING												
	General												
	Waterproof and common lighting fixtures, switches and device			30	0,03					7,20	0,22	12,50	0,38
	cables, supports and devices			10	0,01					7,20	0,07	12,50	0,13
	Transient Emergency Light												
	DC 24V transient emergency lighting fro chart space, W/H, main generator, main switchboard			30	0,03					7,20	0,22	12,50	0,38
	TOTAL				0,07					7,20	0,50	12,50	0,88



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								Per ton.	compressive	m	T x m	m	T x m
7.17	SOCKETS												
	Socket plugs												
	AC 230V Three pole DIN type socket plugs for general users			30	0,03					18,50	0,56	21,20	0,64
	AC 380V Watertight socket plugs for electric welder machine in ER workshop, forecastle, cargo hose crane, poop deck aft		4	7	0,03					11,00	0,31	64,50	1,81
	TOTAL				0,06					14,88	0,86	42,10	2,44
7.18	NAVIGATION LIGHT AND SIGNAL EQUIPMENT												
	Navigation lights												
	Navigation lights and signals, switches, device and shunts' boxes (two waterproof sets)			30	0,03					26,50	0,80	64,50	1,94
	Cables' supports, device, lamps and lights' supports			100	0,10					26,50	2,65	64,50	6,45
	Navigation lights indicating Panel												
	Panel with mimic diagram recessed			10	0,01					26,00	0,26	20,50	0,21
	Signal lights general												
	Anchor lights, Not-under Command Lights, Restricted maneuverability lights, towing lights, steering light			10	0,01					26,00	0,26	20,50	0,21
	TOTAL				0,15					26,43	3,97	58,63	8,80



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№	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
	TOTAL				0,00					#DIV/0!	0,00	#DIV/0!	0,00
7.20	WHISTLE AND SYRENS COLREG 1972												
	Electric operated typhoon foundations	pcs	1	30	0,03 0,02					8,60 8,60	0,26 0,13	15,00 15,00	0,45 0,23
	TOTAL				0,05					8,60	0,39	15,00	0,68
7.21	FIRE DETECTION, FIRE AND GENERAL ALARM SYSTEM												
	Fire detection system												
	Panels in W/H, ER; waterproof and non-waterproof visual and acoustic fire alarms, cables and fittings			20	0,02					6,60	0,13	16,50	0,33
	Fire and general alarm system												
	Main control switch in W/H call points, alarm bells, cables and fittings			20	0,02					6,60	0,13	16,50	0,33
	Other calling and alarm systems												
	Panels, bells, visual and acoustic alarm/calling systems for dead man alarm, engineers calling, bridge alarm, alarm handling.			20	0,02					6,60	0,13	16,50	0,33
	CO2 alarm see 7.14.8												
	TOTAL				0,06					6,60	0,40	16,50	0,99



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.22	AUTOMATIC TELEPHONE Automatic telephone system with thirty circuits, sockets, clakson, connection and distribution boxes, sockets for external connections Feeding and distribution cables Cables' and devices' supports			30 30 30	0,03 0,03 0,03					7,00 7,00 7,00	0,21 0,21 0,21	17,50 17,50 17,50	0,53 0,53 0,53
7.24	PUBLIC ADDRESS Master station and control panel with amplifier, ratio tuner and CD player; amplifiers, microphones, reversible and undirectional loudspeakers, waterproof boxes,sockets, push buttons. Feeding and distribution cables, supports.			50	0,05					7,00	0,35	17,50	0,88
	TOTAL				0,14					7,00	0,98	17,50	2,45
7.25/26	Radio/TV/VSAT/Mobilephone system TV, Radio and TVSAT antennas ColorTV, DVD, stereo (supplied by owner), sockets, cables			50 20	0,05 0,02					26,00 18,00	1,30 0,36	19,80 19,80	0,99 0,40
	TOTAL				0,07					23,71	1,66	19,80	1,39



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.27	COMMUNICATION EQUIPMENT												
	Radio Plant + EPIRB												
	GMDSS system including all the accessories												
	Satellite emergency position indicator EPIRB float free type			50	0,05					4,50	0,23	16,50	0,83
	VHF Radio telephone												
	Auxiliary VHF radio telephone set for WH			20	0,02					7,00	0,21	15,00	0,45
	TOTAL									5,75	0,58	15,75	1,58
7.28	ECHO-SOUNDER SYSTEM												
	Transducer, graphic and digital repeater with alarms. Depth range 400m. 200 KHz frequency			20	0,02					7,40	0,15	18,00	0,36
	Feeding and distribution cables			20	0,02					5,50	0,11	18,00	0,36
	TOTAL									6,45	0,26	18,00	0,72



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.29	SPEED LOG												
	One set of dual axis doppler speed log system with speed and distance indicator. Repeaters and unit interfaced with radar.			20	0,02					2,80	0,06	19,00	0,38
	Feeding and distribution cables			100	0,10					5,50	0,55	18,00	1,80
	Cables' and devices' supports, valves, etc.			100	0,10					5,50	0,55	18,00	1,80
	TOTAL				0,22					5,25	1,16	18,09	3,98
7.30	RADAR PLANT												
	X-band, 9" wave lenght radar set			30	0,03					10,50	0,32	15,50	0,47
	Interswitch set			10	0,01					8,00	0,08	18,00	0,18
	Feeding and distribution cables			20	0,02					8,90	0,18	18,00	0,36
	Cables supports and devices			10	0,01					8,50	0,09	18,00	0,18
	TOTAL				0,07					9,40	0,66	16,93	1,19
7.31	Magnetic compass												
	Magnetic compass with reflector and pedestal			10	0,01					9,00	0,09	17,50	0,18
	Spare compass bowl, spare cards with floater and spare auxiliary compass			5	0,01					8,00	0,04	17,50	0,09
	Helmet of fiberglass, supports and fittings			10	0,01					9,00	0,09	17,50	0,18
	TOTAL				0,03					8,80	0,22	17,50	0,44
7.32	Autopilot												
	Adaptive digital heading type autopilot with off-course alarm			30	0,03					8,00	0,24	17,50	0,53
	cable and supports			10	0,01					7,50	0,08	17,50	0,18
	TOTAL				0,04					7,88	0,32	17,50	0,70



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.33	Propulsion angle Indicating												
	Transmitter, indicators in W/H, steering gear room			10	0,01					8,00	0,08	15,80	0,16
	Feeding cables and hunts boxes			10	0,01					7,20	0,07	15,80	0,16
	Cables' and devices' supports			10	0,01					7,20	0,07	15,80	0,16
	TOTAL				0,03					7,47	0,22	15,80	0,47
7.34	DGPS Navigators												
	DGPS satellite navigation system	2pcs		15	0,02					8,00	0,12	17,00	0,26
	cable and supports			10	0,01					8,00	0,08	15,00	0,15
	TOTAL				0,03					8,00	0,20	16,20	0,41



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.35	Navigation AIDS												
	One set of navigation aids system complete with antenna.			10	0,01					8,00	0,08	15,00	0,15
	Cables' and devices' supports .			20	0,02					8,00	0,16	15,00	0,30
7.36	Facsimile recorder												
	frequency synthesized type weather facsimile recorder with cables and fittings			20	0,02					8,00	0,16	15,00	0,30
7.37	NAVTEX receiver												
	NAVTEX receiver for reception of navigational and meteorological warnings			20	0,02					8,00	0,16	15,00	0,30
7.38	Anemometer and anemoscope												
	Wind speed and direction indicator with lamp and dimmer switch, cables and fittings			15	0,02					10,50	0,16	17,00	0,26
	TOTAL				0,09					8,44	0,72	15,35	1,31
7.40	WINDOW WIPERS												
	Window wipers included moving device for W/H		3	5	0,02					5,30	0,08	17,50	0,26
	Cables' and devices' supports .		1	10	0,01					5,30	0,05	17,50	0,18
	TOTAL				0,03					5,30	0,13	17,50	0,44



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
7.41	ELECTRICAL DRAINAGE AN HULL HEARTENING												
	Steel connections for grounding and heartening			30	0,03					3,80	0,11	12,50	0,38
	TOTAL				0,03					3,80	0,11	12,50	0,38
7.42	EMERGENCY STOP SYSTEM												
	emergency stop systems with cables, supports and devices			300	0,30					4,50	1,35	16,00	4,80
	TOTAL				0,30					4,50	1,35	16,00	4,80
7.43	NAVIGATION CONSOLE												
	Navigation's W/H console			180	0,18					4,20	0,76	18,00	3,24
	TOTAL				0,18					4,20	0,76	18,00	3,24
	TOTAL CHAPTER 7				3,96					6,53	25,86	16,75	66,31



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Art.	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	complessive	m	T x m	m	T x m
8	ACCOMMODATIONS AND FURNITURE												
8.1	GENERAL ARRANGEMENT												
8.1	WALLS AND PANEL												
	Panel				0,50					7,30	3,65	17,00	8,50
	Ceiling				0,20					7,35	1,47	17,25	3,45
	TOTAL				0,70					7,31	5,12	17,07	11,95
8.3	INTERIOR DOORS												
	Internal Doors		3	29	0,09					4,35	0,38	17,50	1,52
	TOTAL				0,09					4,35	0,38	17,50	1,52
8.4	FOUR BED CREW & SCIENTISTICS CABIN												
	Bed 2000x930 with two lower drawers and life jacket housing		12	0	0,00					0,00	0,00	0,00	0,00
	One door cupboard with drawers, mirror		5	0	0,00					0,00	0,00	0,00	0,00
	Coat hook with two hooks		12	0	0,00					0,00	0,00	0,00	0,00
	Curtain and rolling deadlight		1	0	0,00					0,00	0,00	0,00	0,00
	TOTAL		1	500	0,50					4,35	2,18	18,00	9,00



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Art.	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	complessive	m	T x m	m	T x m
8.5	DINETTE/GALLEY ROOM												
	One 5places table a of melamine laminated plastic		1	0	0,00					0,00	0,00	0,00	0,00
	Angle seats settees for 10 pers.		1	0	0,00					0,00	0,00	0,00	0,00
	Bookcase with overhanging unit for radio set, TV and video recorders		1	0	0,00					0,00	0,00	0,00	0,00
	Wall cupboard		1	0	0,00					0,00	0,00	0,00	0,00
	coat hook		12	0	0,00					0,00	0,00	0,00	0,00
	Rolling deadlight		1	0	0,00					0,00	0,00	0,00	0,00
	Stainless steel bench with two tubs, shelves, drawer and doors beneath		1	0	0,00					0,00	0,00	0,00	0,00
	Cup board		1	0	0,00					0,00	0,00	0,00	0,00
	Cup rack		1	0	0,00					0,00	0,00	0,00	0,00
	Stainless steel refrigerator 100lit two doors		1	0	0,00					0,00	0,00	0,00	0,00
	One electric range of 2kW , with anti-rolling bars in stainless stee.		1	0	0,00					0,00	0,00	0,00	0,00
	TOTAL		1	400	0,40					4,35	1,74	17,50	7,00



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A#	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
8.6	W/H , CHART AND RADIO ROOM												
	Wheelhouse room												
	Control /signalling console		1	0	0,00					0,00	0,00	0,00	0,00
	Two pit stalls with adjustable seat back, feet rest and adjustable height device		2	0	0,00					0,00	0,00	0,00	0,00
	Sideboards with drawers		2	0	0,00					0,00	0,00	0,00	0,00
	Binocular boxes		3	0	0,00					0,00	0,00	0,00	0,00
	Locker with shelves for 56 flags		1	0	0,00					0,00	0,00	0,00	0,00
	Two armchairs for navigation		1	0	0,00					0,00	0,00	0,00	0,00
	coat hooks etc.		1	0	0,00					0,00	0,00	0,00	0,00
	Office												
	Large chart table included 4 drawers,closed by door space and chronometer compartment		1	0	0,00					0,00	0,00	0,00	0,00
	Bookshelf with a small armchair		1	0	0,00					0,00	0,00	0,00	0,00
	Settee		1	0	0,00					0,00	0,00	0,00	0,00
	Coat hooks etc.		1	0	0,00					0,00	0,00	0,00	0,00
	TOTAL		1	300	0,30					6,70	2,01	16,00	4,80



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A#	OBJECT & FEATURE	TYPE	Quantity m²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
8.7.1	TOILET ROOMS												
	Cabin's toilet room												
	Toilet cabin with WC, shower and sink	pcs	3	100	0,30					4,50	1,35	18,50	5,55
8.7.2	Public toilet												
	Public toilet with WC and sink	pcs	2	80	0,16					5,10	0,82	13,00	2,08
	TOTAL				0,46					4,71	2,17	16,59	7,63
8.10	MISCELLANEOUS ITEMS												
	Plastic labels for doors and s/s indication plates			10	0,01					5,50	0,06	18,00	0,18
	Frames and paintings			30	0,03					5,50	0,17	18,00	0,54
	Foundations and supports			20	0,02					5,50	0,11	18,00	0,36
	Severals reserves			20	0,02					5,50	0,11	18,00	0,36
	TOTAL				0,08					5,50	0,44	18,00	1,44
	TOTAL CHAPTER 8				2,53					5,55	14,03	17,15	43,34



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Art.	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	complessive	m	T x m	m	T x m
9	INVENTORY												
9.1	GENERAL												
9.2	AWNING AND CANVAS COVERING												
	Canvas covers for equipments and fittings on weather deck			50,0	0,05					8,00	0,40	15,00	0,75
	TOTAL				0,05					8,00	0,40	15,00	0,75
9.2	FLAGS AND SIGNALS												
	Flags' sets			10	0,01					8,00	0,08	17,65	0,18
	TOTAL				0,01					8,00	0,08	17,65	0,18
9.4	SIGNALS (WHEELHOUSE)												
	Aids' signals line throwers, parachute signals, hand flares, smoke signals, shapes according to the rules			30	0,03					7,50	0,23	17,65	0,53
	TOTAL				0,03					7,50	0,23	17,65	0,53

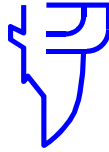


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A7	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
9.5	NAVIGATION AND NAUTICAL INSTRUMENTS												
	Stop-watch, barometers, thermometers for sea water and atmosphere, megaphones, clinometers, leas, barograph, log with line, precision chronometer, salinometers, binoculars for nightlight			20	0,02					7,50	0,15	17,00	0,34
	TOTAL				0,02					7,50	0,15	17,00	0,34
9.6	SPARE PARTS												
	BOATSWAIN'S AND CARPENTER'S												
	Boatswain's and carpenter's inventory			50	0,05					4,90	0,25	21,00	1,05
	ELECTRICIAN WORKSHOP INVENTORY												
	Electrician workshop inventory			50	0,05					2,50	0,13	12,50	0,63
	ROPE STORE												
	Rope store's fittings			30	0,03					4,90	0,15	21,00	0,63
	TOTAL				0,13					3,98	0,52	17,73	2,31
9.13	OWNER'S SUPPLY												
	Severals			50	0,05					4,50	0,23	15,50	0,78
	TOTAL				0,05					4,50	0,23	15,50	0,78
	TOTAL CHAPTER 9				0,29					5,51	1,60	16,81	4,88



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard kg	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
11	PROPULSION												
11.1/2	MAIN GENSETS - FUNCTIONALITY												
11.3	MAIN ENGINES												
	Main engine for genset		2	2000	4,00					1,39	5,54	9,78	39,10
	Main engines fittings		2	100	0,20					1,25	0,25	9,78	1,96
	Generators		4	250	1,00								
	VULKAN flexible coupling		4	50	0,20					1,23	0,25	8,75	1,75
	On port generaor 40kW		1	80	0,08					1,23	0,10	8,75	0,70
	TOTAL				5,40					1,07	5,79	7,60	41,06
11.4	PROPULSION SYSTEM												
	Propulsion system		2	2100	4,20					1,01	4,24	8,00	33,60
	Electrical motor		4	250	1,00					0,95	0,95	8,00	8,00
	VULKAN flexible coupling		2	250	0,50					1,23	0,62	8,75	4,38
	TOTAL				5,70					1,02	5,81	8,07	45,98
11.3	THRUSTER												
	Bow thruster with flexible coupling engine/reduction gear		1	300	0,30					0,00	0,00	15,35	4,61
	Electrical motor 700Nm@1500rpm		1	120	0,12					1,24	0,15	15,00	1,80
	TOTAL				0,42					0,35	0,15	15,25	6,41
11.4	SPARE PARTS - TOOLS												
	See 11.1,11.2,11.3												
TOTAL CHAPTER 11										1,02	11,75	8,11	93,44



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A#	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
16	ENGINE ROOM VENTILATION												
13	ENGINE ROOM VENTILATION												
	Axial fan for E.R. 20.000m ³ /h-600MPa		2	50	0,10					7,50	0,75	15,00	1,50
	Venting ducts in E.R. (in linermeter)		35	2,5	0,09					3,60	0,32	12,00	1,05
	TOTAL				0,19					5,68	1,07	13,60	2,55
TOTAL CHAPTER 13										5,68	1,07	13,60	2,55

Cd	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
18	MISCELLANEOUS												
18.1	FLOORS, GRATINGS AND LADDERS												
18.1.1	General												
18.1.2	Engine room floor, platforms and gratings												
	Alluminium alloy plate supported by steel angle frames, platform for main engine			300,00	0,30				1,20	0,36		13,25	3,98
	TOTAL				0,30				1,20	0,36		13,25	3,98
18.2	WORKSHOP MACHINERY												
18.2.1	General												
9.11	ENGINE ROOM WORKSHOP INVENTORY												
	E.R. Workshop inventory			100	0,10				12,00	1,20		16,22	1,62
	TOTAL				0,10				12,00	1,20		16,22	1,62
3.22	LIFTING ARRANGEMENT IN ENGINE ROOM												
	Lifting beams rails fitted with trolleys for main engines 100 kg capacity	pcs	2,0	20,00	0,04							12,95	0,52
	Eye plates near shafting and machines			100,0	0,10							12,00	1,20
	Pad eyes			100,0	0,10							12,00	1,20
	TOTAL				0,24				3,13	0,75		12,16	2,92
	TOTAL CHAPTER 14				0,64				3,61	2,31		13,30	8,52



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Az	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
15	PIPING SYSTEM												
15.2	SEA WATER COOLING SYSTEM												
	Two sea chest . Before and after butterfly valves and cross manifolds in galvanized steel. Electrolytic anti-fouling system shall be fitted												
	Sea water central cooling system pipes, valves and fittings			250	0,25					0,80	0,20	14,00	3,50
	Sea chest		2	25	0,05					0,95	0,05	14,00	0,70
	Supports and clamps			20	0,02					1,50	0,03	15,00	0,30
	Sundries			20	0,02					1,50	0,03	15,00	0,30
	TOTAL				0,34					0,90	0,31	14,12	4,80
15.2	FRESH WATER COOLING SYSTEM												
	Pipes for FW cooling system, valves, fittings and flanges			80	0,08					1,80	0,14	14,00	1,12
	Supports, clamps			20	0,02					1,80	0,04	14,00	0,28
	TOTAL				0,10					1,80	0,18	14,00	1,40
153	MDO												
	MDO pipes, valves and fittings			50	0,05					1,80	0,09	14,00	0,70
	Supports and clamps			20	0,02					1,80	0,04	14,00	0,28
	TOTAL				0,07					1,80	0,13	14,00	0,98
15.4	LUBRICATING OIL												
	Lubricating oil pipes in ER, valves and fittings			120	0,12					1,20	0,14	14,00	1,68
	Supports and clamps			30	0,03					1,20	0,04	14,00	0,42
	TOTAL				0,15					1,20	0,18	14,00	2,10



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A#	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard T	Price per unit	Total price	Giornate manodopera		L.C.		Pp	
								Per ton.	compressive	m	T x m	m	T x m
15.5	EXHAUST GAS SYSTEM												
	Ducts and accessories for exhaust gas system for main engines/gensets - Pipes in steel			200	0,20					5,90	1,18	13,20	2,64
	Expansion joints in stainless steel - elastic supports			20	0,02					5,90	0,12	13,20	0,26
	Silencer and parafavillas			100	0,10					5,90	0,59	13,20	1,32
	Supports and clamps			30	0,03					1,50	0,05	15,00	0,45
	TOTAL				0,35					5,52	1,93	13,35	4,67
15.6	INSULATION AND LAGGING												
	Insulations			50	0,05					5,90	0,30	13,20	0,66
	Supports, severals			20	0,02					5,90	0,12	13,20	0,26
	TOTAL				0,07					5,90	0,41	13,20	0,92
	TOTAL CHAPTER 15				1,08					2,91	3,14	13,78	14,88



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№	OBJECT & FEATURE	TYPE	Quantity m ²	Unit weight kg	Netweight onboard t	Price per unit	Total price	Glornate manodopera		L.C.		Pp	
								Per ton.	comprehensive	m	T x m	m	T x m
15	RESEARCH EQUIPMENT												
15.1	LATERAL REACHER'S CRANE												
	Lateral reacherc's crane with hyd. Unit	pcs	1,0	300,00	0,30					4,50	1,35	7,50	2,25
	Foundations for crane	pcs	1,0	100,00	0,10					3,50	0,35	7,50	0,75
	Accessories			50,00	0,05					4,50	0,23	7,50	0,38
	TOTAL				0,45					4,28	1,93	7,50	3,38
15.2	AFT REACHER'S CRANE												
	Aft reacherc's crane with hyd. Unit	pcs	1,0	400,00	0,40					5,50	2,20	1,00	0,40
	Foundations for crane	pcs	1,0	100,00	0,10					3,50	0,35	1,00	0,10
	Accessories			75,00	0,08					5,50	0,41	1,00	0,08
	TOTAL				0,58					5,15	2,96	1,00	0,58
15.3	Capstan winch for lateral crane												
	Capstan winch on bridge deck 1 ton.	pcs	1,0	150,00	0,15					6,00	0,90	7,50	1,13
	Accessories for winch				0,20					6,00	1,20	7,50	1,50
	Hydr. Power unit aft capstan	pcs	1,0	75,00	0,08					1,70	0,13	3,00	0,23
	Mooring winch + pump foundations			200,00	0,20					1,70	0,34	3,00	0,60
	TOTAL				0,63					4,108	2,57	5,52	3,45
15.4	Capstan winch for aft crane												
	Capstan winch on bridge deck 1.5 ton.	pcs	1,0	150,00	0,15					6,00	0,90	5,50	0,83
	Accessories for winch				0,20					6,00	1,20	5,50	1,10
	Hydr. Power unit aft capstan	pcs	1,0	75,00	0,08					1,70	0,13	3,00	0,23
	Mooring winch + pump foundations			200,00	0,20					1,70	0,34	3,00	0,60
	TOTAL				0,63					4,108	2,57	4,4	2,75
TOTAL CHAPTER 15					2,28					1,13	2,57	1,52	3,45

Analysis parameters

Bare-hull	[Calc] Savitsky planing	Appendage	[Calc] Radojicic planing
Friction line	ITTC	Wind	[Calc] Taylor head wind
Technique	Prediction	Seas	[Off]
Align to	[Off]	Channel	[Off]
Align by	[Off]	Misc: Margin	[Calc] - 8% Hull drag only
Correlation allowance	0.0004	Water type	Standard Salt
Roughness (mm)	[On] 0.4	Mass density	1025.86 [kg/m3]
Blount mult.	[Off] 0.5	Kinematic viscosity	1.1883e-06 [m2/s]

Prediction results

Vel [kts]	Fv	Fn	Rn	Cf	Trim [deg]	Lk/Lch	Stability
7.00	0.604	0.267	9.26e+7	0.002107	1.389	2.653	Stable
8.00	0.690	0.305	1.05e+8	0.002069	1.426	2.613	Stable
9.00	0.776	0.343	1.17e+8	0.002037	1.465	2.571	Stable
10.00	0.862	0.381	1.29e+8	0.002010	1.508	2.527	Stable
11.00	0.949	0.419	1.40e+8	0.001986	1.554	2.480	Stable
12.00	1.035	0.457	1.50e+8	0.001966	1.605	2.431	Stable
13.00	1.121	0.496	1.60e+8	0.001948	1.659	2.380	Stable
14.00	1.207	0.534	1.70e+8	0.001932	1.718	2.326	Stable
15.00	1.294	0.572	1.79e+8	0.001918	1.781	2.271	Stable
16.00	1.380	0.610	1.87e+8	0.001906	1.850	2.213	Stable

Vel [kts]	Mult	Lift [N]	LCElift [m]	Rbare/W	Rbare [N]	PEbare [kW]	Req1 [N]
7.00	1.000	480124	10.410	0.03444	16552	60	17787
8.00	1.000	480072	10.406	0.03794	18231	75	19650
9.00	1.000	480012	10.401	0.04178	20075	93	21690
10.00	1.000	479945	10.396	0.04594	22074	114	23898
11.00	1.000	479869	10.390	0.05041	24223	137	26267
12.00	1.000	479783	10.384	0.05516	26507	164	28786
13.00	1.000	479688	10.378	0.06017	28914	193	31439
14.00	1.000	479583	10.371	0.06542	31434	226	34218
15.00	1.000	479467	10.364	0.07086	34052	263	37108
16.00	1.000	479339	10.356	0.07649	36756	303	40097

Vel [kts]	Rapp [N]	Rwind [N]	Rseas [N]	Rchan [N]	Rmisc [N]	Rtotal [N]	PEtotal [kW]
7.00	0	1235	0	0	1324	19111	69
8.00	0	1419	0	0	1458	21108	87
9.00	0	1615	0	0	1606	23296	108
10.00	0	1823	0	0	1766	25664	132
11.00	0	2045	0	0	1938	28205	160
12.00	0	2279	0	0	2121	30906	191
13.00	0	2525	0	0	2313	33752	226
14.00	0	2785	0	0	2515	36733	265
15.00	0	3057	0	0	2724	39832	307
16.00	0	3341	0	0	2940	43038	354

Vel [kts]	FlapL [N]	FlapD [N]	FlapM [Nm]
7.00	0	0	0
8.00	0	0	0
9.00	0	0	0
10.00	0	0	0
11.00	0	0	0
12.00	0	0	0
13.00	0	0	0
14.00	0	0	0

15.00	0	0	0
16.00	0	0	0

Hull data

General:

Length between PP	18.575 [m]
WL bow pt aft FP	0.000 [m]
Length on WL	18.575 [m]
Max beam on WL	6.700 [m]
Max molded draft	1.250 [m]
Displacement bare	49.00 [t]
Wetted surface	89.500 [m2]
Chine type	Hard chine

Parameters:

Lwl/B	2.7724
B/T	5.36
Cb	0.307
Cws	3.0047

Planing:

Proj chine length	17.847 [m]
Max chine beam	6.700 [m]
Proj bottom area	93.230 [m2]
Deadrise midchine	23.000 [deg]
LCG fwd transom	10.490 [m]
VCG above BL	2.800 [m]
Shaft angle to BL	0.000 [deg]
VCE above BL	0.000 [m2]
LCE fwd transom	0.000 [m]
Number of flaps	2
Flap chord length	0.500 [m]
Flap span	14.500 [m]
Flap angle	0.000 [deg]
Flap location	Under hull

Parameters: **Savitsky planing**

Fn(Bch)	0.797...13	0.4	Limit
Fn-high	0.797...13	1.0	
LCG/Bch	0.6...3	1.57	
Clb-high	0...0.5	0.31	
Deadrise	0...30	23.0	

Appendages

Extended appendages:

Front transv area	0.000 [m2]
Drag coefficient	0.0000

Shafts/struts:

Number of propellers	0
Propeller diam	0.000 [m]
Shaft/boss length	0.000 [m]
Shaft/boss diam	0.000 [m]
Shaft angle to BL	0.000 [deg]
Strut T/C ratio	0.000
Strut proj area	0.000 [m2]
Mean strut chord	0.000 [m]
Strut type	Single strut
Palm thickness	0.000 [m]
Trans palm width	0.000 [m]

Rudders/skegs:

Number of rudders	0
T/C ratio	0.0000
Rudder proj area	0.000 [m2]
Mean rudder chord	0.000 [m]
Rudder location	Behind prop
Skeg proj area	0.000 [m2]
Skeg length	0.000 [m]

Appendage parameters:

VCE above BL	0.000 [m]
LCE fwd transom	0.000 [m]
Drag multiplier	1.000

Parameters: **Radojic planing**

Speed(Kts)	0...33	16.0
No. props	2...2	2

Environment data

Wind:

Wind speed	8.50 [kts]
Angle off bow	35.000 [deg]
Tran hull area	17.400 [m ²]
VCE above WL	1.275 [m ²]
Tran superst area	13.100 [m ²]
VCE above WL	3.725 [m]
Total Longl area	80.500 [m ²]
VCE above WL	1.500 [m]
Wind speed	On hull
Arrangement	Passenger

Seas:

Sig. wave height	0.000 [m]
Modal wave period	0 [sec]

Channel:

Channel width	0.000 [m]
Channel depth	0.000 [m]
Side slope	0.000 [deg]
Wetted hull girth	0.000 [m]

Symbols and values

Fv = Volumetric Froude number
 Fn = Length Froude number
 Rn = Reynolds number
 Cf = Frictional resistance coefficient
 Trim = Equilibrium-state trim angle
 Lk/Lch = Predicted wetted keel vs chine length ratio
 Stability = Longitudinal dynamic stability (porpoising)

Mult = Blount (M factor) hump-speed multiplier
 Lift = Hydrodynamic planing lift
 LCELift = Longitudinal center of lift forward of transom
 Rbare/W = Bare-hull resistance-weight merit ratio
 Rbare = Bare-hull resistance
 PEbare = Bare-hull effective power
 [Req] = Equilibrium planing resistance

Rapp = Additional appendage resistance
 Rwind = Additional wind resistance
 Rseas = Additional sea-state resistance
 Rchan = Additional channel resistance
 Rmisc = Miscellaneous resistance
 Rtotal = Total vessel resistance
 PETotal = Total effective power

FlapL = Flap lift
 FlapD = Flap drag
 FlapM = Flap moment

* = Exceeds speed parameter

Propulsive coefficients

Wake fraction	[Calc] Simple planing	Wake fract scale correction	[Off]
Thrust deduction	[Calc] Simple planing	Rudder loc	Behind prop
Relative rotative efficiency	[Calc] Simple planing	Wake fract duct correction	[Off]
Friction line	ITTC	Tunnel stern correction	[Off]
Correlation allowance	0.00040	Tunnel Diam	0.000 [m]
3D form factor	1.2294	Tunnel depth	0.000 [m]

System analysis

Analysis type	Free run	Water type	Standard Salt
Cav criteria	Keller eqn	Mass density	1025.86 [kg/m3]
CPP method	[On] Max eff'y	Kinematic viscosity	1.1883e-06 [m2/s]
Engine RPM	2000		

Prediction results

Vel [kts]	Rtotal [N]	WakeFr	ThrDed	RelRot	EngRPM	PropRPM	Pitch [m]
7.00	19111	0.0905	0.0600	1.0000	168.1	44.2	1.921
8.00	21108	0.0848	0.0600	1.0000	194.6	51.2	1.905
9.00	23296	0.0797	0.0600	1.0000	221.2	58.2	1.893
10.00	25664	0.0751	0.0600	1.0000	247.9	65.2	1.884
11.00	28205	0.0710	0.0600	1.0000	274.8	72.3	1.877
12.00	30906	0.0672	0.0600	1.0000	301.9	79.4	1.871
13.00	33752	0.0637	0.0600	1.0000	329.0	86.6	1.866
14.00	36733	0.0604	0.0600	1.0000	356.1	93.7	1.862
15.00	39832	0.0573	0.0600	1.0000	383.5	100.9	1.858
16.00	43038	0.0545	0.0600	1.0000	410.9	108.1	1.855

Vel [kts]	PropRn	J	Kt	Kq	PropEff	HullEff	OPC
7.00	1.21e+6	4.9350	27.7762	13.0069	1.6773	1.0335	1.6989
8.00	1.39e+6	4.9040	22.9051	12.5092	1.4291	1.0271	1.4385
9.00	1.57e+6	4.8804	19.5646	12.1482	1.2509	1.0214	1.2522
10.00	1.76e+6	4.8614	17.1511	11.8711	1.1178	1.0164	1.1134
11.00	1.95e+6	4.8458	15.3394	11.6533	1.0152	1.0118	1.0066
12.00	2.13e+6	4.8327	13.9334	11.4770	0.9338	1.0077	0.9221
13.00	2.32e+6	4.8216	12.8091	11.3309	0.8675	1.0039	0.8535
14.00	2.51e+6	4.8138	11.8982	11.2207	0.8124	1.0004	0.7965
15.00	2.70e+6	4.8055	11.1281	11.1157	0.7657	0.9972	0.7482
16.00	2.89e+6	4.7982	10.4716	11.0242	0.7254	0.9942	0.7067

Vel [kts]	Thr/prop [N]	DelThr [N]	PropTorq [Nm]	PD/prop [kW]	PS/prop [kW]	PB/prop [kW]	PBtotal [kW]
7.00	10166	19112	4284	20	20	21	42
8.00	11228	21109	5519	30	30	31	63
9.00	12392	23297	6925	42	43	45	90
10.00	13652	25665	8504	58	59	62	124
11.00	15003	28205	10258	78	79	83	165
12.00	16439	30906	12187	101	103	108	216
13.00	17953	33752	14293	130	132	138	276
14.00	19539	36733	16584	163	166	173	346
15.00	21188	39833	19048	201	205	214	428
16.00	22893	43038	21691	246	251	261	522

Vel [kts]	Fuel/eng [lph]	Sigma	MinP/D	TipSpd [mps]	%Cav	Press [kPa]	MinEAR
7.00	0.0	20.39	7.343	2.1	100.0	15.1	0.0842
8.00	0.0	15.42	6.990	2.4	100.0	16.7	0.1190
9.00	0.0	12.05	6.731	2.7	100.0	18.4	0.1564

10.00	0.0	9.66	6.533	3.1	100.0	20.2	0.1965
11.00	0.0	7.91	6.377	3.4	100.0	22.2	0.2392
12.00	0.0	6.60	6.252	3.7	100.0	24.4	0.2843
13.00	0.0	5.58	6.148	4.1	100.0	26.6	0.3317
14.00	0.0	4.78	6.063	4.4	100.0	29.0	0.3810
15.00	0.0	4.13	5.989	4.8	100.0	31.4	0.4324
16.00	0.0	3.61	5.924	5.1	100.0	33.9	0.4854

Propulsor data

Description				
Series	Cycloidal	Scale corr		None
Blades	5	Kt mult		1.000
Exp area ratio	1.060	Kq mult		1.000
Diameter	0.900 [m]	Blade T/C		0.000
Pitch	1.260 [m]	Roughness		0.0 [mm]
Pitch type	CPP	Cav breakdown		[Off]
		Propeller cup		0.0 [mm]

Engine data

Engine file		Gear ratio	3.800
Gear efficiency	0.96	Shaft efficiency	0.980

Hull data

General:		Planing:	
Length between PP	18.575 [m]	Proj chine length	17.847 [m]
WL bow pt aft FP	0.000 [m]	Max chine beam	6.700 [m]
Length on WL	18.575 [m]	Proj bottom area	93.230 [m2]
Max beam on WL	6.700 [m]	Deadrise midchine	23.000 [deg]
Max molded draft	1.250 [m]	LCG fwd transom	10.490 [m]
Displacement bare	49.00 [t]	VCG above BL	2.800 [m]
Wetted surface	89.500 [m2]	Shaft angle to BL	0.000 [deg]
Chine type	Hard chine	VCE above BL	0.000 [m2]
		LCE fwd transom	0.000 [m]
Parameters:		Number of flaps	2
Lwl/B	2.7724	Flap chord length	0.500 [m]
B/T	5.36	Flap span	14.500 [m]
Cb	0.307	Flap angle	0.000 [deg]
Cws	3.0047	Flap location	Under hull

Wake fract:	Simple planing		
Fv-low	1...4	0.60	Limit
Fv-high	1...4	1.38	

Thrust ded:	Simple planing		
Fv-low	1...4	0.60	Limit
Fv-high	1...4	1.38	

Rel rot eff:	Simple planing		
Fv-low	1...4	0.60	Limit
Fv-high	1...4	1.38	

Symbols and values

Vel = Ship speed

Rtotal = Total vessel resistance

WakeFr = Taylor wake fraction coefficient

ThrDed = Thrust deduction coefficient

RelRot = Relative-rotative efficiency

VelAdv = Advance velocity = $(1 - \text{WakeFr}) * \text{Vel}$

EngRPM = Engine RPM

Pitch = CPP pitch

PropRPM = Propeller RPM

PropRn = Propeller Reynolds number

J = Advance coefficient

Kt = Thrust coefficient

Kq = Torque coefficient

PropEff = Propeller open-water efficiency

HullEff = Hull efficiency = $(1 - \text{ThrDed}) / (1 - \text{WakeFr})$

OPC = Overall propulsive coefficient

Thr/prop = Open-water thrust per propeller

DelThr = Total delivered thrust

PropTorq = Propeller open water torque

PD/prop = Delivered power per propeller

PS/prop = Shaft power per propeller

PStotal = Total shaft power

PB/prop = Brake power per propeller

PBtotal = Total brake power

Fuel/eng = Fuel consumption per engine

Towpull = Total tow pull

Sigma = Cavitation number based on advance velocity

MinP/D = Minimum P/D ratio to avoid face cavitation

TipSpd = Linear velocity of the propeller tips

%Cav = Percent back cavitation

Press = Average propeller blade pressure

MinEAR = Minimum expanded area ratio

Wpeak = Peak wake fraction

Impulse = Blade impulse pressure

* = Exceeds speed parameter

