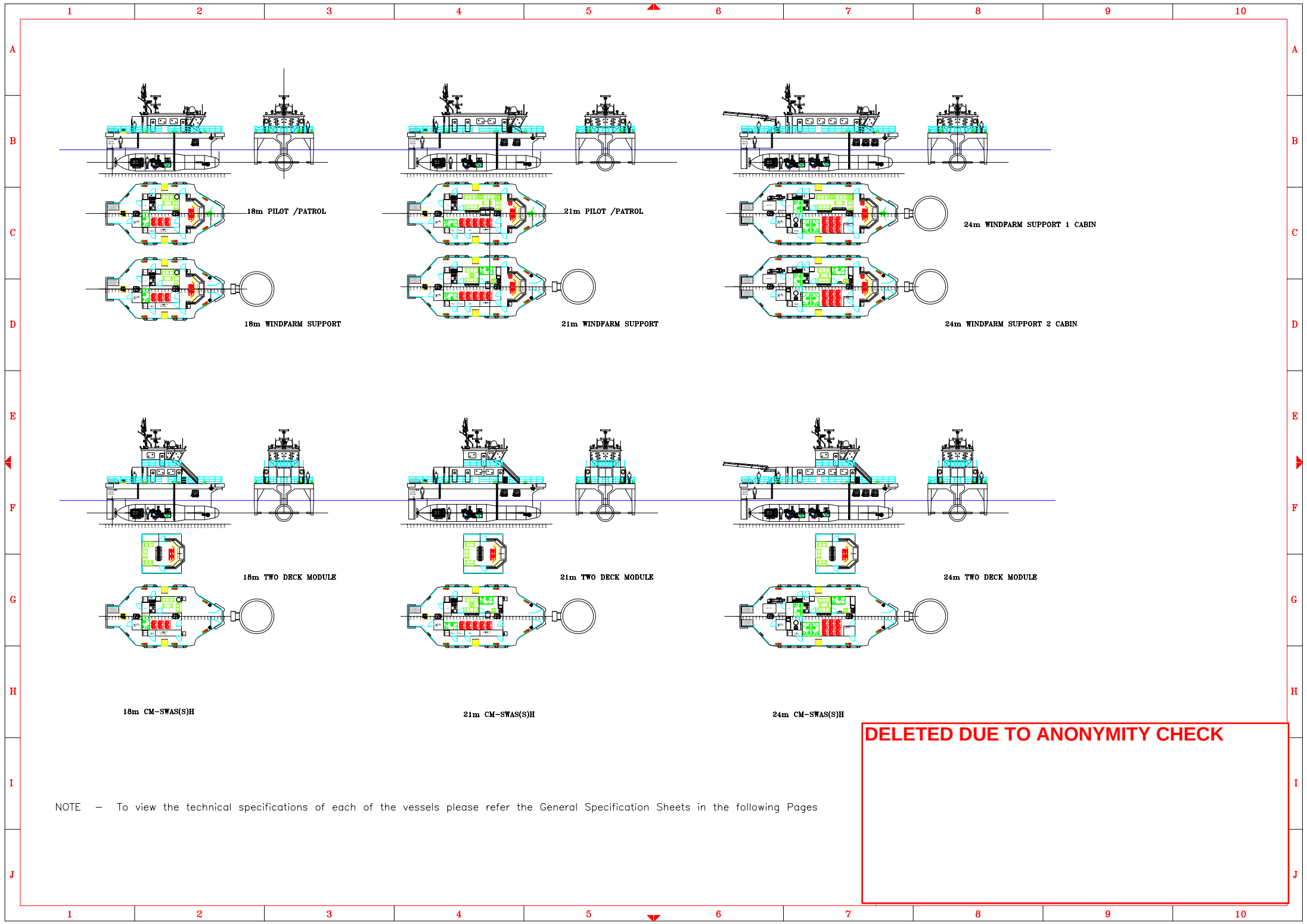


ANNEX – 1

GENERAL ARRANGEMENT

TECHNICAL SPECIFICATION



GENERAL SPECIFICATION – 18 m PILOT / PATROL/CUSTOM BOAT			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	1 x 60 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew and Pilot/Custom/Patrol Duties	DECK CRANE / WINCH	Aft Winch 0.5 T @ 2 m
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	18.0 m	LIFE BUOY	4
LENGTH W.L.	13.0 m	LIFE JACKETS	8
BEAM O.A.	9.50 m	LIFE RAFT	1 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	-
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	5 tonne	ENGINE ROOM VENTILATION	6380 m3/hr in engine room
FUEL OIL TRIM TANK	3 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	1 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	6 People
CREW	2	TOILETS	2
INDUSTRIAL PERSONNEL	6	SEATING AREA	6
		CABINS	-
PERFORMANCE		AIR CONDITIONING	49000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	1x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	1 x MTU 1500 kW	ECHO SOUNDER	
TOTAL POWER	1700 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

GENERAL SPECIFICATION – 18 m PILOT / PATROL/CUSTOM BOAT

GENERAL SPECIFICATION – 18 m WINDFARM SUPPORT VESSEL			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	2 x 60 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew, Personnel And Cargo Duties	DECK CRANE / WINCH	Aft Winch 0.5 T @ 2 m
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	18.0 m	LIFE BUOY	4
LENGTH W.L.	13.0 m	LIFE JACKETS	8
BEAM O.A.	9.50 m	LIFE RAFT	1 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	2
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	7 tonne	ENGINE ROOM VENTILATION	6380 m3/hr in engine room
FUEL OIL TRIM TANK	4 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	1 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	6 People
CREW	2	TOILETS	2
INDUSTRIAL PERSONNEL	6	SEATING AREA	6
		CABINS	-
PERFORMANCE		AIR CONDITIONING	49000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	1x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	1 x MTU 1500 kW	ECHO SOUNDER	
TOTAL POWER	1700 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

GENERAL SPECIFICATION – 18 m WINDFARM SUPPORT VESSEL

GENERAL SPECIFICATION – 21 m PILOT / PATROL/CUSTOM BOAT			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	1 x 67 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew and Pilot/Custom/Patrol Duties	DECK CRANE / WINCH	Aft Winch 0.5 T @ 2 m
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	21.0 m	LIFE BUOY	4
LENGTH W.L.	16.0 m	LIFE JACKETS	15
BEAM O.A.	9.50 m	LIFE RAFT	1 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	-
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	9 tonne	ENGINE ROOM VENTILATION	9560 m3/hr in engine room
FUEL OIL TRIM TANK	4 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	1.5 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	10 People
CREW	2	TOILETS	1
INDUSTRIAL PERSONNEL	6	SEATING AREA	10
		CABINS	-
PERFORMANCE		AIR CONDITIONING	55000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	1x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	1 x MTU 1750 kW	ECHO SOUNDER	
TOTAL POWER	1900 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

GENERAL SPECIFICATION – 21 m PILOT / PATROL/CUSTOM BOAT

GENERAL SPECIFICATION – 21 m WINDFARM SUPPORT VESSEL			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	2 x 67 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew, Personnel And Cargo Duties	DECK CRANE / WINCH	Aft Winch 0.5 T @ 2 m
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	21.0 m	LIFE BUOY	4
LENGTH W.L.	16.0 m	LIFE JACKETS	15
BEAM O.A.	9.50 m	LIFE RAFT	1 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	2
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	10 tonne	ENGINE ROOM VENTILATION	9560 m3/hr in engine room
FUEL OIL TRIM TANK	5 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	1.5 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	10 People
CREW	3	TOILETS	1
INDUSTRIAL PERSONNEL	10	SEATING AREA	10
		CABINS	-
PERFORMANCE		AIR CONDITIONING	55000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	1x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	1 x MTU 1750 kW	ECHO SOUNDER	
TOTAL POWER	1900 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

GENERAL SPECIFICATION – 21 m WINDFARM SUPPORT VESSEL

GENERAL SPECIFICATION – 24 m WINDFARM SUPPORT VESSEL			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	2 x 67 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew, Personnel And Cargo Duties	DECK CRANE / WINCH	Deck Crane Heila HLM 20-2S
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	24.0 m	LIFE BUOY	4
LENGTH W.L.	19.0 m	LIFE JACKETS	16
BEAM O.A.	9.50 m	LIFE RAFT	2 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	2
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	14.2 tonne	ENGINE ROOM VENTILATION	12000 m3/hr in engine room
FUEL OIL TRIM TANK	8 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	2 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	12 People
CREW	3	TOILETS	2
INDUSTRIAL PERSONNEL	12	SEATING AREA	12
		CABINS	1
PERFORMANCE		AIR CONDITIONING	60000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	2x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	2 x MTU 1250 kW	ECHO SOUNDER	
TOTAL POWER	2700 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

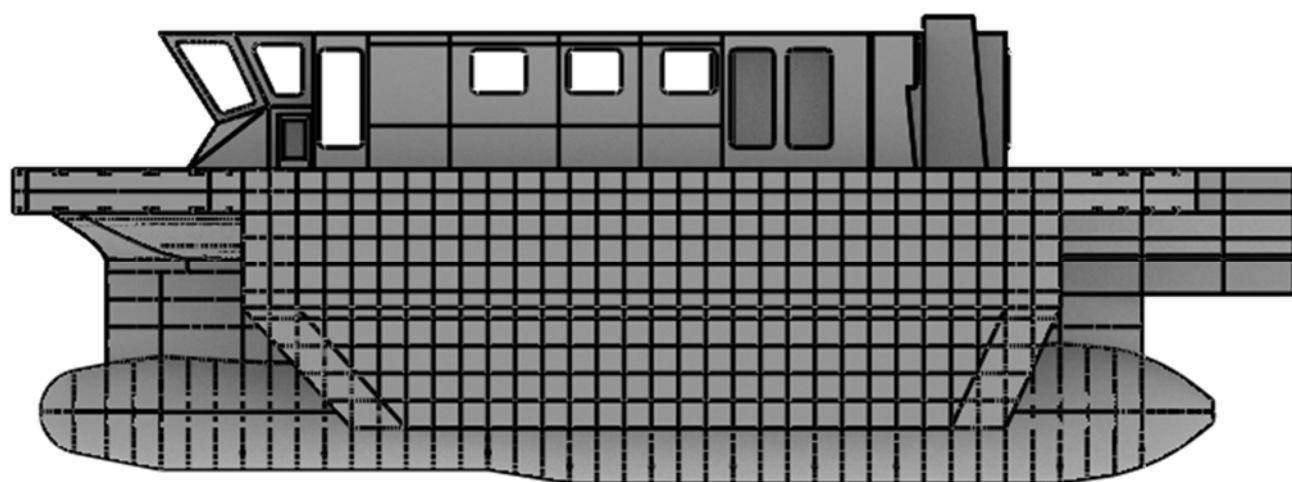
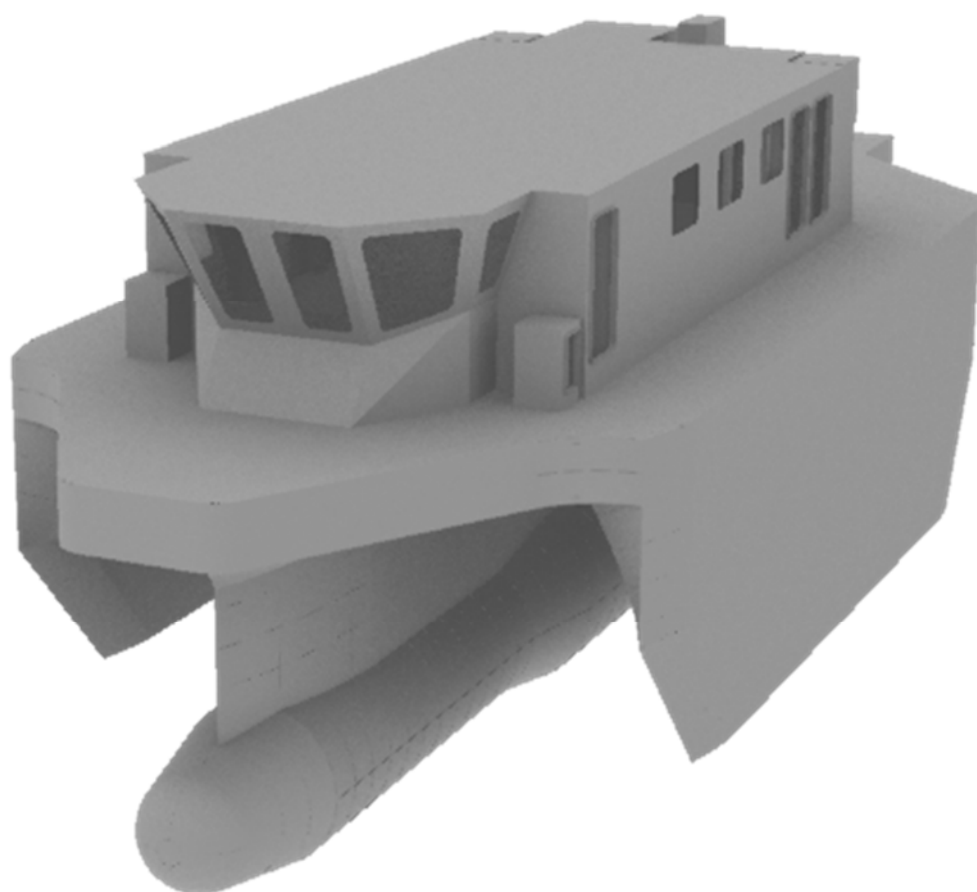
GENERAL SPECIFICATION – 24 m WINDFARM SUPPORT VESSEL

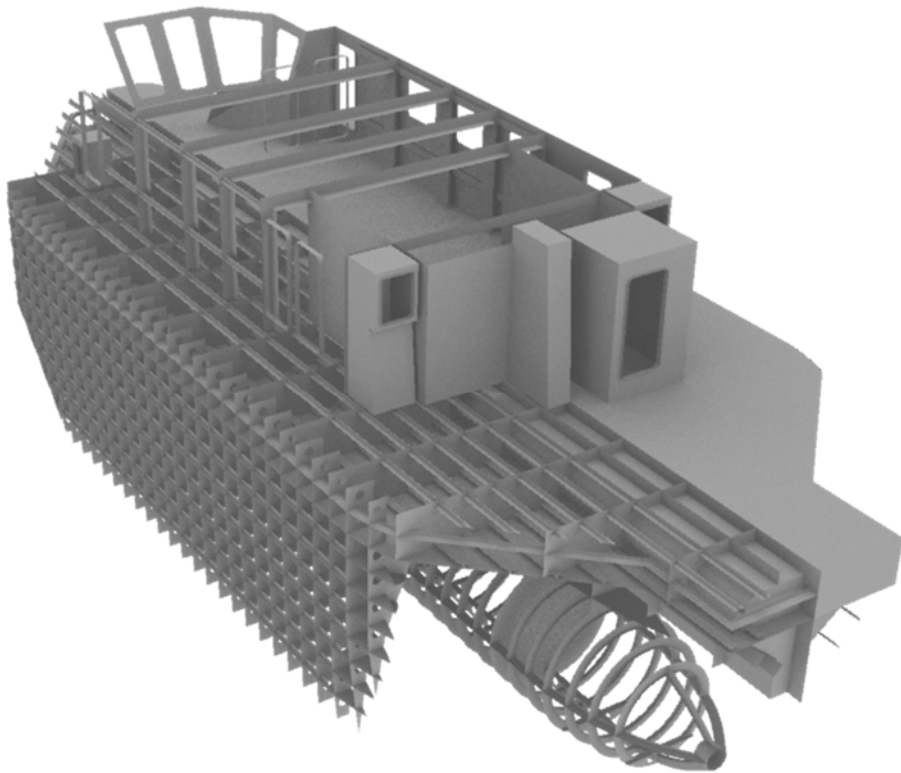
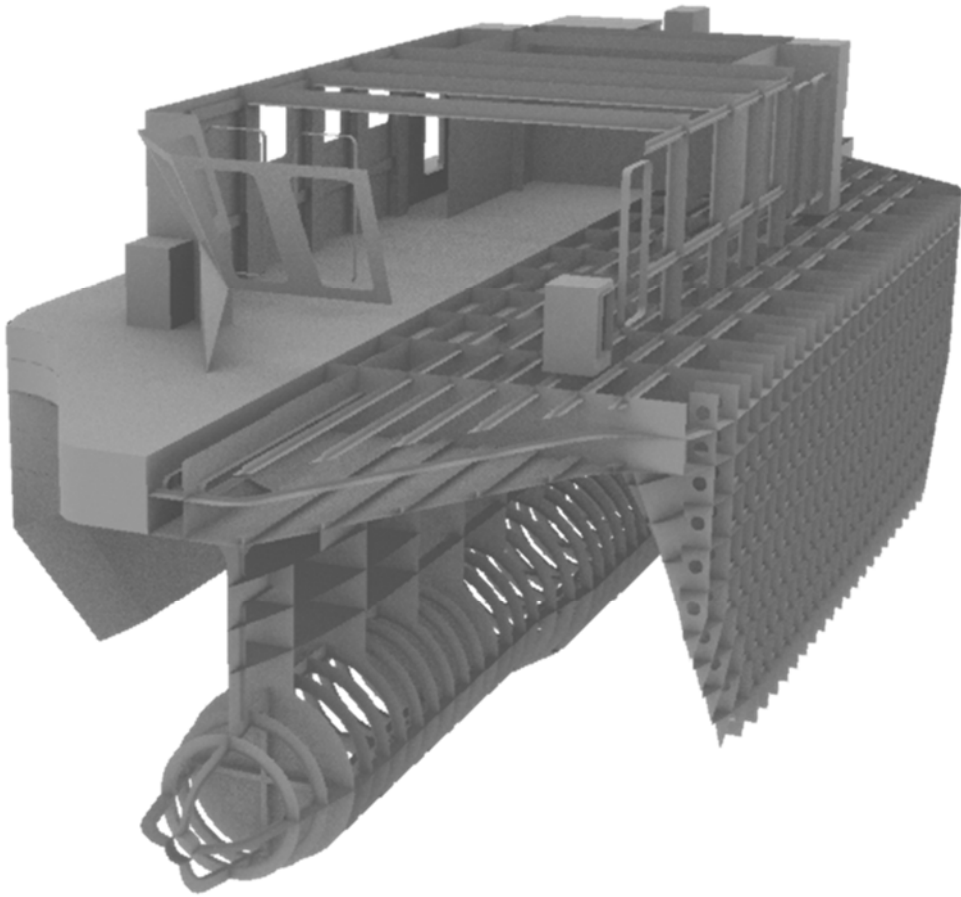
GENERAL SPECIFICATION – 24 m WINDFARM SUPPORT VESSEL (With Capt. Cabin)			
GENERAL		DECK LAYOUT	
HULL MATERIAL	Aluminium 5083, H116	ANCHOR EQUIPMENT	2 x 67 kg HHP with chain and line
SUPERSTRUCTURE	Aluminium 5083, H116	FENDERING	Rubber “D” type and heavy duty foam filled
BASIC FUNCION	Crew, Personnel And Cargo Duties	DECK CRANE / WINCH	Deck Crane Heila HLM 20-2S
CLASSIFICATION RULES	DNV - GL 100 A5 HSDE RAS (200), Transfer Vessel + MC AUT	MOB RECOVERY SYSTEM	Electrically operated elevation platform
DIMENSIONS		LIFE SAVING EQUIPMENT	
LENGTH O.A.	24.0 m	LIFE BUOY	4
LENGTH W.L.	19.0 m	LIFE JACKETS	16
BEAM O.A.	9.50 m	LIFE RAFT	2 x 16
DEPTH	5.75 m	FIRE EXTINGUISHER	Hand fire extinguishers Fixed Fi-Fi system
DRAUGHT	3.20 m	EPIRB + SART	2
CAPACITIES		AUXILLIARY EQUIPMENT	
FUEL OIL	14.2 tonne	ENGINE ROOM VENTILATION	12000 m3/hr in engine room
FUEL OIL TRIM TANK	8 tonne	GENERAL SERVICE PUMP	Electrically driven, 400V, Azcue CA 50
LUBE OIL	2 tonne		
FRESH WATER	1.2 tonne	ACCOMMODATION	
WASTE WATER	0.8 tonne	LOUNGE / GALLEY	12 People
CREW	3	TOILETS	2
INDUSTRIAL PERSONNEL	12	SEATING AREA	12
		CABINS	2
PERFORMANCE		AIR CONDITIONING	60000 BTU
SPEED	25 Knots		
MAX. RANGE	700 nm at Max Speed	NAUTICAL AND COMMUNICATION	
		SEARCH LIGHT	2x 1000W 230V
DIESEL ELECTRIC SYSTEM		COMPASS	Magnetic
PROPULSION	2 x MTU 1250 kW	ECHO SOUNDER	
TOTAL POWER	2700 kW	VHF + VHF HAND HELD	
PROPELLER	Fixed Pitch 5 Blade 2.0 D	RADAR + GPS + NAVTEX	
BOW THRUSTER	1 x 48 kW	AIS + MF/HF	
ELECTRICAL NETWORK	24V d.c. 230V/400V 50 Hz a.c.	IMMERSAT / V-SAT WIFI SYSTEM + CCTV	
EMERGENCY BATTERY	68 kVA		

GENERAL SPECIFICATION – 24 m WINDFARM SUPPORT VESSEL (With Capt. Cabin)

ANNEX – 2

STRUCTURE





CLASSIFICATION RULES - DNV-GL

CLASS NOTATION

✠ 100 A5 HSDE RSA (200) "Transfer Vessel"

✠ MC AUT

In GL rules the notation above is divided into following representations:	
✠	The Maltese Cross means Hull, machinery and/or special equipment (e.g. refrigerating installation) have been constructed :under the supervision of and in accordance with the Rules of DNV-GL at the shipyard and/or at subcontractors supplying construction components/hull sections – with certification by DNV-GL of components and materials requiring inspection, subject to the DNV-GL Construction Rules As for example, hull, which has been constructed under supervision as stated in 2.3, and for which proof of subdivision and damage stability has been furnished, one of the two markings, shown on the left are assigned.
100 A5	The ship's hull fully complies with the requirements of the Construction Rules of DNV-GL or other rules considered to be equivalent.
HSDE	Notation for craft which have been constructed by using elements of Part 3 – Special Craft, Chapter 1 – High Speed Craft and which are not subject to the IMO HSC Code. Details regarding rule application are specified in the Class Certificate.
RSA (200)	this area of service is restricted, in general, to trade along the coast, provided that the distance to the nearest port of refuge as well as the offshore distance do not exceed 200 nautical miles. This applies also to trade in the North Sea and within enclosed seas, such as the Mediterranean, the Black Sea and waters with similar seaway conditions. Trade to Iceland, Spitsbergen and the Azores is exempted.
MC	MC means that the machinery including electrical installations complies with the requirements of the Construction Rules of DNV-GL or other rules considered to be equivalent.
AUT	The machinery installation is fitted with equipment for unattended machinery spaces, so that it does not require to be operated and/ or maintained for periods of at least 24 hours.

CLASSIFICATION RULES - DNV-GL

CLASS NOTATION

- ✕ 100 A5 HSDE RSA (200) "Transfer Vessel"
- ✕ MC AUT

BASIC PARTICULARS				
S. No.	PARTICULARS	SYMBOL	VALUE	UNITS
1	Length Over All	Loa	24	m
2	Length b/w Perpendiculars	Lbp	21	m
3	Length at Waterline	Lwl	19	m
4	Depth	D	5.75	m
5	Draft Amidships	T	3.2	m
6	Immersed depth	d	3.2	m
7	Beam Overall	Boa	9.5	m
8	Beam max extents on WL	Bwl	9	m
9	Block coeff. (Cb)	Cb	0.848	
10	Speed	Vs	20	Knots
11	Speed	Vs	10.28	m/s
12	Displacement (Volume)	∇	118.5	m ³
13	Displacement (Mass)	Δ	121.4625	Tonne
14	Applicability of GL-HSC Rule		TRUE	
15	Longitudinal CG	LCG	9.6	m
16	Vertical CG	VCG	2.1	m
17	Waterplane Area	Awp	27.7	m ²
18	Operational H1/3	Hs	2	m

NOTES	
I Part 3	
Chapter 1	
C 1.4.63	“Small waterplane area twin hull” (SWATH) is a craft for which the weight is substantially supported by a submerged twin hull connected to the emerging part of the craft by struts with a small waterplane area.
Section 2	Buoyancy, Stability and Subdivision
C 2.1.6	Model or full-scale tests and/or calculations (as appropriate) shall also include consideration of the following known stability hazards to which highspeed craft are known to be liable, according to craft type:
C 2.1.6.1	directional instability, which is often coupled to roll and pitch instabilities;
C 2.1.6.2	broaching and bow diving in following seas at speeds near to wave speed, applicable to most types;
C 2.1.6.8	pitch instability of SWATH (small waterplane area twin hull) craft due to the hydrodynamic moment developed as a result of the water flow over the submerged lower hulls;

CLASSIFICATION RULES - DNV-GL

CHAPTER 1, SECTION 2

BUOYANCY, STABILITY AND SUBDIVISION

FRAME SPACING & COLLISION BULKHEAD (CB)				
24 m - CM-SWAS(S)H				
S. No.	PARTICULAR	FORMULA	VALUE	UNITS
1	Frame Spacing	$1.2 \cdot (0.35 + 0.005L)$	0.534	m
2	CB Min Dist. From FP	0.05 L	0.95	m
3	CB Max Dist. From FP	0.05 L + 3	3.95	m
21 m - CM-SWAS(S)H				
S. No.	PARTICULAR	FORMULA	VALUE	UNITS
1	Frame Spacing	$1.2 \cdot (0.35 + 0.005L)$	0.516	m
2	CB Min Dist. From FP	0.05 L	0.8	m
3	CB Max Dist. From FP	0.05 L + 3	3.8	m
18 m - CM-SWAS(S)H				
S. No.	PARTICULAR	FORMULA	VALUE	UNITS
1	Frame Spacing	$1.2 \cdot (0.35 + 0.005L)$	0.498	m
2	CB Min Dist. From FP	0.05 L	0.65	m
3	CB Max Dist. From FP	0.05 L + 3	3.65	m

APPROXIMATE FRAME SPACING

To initiate the design a conservative approach is followed to fix the frame spacing. This rule to approximate the frame spacing is taken from DNV-GL Rules High Speed Crafts: Yacht and Boats less than 24 m, Part 3, Section 1, Chapter 3, Hull Structure B. Glass Fibre Reinforced Plastic Hulls, 5.8. In practical scenario also, for aluminium hulls the frame spacing is not more than 500 mm. We could have taken any other value (let's say 380-450mm) also, all it will do is change the structural calculation with plate thickness and scantlings to match the required Section modulus based on the calculated bending moment and shear force. As we intended to do structural optimisation we took this as a starting reference.

NOTES			
C 2.1.8	At least the following watertight bulkheads are to be fitted in all craft: – one collision bulkhead, – one afterpeak bulkhead, – one bulkhead at each end of the machinery space.		
C 2.6.2	For the purpose of making damage stability calculations, the volume and surface permeabilities shall be, in general, as follows:		
	SPACE	PERMEABILITY	REMARKS
	Appropriate to cargo or stores	60	
	Occupied by Accomodation	95	
	Occupied by Machinery	85	
	Intended for Liquids	0 or 95	
	Appropriate to cargo vehicles	90	
	Void Spaces	95	
C 2.6.4	The Administration may permit the use of low-density foam or other media to provide buoyancy in void spaces, provided that satisfactory evidence is provided that any such proposed medium is the most suitable alternative and is:		
C 2.6.4.1	of closed-cell form if foam, or otherwise impervious to water absorption;		
C 2.6.4.2	structurally stable under service conditions;		
C 2.6.4.3	chemically inert in relation to structural materials with which it is in contact or other substances with which the medium is likely to be in contact (reference is made to 7.4.3.7); and		
C 2.6.4.4	properly secured in place and easily removable for inspection of the void spaces.		
C 2.6.5	The Administration may permit void bottom spaces to be fitted within the watertight envelope of the hull without the provision of a bilge system or air pipes provided that:		
C 2.6.5.1	the structure is capable of withstanding the pressure head after any of the damages required by this section;		
C 2.6.5.2	when carrying out a damage stability calculation in accordance with the requirements of this section, any void space adjacent to the damaged zone shall be included in the calculation and the criteria in 2.6, 2.13 and 2.15 complied with;		
C 2.6.5.3	the means by which water which has leaked into the void space is to be removed shall be included in the craft operating manual required by Section 18; and		
C 2.6.5.4	adequate ventilation is provided for inspection of the space under consideration as required by 2.2.1.2.		
C 2.6.5.5	void spaces filled with foam or modular buoyancy elements or any space without a venting system are considered to be void spaces for the purposes of this paragraph, provided such foam or elements fully comply with 2.6.4.		

CLASSIFICATION RULES - DNV-GL

CHAPTER 1, SECTION 3 STRUCTURAL DETAILS

Applicability of DNV-GL-HSC Rule

If $V \geq 7,16 \cdot \Delta^{1/6}$	15.93	Knots
Applicability of DNV-GL-HSC Rule	TRUE	

C 3.1.3

Units

C 3.1.3.1

Unless otherwise specified, the following units are used in the Rules:

- thickness of plating [mm]
- section modulus of stiffeners [cm³]
- shear area of stiffeners [cm²]
- span and spacing of stiffeners [m]
- stresses [MPa]
- concentrated loads [kN]
- distributed loads [kN/m] or [kPa]

Table C 3.2.1

Aluminium alloys for welded construction

Guaranteed Mechanical Characteristics							
Aluminium Alloy				Unwelded Condition		Welded Condition	
ALLOY	Products	Temper	Thickness	Rp0.2	Rm	Rp0.2'	Rm'
			mm	Mpa	Mpa	Mpa	Mpa
5083	Rolled	0/H111/H112	t ≤ 50	125	275	125	275
		H116/H32/H321	t ≤ 50	215	305	125	275
Rp0.2 and Rp0.2' are the minimum guaranteed yield stresses							
Rm and Rm' are the minimum guaranteed tensile strengths							

The heat-affected zone may be taken to extend 25 mm on each side of the weld axis.

C 3.2.3.2	Influence of welding on mechanical characteristics
C 3.2.3.2.5	Aluminium alloys of series 5000 other than condition 0 or H111 are subjected to a drop in mechanical strength in the welded areas. The mechanical characteristics to consider in welded condition are, normally, those of condition 0 or H111, except otherwise indicated in Table C3.2.1. Higher mechanical characteristics may be taken into account, provided they are duly justified.

CLASSIFICATION RULES - DNV-GL

CHAPTER 1, SECTION 3 STRUCTURAL DETAILS

C 3.2.3.3.1 Material factor "k" for scantlings of structural members made of aluminium alloy

k 0.8

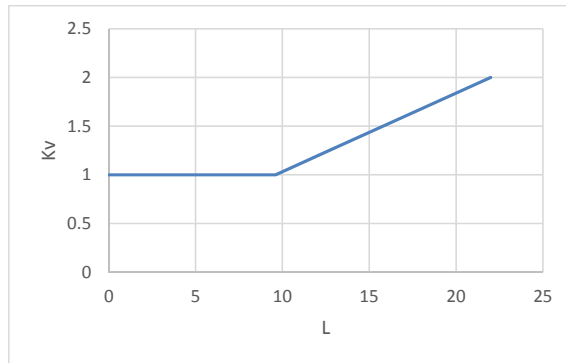
C 3.3.1 Vertical acceleration at LCG

S. No.	Parameter	Value	Units	REMARKS
1	aCG	2.294	m/sec ²	
2	cHSC	0.5		Table C 3.3.1 Pilot Boat Conservative Approach
3	cRW	1		

The longitudinal distribution of vertical acceleration along the hull is given by:

LCG	9.6	m
-----	-----	---

S. No.	Position X	Kv	aV
1	0	1	2.294
2	9.6	1	2.294
3	12.7	1.25	2.868
4	15.8	1.5	3.441
5	18.9	1.75	4.015
6	22	2	4.588



C 3.3.2 Transverse acceleration

S. No.	Parameter	Value	Units
1	at	1.605	m/s ²
2	r	19	m

C 3.3.3 Assessment of limit operating conditions

S. No.	Parameter	Value	Units	REMARKS
1	Hsm	5.485	m	Max Hs
2	Hs	2	m	NOTE : Selected from the General Data Available

C 3.3.3.2 Limitation imposed by vertical acceleration at LCG

S. No.	Parameter	Value	Units
1	Kt	0.845	
2	Kf	5.201	
3	K	6.155	
4	Kh	1.896	
5	Xcg	8.800	m
6	Hs	1.753	m

C 3.3.3.4 Limitation imposed by global loads

C 3.3.3.4.3 For SWATH craft, the global loads as given in C3.4.3 are not depending on ship motions.

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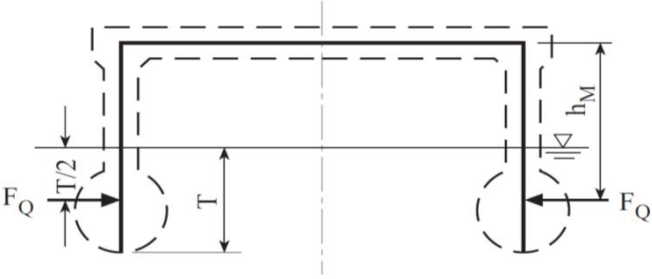
C 3.4 Overall Loads

C 3.4.3 Small waterplane area twin-hull (SWATH) craft - Forces and moments acting on twin-hull connections

C 3.4.3.1 Side beam force

The design beam side force

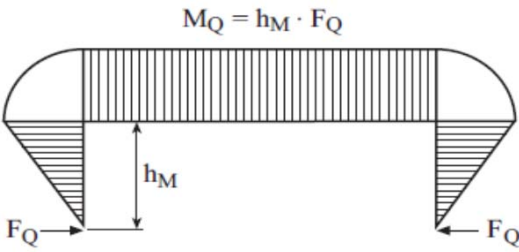
S. No.	Parameter	Value	Units
1	F_Q	3228.606	kN
2	T	3.2	m
3	Δ	121.4625	tonne
4	d	1.541719	m
5	L_s	2.134626	m
6	λ	1.901863	
7	Alat	220	m ²



S. No.	Parameter	Value	Units
1	The lateral pressure		
	P_q	14.67548346	kN/m ²
2	Effective length		
	L_e	68.75	m
3	The constant lateral force per unit length		
	q_Q	46.96154706	kN/m

C 3.4.3.2 Bending moment

S. No.	Parameter	Value	Units
1	M_q	6941.504	kN.m
2	h_M	2.15	m
3	Height of Deck	0.8	m
4	Depth of Vessel	5.75	m



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C 3.5 Local Loads and Design Criteria

C 3.5.2 Load centre

C 3.5.2.1 For plates:

vertical stiffening system:		
stiffener spacing	0.5	m

horizontal stiffening system		
Midpoint of plate field	0.25	m

C 3.5.2.2 For stiffeners and girders:

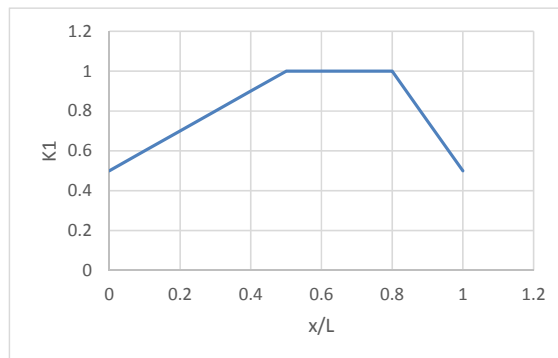
centre of span	0.5	m
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C 3.5.3 Impact pressure on the bottom of hull

S. No.	Parameter	Value	Units
1	Vfr	2.358	m/s
2	Lwl	19	m
The impact pressure			
3	Psl	NA	kPa

Longitudinal bottom impact pressure distribution factor

S. No.	Position X	x/L	K1
1	0	0	0.5
2	1.9	0.1	0.6
3	3.8	0.2	0.7
4	5.7	0.3	0.8
5	7.6	0.4	0.9
6	9.5	0.5	1
7	11.4	0.6	1
8	13.3	0.7	1
9	15.2	0.8	1
10	17.1	0.9	0.75
11	19	1	0.5



Factor accounting for impact area

S. No.	Parameter	Value	REMARKS
1	K2 ≥	0.5	Plating
2	K2 ≥	0.45	Stiffener
3	K2 ≥	0.35	Girder and Floors

PLATING				
S. No.	Parameter	Value	UNITS	REMARKS
1	K2	0.412		
2	u	2.823		
3	s	0.750		
4	Sr	26.570	m2	Reference Area
5	Stiffener Spacing	0.5	m	
6	Stiffener Span	1.5	m	
7	Selected K2	0.5		

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STIFFNER				
S. No.	Parameter	Value	UNITS	REMARKS
1	K2	0.412		
2	u	2.823		
3	s	0.750		
4	Sr	26.570	m2	Reference Area
5	Stiffener Spacing	0.5	m	
6	Stiffener Span	1.5	m	
7	Selected K2	0.45		

GIRDERS AND FLOORS				
S. No.	Parameter	Value	UNITS	REMARKS
1	K2	0.412		
2	u	2.823		
3	s	0.750		
4	Sr	26.570	m2	Reference Area
5	Stiffener Spacing	0.5	m	
6	Stiffener Span	1.5	m	
7	Selected K2	0.412		

Factor accounting for shape and deadrise of the hull

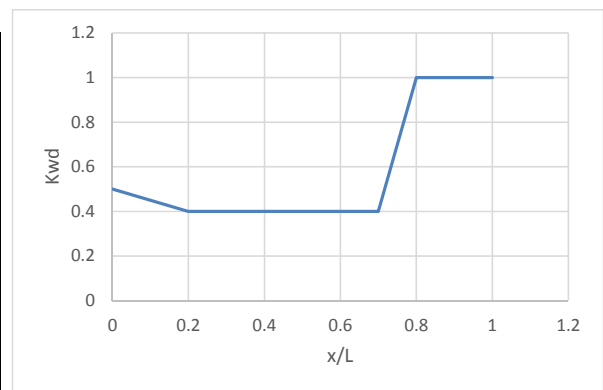
S. No.	Parameter	Value	Units
1	K3	1.1	
2	α_d	15	deg
3	α_{dCG}	20	deg

C 3.5.4 Impact pressure on wet deck (including tunnel radius)

S. No.	Parameter	Value	Units	REMARKS
1	psl		kPa	
2	Vsl	2.835	m/s	relative impact velocity

Longitudinal wet deck impact pressure distribution factor

S. No.	Position X	x/L	KWD	psl
1	0	0	0.5	-3.918
2	1.9	0.1	0.45	-3.526
3	3.8	0.2	0.4	-3.134
4	5.7	0.3	0.4	-3.134
5	7.6	0.4	0.4	-3.134
6	9.5	0.5	0.4	-3.134
7	11.4	0.6	0.4	-3.134
8	13.3	0.7	0.4	-3.134
9	15.2	0.8	1	-7.836
10	17.1	0.9	1	-7.836
11	19	1	1	-7.836



Vx	20	knots	
Ha	2.55	m	air gap equal to the distance between the waterline at draught T and the wet deck

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C 3.5.5 Sea pressures

C 3.5.5.1 Sea pressure on bottom and side shell

For Under Water Hull Central Tube				
S. No.	Position X	x/L	Ps min	Ps (kPa)
1	0	0	7.52	33.17
2	1.9	0.1	7.52	33.17
3	3.8	0.2	7.52	33.17
4	5.7	0.3	7.52	33.17
5	7.6	0.4	7.52	33.17
6	9.5	0.5	7.52	33.17
7	11.4	0.6		33.17
8	13.3	0.7		33.17
9	15.2	0.8		33.17
10	17.1	0.9	15.04	33.17
11	19	1	15.04	33.17

For Over Water Hull Central Tube				
S. No.	Position X	x/L	Ps min	Ps (kPa)
1	0	0	7.52	7.67
2	1.9	0.1	7.52	7.67
3	3.8	0.2	7.52	7.67
4	5.7	0.3	7.52	7.67
5	7.6	0.4	7.52	7.67
6	9.5	0.5	7.52	7.67
7	11.4	0.6		7.67
8	13.3	0.7		7.67
9	15.2	0.8		7.67
10	17.1	0.9	15.04	7.67
11	19	1	15.04	7.67

For Under Water Hull Outrigger				
S. No.	Position X	x/L	Ps min	Ps (kPa)
1	0	0	7.52	36.05
2	1.9	0.1	7.52	36.05
3	3.8	0.2	7.52	36.05
4	5.7	0.3	7.52	36.05
5	7.6	0.4	7.52	36.05
6	9.5	0.5	7.52	36.05
7	11.4	0.6		36.05
8	13.3	0.7		36.05
9	15.2	0.8		36.05
10	17.1	0.9	15.04	36.05
11	19	1	15.04	36.05

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For Over Water Hull Outrigger				
S. No.	Position X	x/L	Ps min	Ps (kPa)
1	0	0	7.52	10.55
2	1.9	0.1	7.52	10.55
3	3.8	0.2	7.52	10.55
4	5.7	0.3	7.52	10.55
5	7.6	0.4	7.52	10.55
6	9.5	0.5	7.52	10.55
7	11.4	0.6		10.55
8	13.3	0.7		10.55
9	15.2	0.8		10.55
10	17.1	0.9	15.04	10.55
11	19	1	15.04	10.55

C 3.5.5.5 **Sea pressures on deckhouses**

S. No.	Parameter	Value	Units
1	Front Wall		
	pSU	17.9	kPa
2	Side and Aft Wall		
	pSU	4	kPa
3	Other Walls and Side		
	pSU	3	kPa
4	Unprotected front walls located at the fore end		
	pSU	NA	kPa

C 3.5.6.2 **Pressures on watertight bulkheads**

S. No.	Parameter	Value	Units
1	pSB	31.883	kPa
2	h3	3.25	m

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C 3.5.8 Deck loads

C 3.5.8.1 General

S. No.	Parameter	Value	Units	REMARKS
1	Pd	12.334	kPa	
2	p	4.350	kPa	uniform pressure due to the load carried [kPa]
3	av	4.588	m/s ²	design vertical acceleration, defined in C3.3

C 3.5.8.2 Weather decks and exposed areas

S. No.	Parameter	Value	Units	REMARKS
1	p	4.35	kPa	if $2 < z_d < 3$
2	zd	2.55	m	vertical distance from deck to waterline at draught T

C 3.5.8.4 Enclosed accommodation decks

p	3	kPa
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C 3.5.8.6 Platforms of machinery spaces and mooring decks

The minimum value to be considered for platforms of machinery spaces

p	8	kPa
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The minimum value to be considered for platforms of mooring decks

p	6	kPa
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C 3.7 Steel and Aluminium Alloy Craft C 3.7.1 Structural Details

$$\mu = \sqrt{1.1 - 0.5 * \left(\frac{s}{l}\right)^2}$$

S. No.	Parameter	Value	Units	REMARKS
1	μ	1.022		which needs not be taken greater than 1.0
2	s	0.5	m	
3	l	1.5	m	
4	μ	1		Selected

C 3.7.3 Overall strength (Global) C 3.7.3.1 Longitudinal strength

$$\sigma_{bl} = \left| \frac{M_{bl}}{I_y} * (z - z_0) * 10^{-3} \right|$$

S. No.	Parameter	Value	Units	REMARKS
1	σ_{am}	87.5	MPa	Refer Allowable Stress Annex
2	M _{bl}	6941.504	kNm	
3	σ_{bl}	58.34	MPa	
4	Structure	TRUE		if $\sigma_{bl} < \sigma_{am}$

C 3.7.4 Effective width of plating C 3.7.4.1 Stiffeners

Plating Width	0.5	m	spacing of stiffeners (secondary members)
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C 3.7.4.2 Girders

Table C 3.7.1 Effective width "em" of frames and girders

S. No.	Parameter	Value	Units	REMARKS
1	l	1.5	m	
2	e	0.5	m	
3	l by e	3		
4	em1/e	0.82		Selected for Our Case
5	em2/e	0.52		

C 3.7.7 Plating C 3.7.7.1 Formula

$$t = 22.4 * \mu * s * \sqrt{\frac{p}{\sigma_{am}}}$$

C 3.7.7.2 Keel

The thickness of keel plating is to be not less than that required for adjacent bottom plating.

This requirement may be waived in the case of special arrangements for dry-docking of craft of unusual hull design in the opinion of GL.

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C 3.7.7.3 **Bottom shell and bilge plating**

S. No.	Parameter	Value	Units
1	p	33.17	kPa
2	σ_{am}	106.25	MPa
3	μ	1	
4	s	0.5	m
5	t	6.258	mm

C 3.7.7.4 **Plating of front walls**

S. No.	Parameter	Value	Units
1	p	17.9	kPa
2	σ_{am}	106.25	MPa
3	μ	1	
4	s	0.5	m
5	t	4.597	mm

C 3.7.7.4 **Plating of side shell**

S. No.	Parameter	Value	Units
1	p	4	kPa
2	σ_{am}	106.25	MPa
3	μ	1	
4	s	0.5	m
5	t	2.173	mm

C 3.7.7.6 **Deck plating**

S. No.	Parameter	Value	Units
1	p	12.33367	kPa
2	σ_{am}	106.25	MPa
3	μ	1	
4	s	0.5	m
5	t	3.816	mm

C 3.7.7.8 **Plating of deckhouse walls**

S. No.	Parameter	Value	Units
1	p	3	kPa
2	σ_{am}	106.25	MPa
3	μ	1	
4	s	1.5	m
5	t	5.646	mm

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C 3.7.8 Ordinary stiffeners

C 3.7.8.1 General

$$Z = 1000 * \frac{l^2 * s * p}{m * \sigma_{am}}$$

$$A_t = 5 * \frac{l * s * p}{\tau_{am}}$$

Z cm³ section modulus
A_t cm² shear area

C 3.7.4

Coefficient "m"	Value
Continuous stiffeners	12
Non-continuous stiffeners and without brackets at the end of span	8

The web thickness is to be not less than	
S. No.	REMARKS
1	1/15 of the depth, for flat bars
2	1/35 of the depth, for other sections
3	The thickness of the face plate is to be not less than 1/20 of its width.

C 3.7.8.2 Bottom and bilge stiffeners

S. No.	Parameter	Value	Units
1	l	1.5	m
2	s	0.5	m
3	p	33.17	kPa
4	m	8	
5	σ _{am}	87.5	MPa
6	τ _{am}	56.25	MPa
7	Z	53.309	cm ³
8	A _t	2.211	cm ²

C 3.7.8.3 Side wall stiffeners

S. No.	Parameter	Value	Units
1	l	1.5	m
2	s	0.5	m
3	p	4	kPa
4	m	8	
5	σ _{am}	87.5	MPa
6	τ _{am}	56.25	MPa
7	Z	6.429	cm ³
8	A _t	0.267	cm ²

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C 3.7.8.3 Front wall stiffeners

S. No.	Parameter	Value	Units
1	l	1.5	m
2	s	0.5	m
3	p	17.9	kPa
4	m	8	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	28.768	cm ³
8	At	1.193	cm ²

C 3.7.8.5 Deck stiffeners

S. No.	Parameter	Value	Units
1	l	1.5	m
2	s	0.5	m
3	p	12.33367	kPa
4	m	8	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	19.822	cm ³
8	At	0.822	cm ²

C 3.7.8.6 Stiffeners of boundary walls of deckhouses

S. No.	Parameter	Value	Units
1	l	1.5	m
2	s	0.5	m
3	p	3	kPa
4	m	8	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	4.821	cm ³
8	At	0.200	cm ²

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STRUCTURAL DETAILS

C 3.7.9 Primary supporting members

C 3.7.9.1 General

$$Z = 1000 * \frac{S^2 * b * p}{m * \sigma_{am}}$$

$$A_t = 5 * \frac{S * b * p}{\tau_{am}}$$

m	10
---	----

The web thickness is to be not less than	
S. No.	REMARKS
1	The web thickness is to be not less than 1/35 of web depth.
2	1/35 of the depth, for other sections
3	The face plate thickness is to be not less than 1/20 of face plate breadth (1/10 for face plates which are not symmetrical with respect to the web).

C 3.7.9.2 Floors and girders of single bottom

S. No.	Parameter	Value	Units
1	S	0.5	m
2	b	1.5	m
3	p	33.17	kPa
4	m	10	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	14.216	cm ³
8	At	2.211	cm ²
9	t	3.426	mm

C 3.7.9.3 Primary supporting members of sides walls

S. No.	Parameter	Value	Units
1	S	0.5	m
2	b	1.5	m
3	p	4	kPa
4	m	10	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	1.714	cm ³
8	At	0.267	cm ²

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C 3.7.9.3 Primary supporting members of front walls

S. No.	Parameter	Value	Units
1	S	0.5	m
2	b	1.5	m
3	p	17.9	kPa
4	m	10	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	7.671	cm ³
8	At	1.193	cm ²

C 3.7.9.5 Primary supporting members of decks

S. No.	Parameter	Value	Units
1	S	0.5	m
2	b	1.5	m
3	p	12.33367	kPa
4	m	10	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	5.286	cm ³
8	At	0.822	cm ²

C 3.7.9.6 Primary supporting members of deckhouse boundary walls

S. No.	Parameter	Value	Units
1	S	0.5	m
2	b	1.5	m
3	p	3	kPa
4	m	10	
5	σ_{am}	87.5	MPa
6	τ_{am}	56.25	MPa
7	Z	1.286	cm ³
8	At	0.200	cm ²

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CHAPTER 1, SECTION 3 STRUCTURAL DETAILS

C 3.7.11 Bulkhead Structures

C 3.7.11.1 Plating

$$t = 22.4 * f_m \mu * s * \sqrt{\frac{p_s}{\sigma_{am}}}$$

S. No.	Parameter	Value	Units	REMARKS
1	f _m	0.7		for aluminium alloy structures
2	μ	1		
3	s	0.5	m	
4	P _{sb}	31.883	kPa	
5	σ _{am}	118.750	MPa	
6	t	4.062	mm	

C 3.7.11.2 Stiffeners and girders

The required scantlings of stiffeners and girders are determined according to strength calculations, by applying the following permissible stress Values

Refer Table Allowable Stress

C 3.7.13 Bow, Shell Side and Stern Doors

C 3.7.13.1 Plating

$$t = 22.4 * \mu * s * \sqrt{\frac{p_s}{\sigma_{am}}}$$

S. No.	Parameter	Value	Units
1	μ	1	
2	s	0.5	m
3	P _{sb}	36.05	kPa
4	σ _{am}	106.25	MPa
5	t	6.524	mm

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CHAPTER 1, SECTION 3.7 ALLOWABLE STRESS

BASIC PROPERTIES		
Young's Modulus of aluminium (N/mm ²)	E	70000
Poisson's ratio of aluminium	ν	0.33
material factor k	k	0.8
	Aluminium Alloy	5083 H116
In welded condition_table 1 (N/mm ²)	R' _{p0,2}	125
In welded condition_table 1 (N/mm ²)	R' _m	275
Proof stress (yield strength) in N/mm ² as indicated by the supplier	R _{p0,2}	215
Tensile strength, in N/mm ² as indicated by the supplier	R _m	305

Type of Stress considered	Structural component considered	Design admissible stress (N/mm2)
Global stress induced by longitudinal hull girder loads	plating	87.5
		87.5
	stiffeners	87.5
		87.5
PLATING		
C3.7.7.3 Bottom shell and bilge plating	Impact Pressure	
	σam	118.75
	Sea Pressure	
	σam	106.25
C3.7.7.4 Plating of side shell and front walls	σam	106.25
C3.7.7.6 Deck plating	σam	106.25
C3.7.7.8 Plating of deckhouse walls	σam	106.25
ORDINARY STIFFENERS		
C3.7.8.2 Bottom and bilge stiffeners	σam	87.5
	τam	56.25
b. stiffeners contributing to the longitudinal strength c. stiffeners not contributing to the longi. strength	σam	87.5
	τam	56.25
C3.7.8.3 Side and front wall stiffeners	σam	87.5
	τam	56.25
b. stiffeners contributing to the longitudinal strength c. stiffeners not contributing to the longi. strength	σam	87.5
	τam	56.25
C3.7.8.5 Deck stiffeners	σam	87.5
	τam	56.25
b. stiffeners contributing to the longitudinal strength c. stiffeners not contributing to the longi. strength	σam	87.5
	τam	56.25
C3.7.8.6 Stiffeners of boundary walls of deckhouses	σam	87.5
	τam	56.25

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PRIMARY STIFFENERS		
C3.7.9.2 Floors and girders of single bottom	σ_{am}	87.5
	τ_{am}	56.25
b. Floor	σ_{am}	87.5
c. Girder	τ_{am}	56.25
C3.7.9.3 Primary supporting members of sides and front walls	σ_{am}	87.5
	τ_{am}	56.25
C3.7.9.5 Primary supporting members of decks	σ_{am}	87.5
	τ_{am}	56.25
C3.7.9.6 Primary supporting members of deckhouse boundary walls	σ_{am}	87.5
	τ_{am}	56.25
BULKHEAD STRUCTURE		
C3.7.11.1 Plating	σ_{am}	118.75
C3.7.11.2 Stiffeners and girders	σ_{am}	112.5
	τ_{am}	68.75
	σ_{VM}	118.75
BOW AND SIDE SHELL		
C3.7.13.1 Plating	σ_{am}	106.25
C3.7.13.2 Ordinary stiffeners	σ_{am}	87.5
	τ_{am}	56.25
C3.7.13.3 Primary members, securing and supporting devices	σ_{am}	68.75
	τ_{am}	43.75
	σ_{VM}	87.5

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CHAPTER 1, SECTION 3 STRUCTURAL DETAILS

DIRECT CALCULATION	
C 3.1.2	Direct calculations
C 3.1.2.1	DNV-GL may require direct calculations to be carried out, if deemed necessary. Such calculations are to be carried out based on structural modelling, loading and checking criteria described below. Calculations based on other criteria may be accepted if deemed equivalent to those laid down by DNV-GL.
C 3.1.2.2	In order to increase the flexibility in the structural design of ships DNV-GL also accepts direct calculations with computer programs. The aim of such analyses should be the proof of equivalence of a design with the rule requirements.
C 3.1.2.3	Direct calculations may also be used in order to optimise a design; in this case only the final results are to be submitted for review.
C 3.1.2.2	General programs
C 3.1.2.2.1	The choice of computer programs according to "State of the Art" is free. The programs may be checked by DNV-GL through comparative calculations with predefined test examples. A generally valid approval for a computer program is, however, not given by DNV-GL.
C 3.1.2.2.2	Direct calculations may be used in the following fields – global strength – longitudinal strength – beams and grillages – detailed strength
C 3.1.2.2.3	For such calculation the computer model, the boundary condition and load cases are to be agreed upon with DNV-GL. The calculation documents are to be submitted including input and output. During the examination it may prove necessary that GL perform independent comparative calculations.
C 3.1.2.2.4	DNV-GL is prepared to carry out the following calculations of this kind within the marine advisory services :
C 3.1.2.2.4.1	STRENGTH
	Linear and/or non-linear strength calculations with the FE-method: For an automated performance of these calculations, a number of effective pre- and post processing programmes is at disposal: – calculation of seaway loads as per modified strip method or by 3 D-panel method – calculation of resultant accelerations to ensure quasi-static equilibrium – calculation of composite structures – evaluation of deformations, stresses, buckling behaviour, ultimate strength and local stresses, assessment of fatigue strength

ANNEX – 3

ANCHOR-RUDDER-PROPELLER

ANCHOR CALCULATION AND SELECTION

Aa per DNV-GL Class rules for Special Ships-High Speed Ships, Chapter 1, Part 3, Section 6, Sub-section 5.2 Multi-Hull Craft.

LOA - 18 m		
EQUIPMENT NUMBER CALCULATIONS		
Displacement	79.35	Tonnes
Bo	1.1	m
To	3.2	m
Bi	0.5	m
Ti	2.2	m
Km	1.655152959	
Displacement	79.35	Tonnes
a	2.55	m
B	9	m
hi	2.5	m
θi	0	degree
St	9.4325	m2
A	15	m2
EN	59.09847673	
Anchor Cable Dia	8.5	mm
Proof Loads	42.97312	kN
Breaking Loads	85.94623	kN
Pull Duty of Windlass	3431.875	N
Mass of Anchor	60	kg
Cable Length	82.5	m
Diameter	K2	10 mm
Diameter	K3	8.5 mm

4380.542	kg
8761.084	kg
349.8344	kg

LOA - 21 m		
EQUIPMENT NUMBER CALCULATIONS		
Displacement	101.3	Tonnes
Bo	1.1	m
To	3.2	m
Bi	0.5	m
Ti	2.2	m
Km	1.655152959	
Displacement	101.3	Tonnes
a	2.55	m
B	9	m
hi	2.5	m
θi	0	degree
St	9.4325	m2
A	15	m2
EN	64.50257008	
Anchor Cable Dia	9.5	mm
Proof Loads	53.58009	kN
Breaking Loads	107.1602	kN
Pull Duty of Windlass	4286.875	N
Mass of Anchor	67	kg
Cable Length	82.5	m
Diameter	K2	11 mm
Diameter	K3	9.5 mm

5461.783	kg
10923.57	kg
436.9903	kg

LOA - 24 m		
EQUIPMENT NUMBER CALCULATIONS		
Displacement	118.6	Tonnes
Bo	1.1	m
To	3.2	m
Bi	0.5	m
Ti	2.2	m
Km	1.655152959	
Displacement	118.6	Tonnes
a	2.55	m
B	9	m
hi	2.5	m
θi	0	degree
St	9.4325	m2
A	15	m2
EN	68.48909159	
Anchor Cable Dia	9.5	mm
Proof Loads	53.58009	kN
Breaking Loads	107.1602	kN
Pull Duty of Windlass	4286.875	N
Mass of Anchor	67	kg
Cable Length	82.5	m
Diameter	K2	11 mm
Diameter	K3	9.5 mm

5461.783	kg
10923.57	kg
436.9903	kg

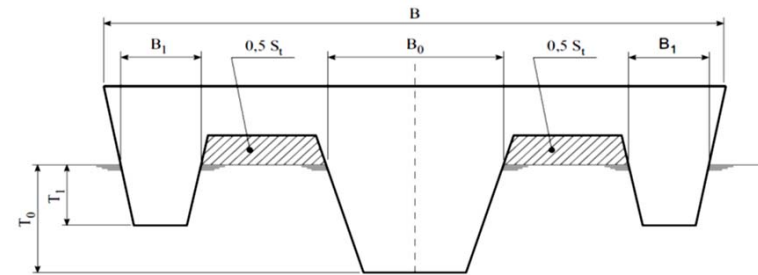
$$EN = K_m * \Delta^{\frac{2}{3}} + 2 * [a * B + \sum_i (b_i * h_i * \sin \theta_i) - S_e] + 0.1 * A$$

$$K_m = \frac{(B_0 * T_0)^{\frac{2}{3}} + 2 * \sum_{i=1}^n (B_1 * T_1)^{\frac{2}{3}}}{(B_0 * T_0 + 2 * \sum_{i=1}^n B_1 * T_1)}$$

$$Proof Load (PL) = 13.73 * d^2 * (44 - 0.08 * d) * 10^{-3}$$

$$Breaking Load (BL) = 2 * PL$$

d – diameter of cable selected from Table C6.5.1 Equipment of Class Rules
Anchor Cable and Windlass Calculations are for K3 studless link chain



RUDDER CALCULATION AND SELECTION				
RUDDER				
Draught	T		3.2	m
Minimum Rudder Blade Span (Height)		0.90 * T	2.88	m
		0.95 * T	3.04	m
Selected Blade Span	Rh		2.6	m
Max Rudder Blade Chord		0.6 * Rh	1.56	m
Min Rudder Blade Chord		0.35 * Rh	0.91	m
Selected Chord	Ch		0.95	m
Rudder Shape			Rectangle	
Rudder Profile			Parabolic Section	
Rudder Area	RA	Rh * Ch	2.47	m ²
Stiffener Spacing	S		250	mm
Speed	Vs		20	knots
Speed	Vs		10.28	m/sec
Plate Thickness			10.048	mm
Plate Thickness Selected			12	mm
Max Stiffener Spacing Aluminium	Smax		485.6	mm
Stiffener Thickness (same as plate thickness)			12	mm
Volume of Rudder			0.05928	m ³
Weight of Rudder			157.092	kg
Coefficient of Lift	CL		1.2	
Propeller Factor	Pf		1.2	
Force on Rudder			1921.433	kg
Twisting Arm	TA		0.325	m
Bending Arm	BA		2.2	m
Twistin Moment	TM		624.466	Kg.m
Bending Moment	BM		4227.153	Kg.m
Combined Moment	CM		8500.182	Kg.m
Combined Moment	CM		83386.788	N.m
RUDDER STOCK				
Safety Factor	SF		3.34	
Ultimate Tensile Strength (Aluminium 5000 Series)	UTS		245	N/mm ²
Rudder Stock Diameter			179.563	mm
Selected Rudder Stock Diameter			200	mm
Length of Rudder Stock			500	mm
Volume of Rudder Stock			15707963	mm ³
Volume of Rudder Stock			0.016	m ³
Weight of Rudder Stock			41.626	kg
TOTAL WEIGHT OF RUDDER			198.718	Kg

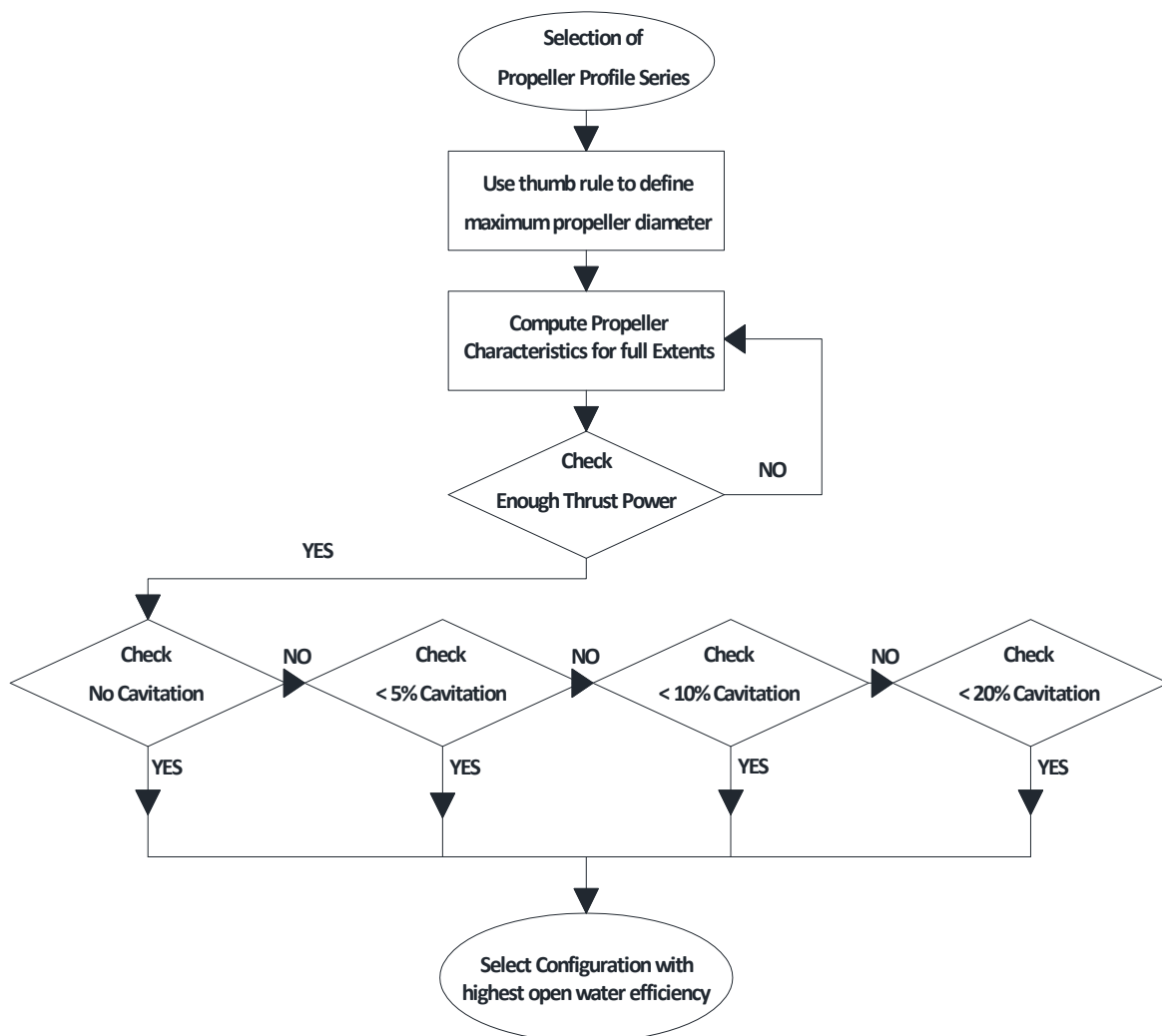
* The Rudder and Rudder Stock Design and Selection is based on
 "Boat Mechanical Systems Handbook - by Dave Gerr" ISBN: 978-0-07-164334-4

PROPELLER

The driving force and at the same time one of the major source for ship vibrations, the selection places very critical role in the efficiency of operation for a vessel. The Wageningen propeller being the most suitable profile for most vessel types, it was decided to select **Bronze made Fixed Pitch Wageningen B Series propeller** for all vessels but based on the configuration best suited for each vessel specifically.

As explained earlier chapters, the vessel uses a diesel electric propulsion system, which gives us the unique advantage of running the propeller at a speed that provides maximum efficiency. But efficiency is not the only factor, Back Cavitation also plays very critical role in selection process. Thus after finalising the diameter, various configurations of propeller profiles were tested for back cavitation based on Burrill's cavitation chart and then the configuration with maximum efficiency was selected.

The flow chart below shows the work flow of propeller selection.



Flow chart for propeller selection for electrically driven propeller

PROPELLER SELECTION

Once the resistance of all the vessels was finalised and validated with Potential Flow and RANSE solves, the next step was to finalise the diameter of the propeller. For the design it is evident that the rules for propeller clearances do not limit the diameter of propeller to a large extent. The maximum possible diameter considering keel clearance is approximately 2.6 m in loaded condition but considering the light ship condition and to ensure 100% propeller immersion the maximum diameter is limited to 2 m.

Based on the design thumb rule of it is said that the maximum diameter of the propeller is estimated by the rule

$$D_{max} = \frac{2}{3} * \text{Loaded/Design Draft } (T)$$

At a design draft of 3.2m,

$$D_{max} = 2.13 \text{ m (approximately)}$$

Considering this diameter was selected as 2.0 m and propeller.

To evaluate the characteristics such as number of blades, BAR, P/D ratio, the propeller design were analysed for thrust, torque, efficiency and cavitation, based on the equation mentioned below in conjunction with KT and KQ curves.

$$\text{wake fraction } (w) = 0.5 C_B - 0.05 = 0.3795$$

$$\text{Velocity of Advance } (V_A), \frac{m}{s} = (1 - w) * V$$

$$\text{Thrust Coefficient } (K_T) = \frac{T}{\rho * n^2 * D^4}$$

$$\text{Advance Ratio } (J) = \frac{V * A}{n * D}$$

For plotting KT and KQ curves the equations are as follows

$$KT = \sum_{n=1}^{39} Cn(J)^{Sn} * \left(\frac{P}{D}\right)^{tn} * \left(\frac{A_E}{A_0}\right)^{un} * (Z)^{vn}$$

$$KQ = \sum_{n=1}^{47} Cn(J)^{Sn} * \left(\frac{P}{D}\right)^{tn} * \left(\frac{A_E}{A_0}\right)^{un} * (Z)^{vn}$$

The above equations are for Wageningen B-Series were represented for Reynolds No. (R_n) = 2×10^6 , for other Reynolds numbers with in the range of 2×10^6 to 2×10^9 we use the equation as follows:

$$KT(R_n) = KT(R_n = 2 * 10^6) + \Delta KT(R_n)$$

$$KQ(R_n) = KQ(R_n = 2 * 10^6) + \Delta KQ(R_n)$$

To eliminate the unknown quantity rotation per second (n)

$$\frac{K_T}{J^2} = \frac{T}{\rho * D^2 * V * A^2}$$

After plotting the curve of K_T as a function of J, we find the value of J using non-linear solver. Then using that value of J, the rotation per second is calculated as

$$n = \frac{V * A}{J * D}$$

And the open water efficiency as

$$\eta_0 = \frac{J * K_T}{2 * \pi * K_Q}$$

To optimise the calculation, it was decided to use the extents of Wageningen B Series as mentioned in the table below

Extents of Wageningen B-Series Propeller															
No. of Blades (Z)	BLADE AREA RATIO A_E/A_0														
2	0.30														
3		0.35			0.50			0.65			0.80				
4			0.40			0.55			0.70			0.85			1.00
5				0.45			0.60			0.75					1.05
6					0.50			0.65			0.80				
7						0.55			0.70			0.85			

Extents of Wageningen B-Series Propeller

Based on the extents mention for different P/D ratios, a total of 200 propeller configurations were obtained. These configurations were then tested to evaluate the ability to provide the required thrust based on the efficiency as assumed and mentioned below.

Two major considerations were made to limit the propeller variables further i.e.:

a) Range of Developed is,

$$1.1 \text{ PE} \leq \text{Developed PT} \leq 1.3 \text{ PE};$$

b) Propeller Efficiency (η_0) = 50% or higher.

DEVELOPED THRUST AND CAVITATION TEST

The 200 propellers configurations were tested for various RPM. All operating speeds of these 200 propellers which satisfied the condition of

$$1.1 \text{ PE} \leq \text{Developed PT} \leq 1.3 \text{ PE}$$

were then tested for back cavitation. This was carried out using the Burrill's Cavitation Test, using the equations as mentioned below.

Cavitation number

$$Cavitation\ Number\ (\sigma_{0.7R}) = \frac{P_{atm} - P_v + \rho gh}{0.5 * \rho * [V_A^2 + (0.7 * \pi * n * D)^2]}$$

Thrust loading on blades

$$Thrust\ Loading\ on\ Blade\ (\tau) = \frac{\frac{T}{A_p}}{0.5 * \rho * [V_A^2 + (0.7 * \pi * n * D)^2]}$$

The equation for Burrill's Cavitation Chart are as follows

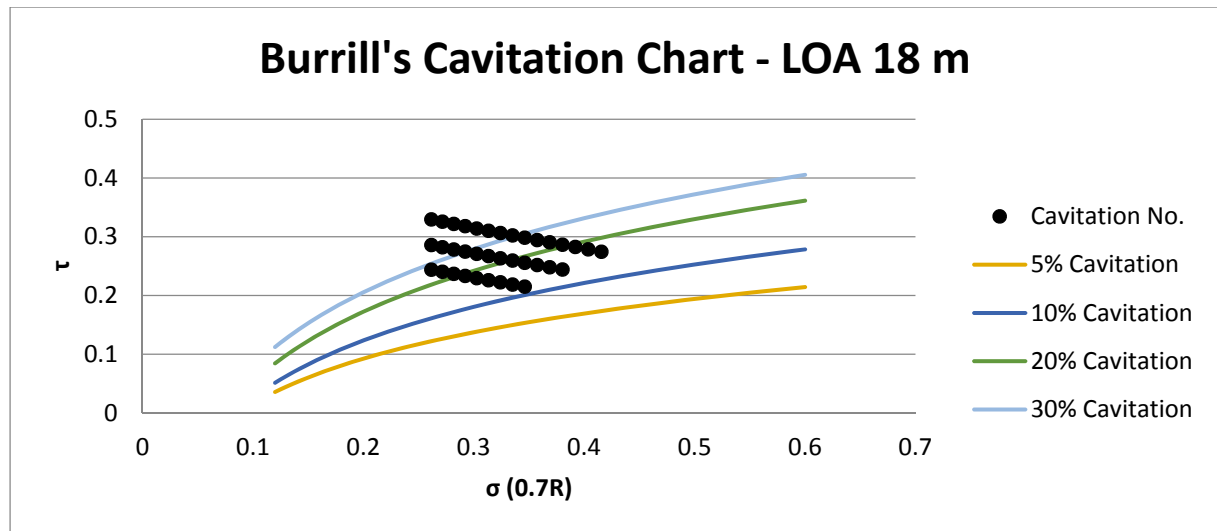
$$\text{For 5\% back cavitation} \quad \tau = 0.11104 * \ln(\sigma) + 0.27104$$

$$\text{For 10\% back cavitation} \quad \tau = 0.1412 * \ln(\sigma) + 0.3506$$

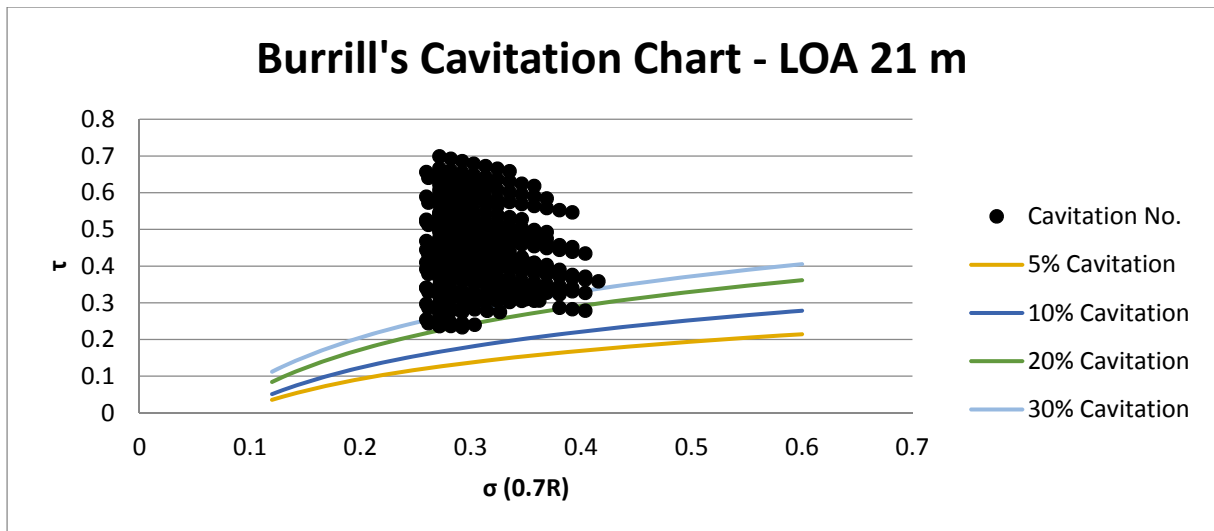
$$\text{For 20\% back cavitation} \quad \tau = 0.1722 * \ln(\sigma) + 0.4494$$

$$\text{For 30\% back cavitation} \quad \tau = 0.1822 * \ln(\sigma) + 0.4985$$

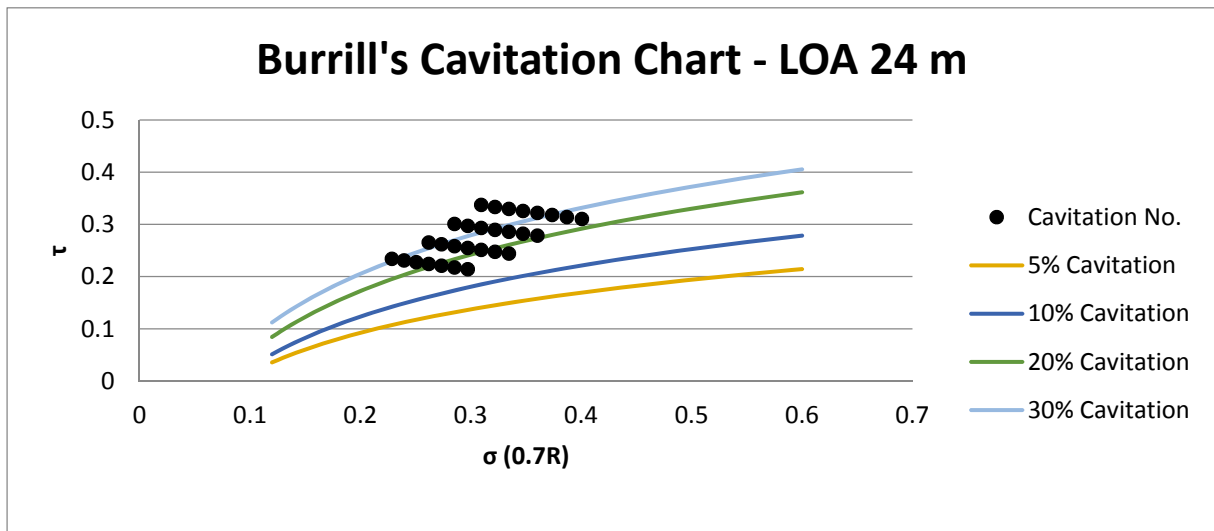
The final Burrill's charts below depict the result of cavitation test for all the three propeller.



Burrill's Cavitation Chart for 18 m LOA Vessel



Burrill's Cavitation Chart for 21 m LOA Vessel



Burrill's Cavitation Chart for 24 m LOA Vessel

A closer look at the charts will show that for all the three vessel lengths there were no propeller configurations with less than 10% back cavitation. For all there were 4 to 5 propellers which had less than 20% back cavitation.

Based on that the final configuration for all the propellers was selected and the same are mention in the table below.

DETAILS OF THE FIXED PITCH PROPELLERS SELECTED				
S. NO.	PARAMENTER	LOA - 18 m	LOA - 21 m	LOA - 24 m
1	Propeller Diameter (D), m	2.0	2.0	2.0
2	No. of Blades (Z)	5	5	5
3	Ratio A_E/A_0	1.05	1.05	1.05
4	Pitch/Diameter Ration (P/D)	1.2	1.4	1.1
5	RPM	341	313.5	407.2
6	Open Water Efficiency (η_o)	68.7	66.1	63.09
7	Back Cavitation	<20%	<20%	<20%
8	Propeller Type	Fixed Pitch	Fixed Pitch	Fixed Pitch
9	Material	Bronze	Bronze	Bronze

Details of the selected Propeller Configurations

ANNEX – 4

POWERPLANT AND ELECTRICAL LOAD

ELECTRICAL LOAD CHART FOR CM-SWAS(S)H - 18 m																	
NO.	POWER RECEIVERS	QUANTITY INSTALLED	QTY. IN USE	MAX. POWER EACH IN (KW)	INSTALLED POWER (KW)	SAILING			HARBOUR			MANOUVRING			EMERGENCY		
						LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)
1	PROPULSION MOTOR	1	1	1500	1765	0.8	1	1412	0.8	0	0.00	0.8	1	1412	0.8	0	0.00
2	STEERING GEAR	1	1	4.00	4.71	0.8	1	3.76	0.8	0	0.00	0.8	1	3.76	0.8	0	0.00
4	LO STANDBY PUMP FOR ME	2	2	2.57	3.02	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97
6	SEA WATER COOLING PUMP	2	1	2.00	2.35	0.8	0.5	0.94	0.8	0.4	0.75	0.8	0.5	0.94	0.8	0.5	0.94
7	BILGE/GS/FIRE/BALLAST PUMP	2	2	1.50	1.76	0.8	0.2	0.56	0.8	0.2	0.56	0.8	0.2	0.56	0.8	1	2.82
8	FO TRANSFER PUMP	2	1	0.75	0.88	0.8	0.7	0.49	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14
9	FW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
10	SW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
11	SEWAGE PUMP	1	1	1.50	1.76	0.8	0.4	0.56	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
13	HOT WATER CALORIFIER	1	1	5.00	5.88	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0	0.00
14	HOT WATER CIRCULATING PUMP	1	1	0.40	0.47	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0	0.00
15	ER VENTILATION FANS	2	2	2.50	2.94	0.8	1	4.71	0.8	0.2	0.94	0.8	1	4.71	0.8	1	4.71
16	EXHAUST FAN FOR GALLEY	1	1	0.60	0.71	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56
17	SUPPLY FAN FOR GALLEY	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
18	A/C PLANT ACCOMODATION	1	1	25.00	29.41	0.8	0.6	14.12	0.8	0.6	14.12	0.8	0.6	14.12	0.8	0	0.00
19	STEERING GEAR ROOM SUPPLY FAN	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
20	SUPPLY FAN FOR BOW THRUSTER ROOM	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
21	SUPPLY FAN FOR DECK STORE FWD	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
22	SUPPLY FAN FOR DECK STORE AFT	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
24	EXHAUST FAN FOR TOILETS	1	1	0.40	0.47	0.8	0.8	0.30	0.8	0.2	0.08	0.8	0.8	0.30	0.8	0.8	0.30
25	EXHAUST FAN FOR PROV. STORE	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
28	GALLEY EQUIPMENT	1	1	20.00	23.53	0.8	0.5	9.41	0.8	0.1	1.88	0.8	0.2	3.76	0.8	0	0.00
30	DIRTY OIL TRANSFER PUMP	1	1	0.74	0.87	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0	0.00
32	BOW THRUSTER	1	1	38.00	44.71	0.8	0	0.00	0.8	0	0.00	0.8	0.4	14.31	0.8	0	0.00
33	WINDLASS	1	1	4.30	5.06	0.8	0	0.00	0.8	0.8	3.24	0.8	0	0.00	0.8	0	0.00
34	GENERAL PURPOSE WINCHES	1	1	32.00	37.65	0.8	0.2	6.02	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
39	BATTERY	1	1	6.00	7.06	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0	0.00
40	EMERGENCY LIGHTING SYSTEM	1	1	4.00	4.71	0.8	0.6	2.26	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
41	NAVIGATIONAL LIGHTS INCL. SEARCH LIGHTS	2	1	1.50	1.76	1	0.9	1.59	1	0.5	0.88	1	0.9	1.59	1	1	1.76
42	NAV AND COMMUNICATION EQUIPMENT	1	1	2.00	2.35	1	0.8	1.88	1	0.4	0.94	1	0.8	1.88	1	1	2.35
43	LIGHTING AND BATTERY CHARGER	2	1	3.00	3.53	1	1	3.53	0.8	1	2.82	0.8	1	2.82	0.8	1	2.82
TOTAL POWER						1467			31.14			1466			18.97		
LOAD IN KW						1467			31.14			1466			18.97		
LOAD IN KVA						1834.1			38.922			1832.6			23.709		
TOTAL LOAD IN KVA WITH 20% RESERVE						2201			46.706			2199.1			28.451		

ELECTRICAL LOAD CHART FOR CM-SWAS(S)H - 21 m

NO.	POWER RECEIVERS	QUANTITY INSTALLED	QTY. IN USE	MAX. POWER EACH IN (KW)	INSTALLED POWER (KW)	SAILING			HARBOUR			MANOUVRING			EMERGENCY		
						LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)
1	PROPULSION MOTOR	1	1	1750	2059	0.8	1	1647	0.8	0	0.00	0.8	1	1647	0.8	0	0.00
2	STEERING GEAR	1	1	4.00	4.71	0.8	1	3.76	0.8	0	0.00	0.8	1	3.76	0.8	0	0.00
4	LO STANDBY PUMP FOR ME	2	2	2.57	3.02	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97
6	SEA WATER COOLING PUMP	2	1	2.00	2.35	0.8	0.5	0.94	0.8	0.4	0.75	0.8	0.5	0.94	0.8	0.5	0.94
7	BILGE/GS/FIRE/BALLAST PUMP	2	2	1.50	1.76	0.8	0.2	0.56	0.8	0.2	0.56	0.8	0.2	0.56	0.8	1	2.82
8	FO TRANSFER PUMP	2	1	0.75	0.88	0.8	0.7	0.49	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14
9	FW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
10	SW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
11	SEWAGE PUMP	1	1	1.50	1.76	0.8	0.4	0.56	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
13	HOT WATER CALORIFIER	1	1	5.00	5.88	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0	0.00
14	HOT WATER CIRCULATING PUMP	1	1	0.40	0.47	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0	0.00
15	ER VENTILATION FANS	2	2	2.50	2.94	0.8	1	4.71	0.8	0.2	0.94	0.8	1	4.71	0.8	1	4.71
16	EXHAUST FAN FOR GALLEY	1	1	0.60	0.71	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56
17	SUPPLY FAN FOR GALLEY	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
18	A/C PLANT ACCOMODATION	1	1	40.00	47.06	0.8	0.6	22.59	0.8	0.6	22.59	0.8	0.6	22.59	0.8	0	0.00
19	STEERING GEAR ROOM SUPPLY FAN	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
20	SUPPLY FAN FOR BOW THRUSTER ROOM	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
21	SUPPLY FAN FOR DECK STORE FWD	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
22	SUPPLY FAN FOR DECK STORE AFT	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
24	EXHAUST FAN FOR TOILETS	1	1	0.40	0.47	0.8	0.8	0.30	0.8	0.2	0.08	0.8	0.8	0.30	0.8	0.8	0.30
25	EXHAUST FAN FOR PROV. STORE	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
28	GALLEY EQUIPMENT	1	1	20.00	23.53	0.8	0.5	9.41	0.8	0.1	1.88	0.8	0.2	3.76	0.8	0	0.00
30	DIRTY OIL TRANSFER PUMP	1	1	0.74	0.87	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0	0.00
32	BOW THRUSTER	1	1	42.00	49.41	0.8	0	0.00	0.8	0	0.00	0.8	0.4	15.81	0.8	0	0.00
33	WINDLASS	1	1	4.30	5.06	0.8	0	0.00	0.8	0.8	3.24	0.8	0	0.00	0.8	0	0.00
34	GENERAL PURPOSE WINCHES	1	1	32.00	37.65	0.8	0.2	6.02	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
39	BATTERY	1	1	6.00	7.06	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0	0.00
40	EMERGENCY LIGHTING SYSTEM	1	1	4.00	4.71	0.8	0.6	2.26	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
41	NAVIGATIONAL LIGHTS INCL. SEARCH LIGHTS	2	1	1.50	1.76	1	0.9	1.59	1	0.5	0.88	1	0.9	1.59	1	1	1.76
42	NAV AND COMMUNICATION EQUIPMENT	1	1	2.00	2.35	1	0.8	1.88	1	0.4	0.94	1	0.8	1.88	1	1	2.35
43	LIGHTING AND BATTERY CHARGER	2	1	3.00	3.53	1	1	3.53	0.8	1	2.82	0.8	1	2.82	0.8	1	2.82
TOTAL POWER						1711			39.61			1711			18.97		

LOAD IN KW	1711	39.61	1711	18.97
LOAD IN KVA	2138.8	49.51	2139.2	23.709
TOTAL LOAD IN KVA WITH 20% RESERVE	2566.6	59.412	2567	28.451

ELECTRICAL LOAD CHART FOR CM-SWAS(S)H - 24 m

NO.	POWER RECEIVERS	QUANTITY INSTALLED	QTY. IN USE	MAX. POWER EACH IN (KW)	INSTALLED POWER (KW)	SAILING			HARBOUR			MANOUVRING			EMERGENCY		
						LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)	LOAD FACTOR	UTILITY FACTOR	INPUT POWER (KW)
1	PROPULSION MOTOR	2	2	1250	1471	0.8	1	2353	0.8	0	0.00	0.8	1	2353	0.8	0	0.00
2	STEERING GEAR	1	1	4.00	4.71	0.8	1	3.76	0.8	0	0.00	0.8	1	3.76	0.8	0	0.00
4	LO STANDBY PUMP FOR ME	3	2	2.57	3.02	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97	0.8	0.2	0.97
6	SEA WATER COOLING PUMP	2	1	2.00	2.35	0.8	0.5	0.94	0.8	0.4	0.75	0.8	0.5	0.94	0.8	0.5	0.94
7	BILGE/GS/FIRE/BALLAST PUMP	2	2	1.50	1.76	0.8	0.2	0.56	0.8	0.2	0.56	0.8	0.2	0.56	0.8	1	2.82
8	FO TRANSFER PUMP	3	1	0.75	0.88	0.8	0.7	0.49	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14
9	FW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
10	SW HYDROPHORE PUMP	2	1	0.50	0.59	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09	0.8	0.2	0.09
11	SEWAGE PUMP	1	1	1.50	1.76	0.8	0.4	0.56	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
13	HOT WATER CALORIFIER	1	1	5.00	5.88	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0.2	0.94	0.8	0	0.00
14	HOT WATER CIRCULATING PUMP	1	1	0.40	0.47	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0.2	0.08	0.8	0	0.00
15	ER VENTILATION FANS	2	2	2.50	2.94	0.8	1	4.71	0.8	0.2	0.94	0.8	1	4.71	0.8	1	4.71
16	EXHAUST FAN FOR GALLEY	1	1	0.60	0.71	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56	0.8	1	0.56
17	SUPPLY FAN FOR GALLEY	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
18	A/C PLANT ACCOMODATION	1	1	55.00	64.71	0.8	0.6	31.06	0.8	0.6	31.06	0.8	0.6	31.06	0.8	0	0.00
19	STEERING GEAR ROOM SUPPLY FAN	1	1	0.30	0.35	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28	0.8	1	0.28
20	SUPPLY FAN FOR BOW THRUSTER ROOM	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
21	SUPPLY FAN FOR DECK STORE FWD	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
22	SUPPLY FAN FOR DECK STORE AFT	1	1	0.30	0.35	0.8	0.8	0.23	0.8	0.2	0.06	0.8	0.8	0.23	0.8	0.8	0.23
24	EXHAUST FAN FOR TOILETS	1	1	0.40	0.47	0.8	0.8	0.30	0.8	0.2	0.08	0.8	0.8	0.30	0.8	0.8	0.30
25	EXHAUST FAN FOR PROV. STORE	1	1	0.25	0.29	0.8	0.8	0.19	0.8	0.2	0.05	0.8	0.8	0.19	0.8	0.8	0.19
28	GALLEY EQUIPMENT	1	1	20.00	23.53	0.8	0.5	9.41	0.8	0.1	1.88	0.8	0.2	3.76	0.8	0	0.00
30	DIRTY OIL TRANSFER PUMP	1	1	0.74	0.87	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0.2	0.14	0.8	0	0.00
32	BOW THRUSTER	1	1	48.00	56.47	0.8	0	0.00	0.8	0	0.00	0.8	0.4	18.07	0.8	0	0.00
33	WINDLASS	1	1	4.30	5.06	0.8	0	0.00	0.8	0.8	3.24	0.8	0	0.00	0.8	0	0.00
34	GENERAL PURPOSE WINCHES	1	1	32.00	37.65	0.8	0.2	6.02	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
39	BATTERY	1	1	6.00	7.06	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0.2	1.13	0.8	0	0.00
40	EMERGENCY LIGHTING SYSTEM	1	1	4.00	4.71	0.8	0.6	2.26	0.8	0	0.00	0.8	0	0.00	0.8	0	0.00
41	NAVIGATIONAL LIGHTS INCL. SEARCH LIGHTS	2	1	1.50	1.76	1	0.9	1.59	1	0.5	0.88	1	0.9	1.59	1	1	1.76
42	NAV AND COMMUNICATION EQUIPMENT	1	1	2.00	2.35	1	0.8	1.88	1	0.4	0.94	1	0.8	1.88	1	1	2.35
43	LIGHTING AND BATTERY CHARGER	2	1	3.00	3.53	1	1	3.53	0.8	1	2.82	0.8	1	2.82	0.8	1	2.82
TOTAL POWER						2425			48.08			2428			18.97		

LOAD IN KW	2425	48.08	2428	18.97
LOAD IN KVA	3031.8	60.098	3034.9	23.709
TOTAL LOAD IN KVA WITH 20% RESERVE	3638.1	72.118	3641.9	28.451

ANNEX – 5

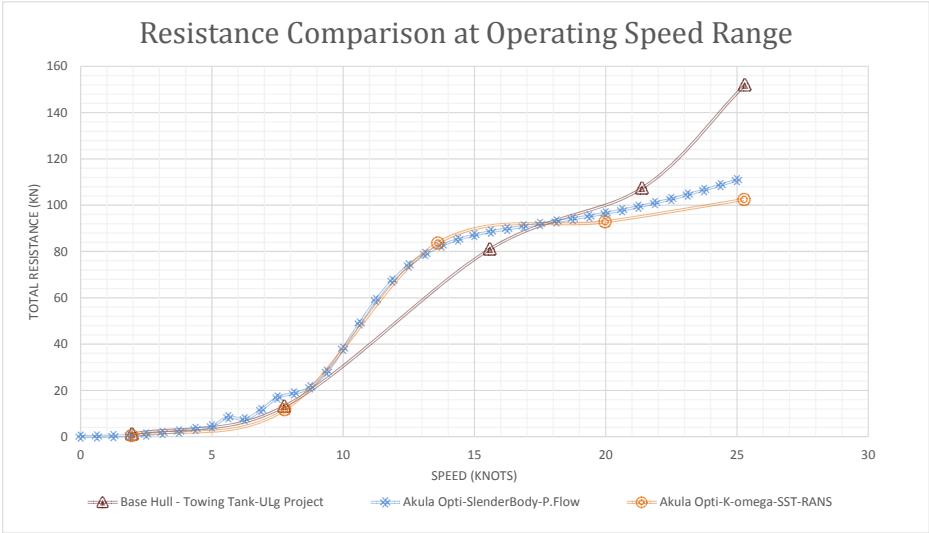
RESISTANCE AND POWER

RESISTANCE DATA FOR OPTIMISATION

Akula-OptiHull	
Potential Flow Results	
Speed (Knots)	Resistance (kN)
0	0
0.625	0.1
1.25	0.2
1.875	0.5
2.5	0.9
3.125	1.6
3.75	2.2
4.375	3.3
5	4.4
5.625	8.4
6.25	7.5
6.875	11.5
7.5	16.9
8.125	18.7
8.75	21.3
9.375	28
10	38
10.625	48.9
11.25	59
11.875	67.4
12.5	74
13.125	78.9
13.75	82.6
14.375	85.2
15	87.1
15.625	88.6
16.25	89.8
16.875	90.9
17.5	91.9
18.125	93
18.75	94.1
19.375	95.2
20	96.5
20.625	97.9
21.25	99.4
21.875	101
22.5	102.7
23.125	104.6
23.75	106.6
24.375	108.7
25	110.9

Akula-OptiHull		
RANS Results		
Speed (m/sec)	Speed (Knots)	Resistance (kN)
1	1.94	0.40
4	7.78	11.60
7	13.61	83.62
10.28	19.98	92.82
13	25.27	102.47

Base Hull	
Towing Tank Results	
Speed (Knots)	Resistance (kN)
1.96	1.13
7.76	13.05
15.59	80.98
21.38	107.37
25.30	151.94



Resistance Comparison for Hull Optimisation			
VESSEL TYPE	Resistance (kN)		
	Base	Akula-Opti	% Reduction
18 m CM-SWAS(S)H	151.80	102.50	32.48
21 m CM-SWAS(S)H	172.40	134.10	22.22
24 m CM-SWAS(S)H	198.33	146.20	26.28

Power Comparison for Advanced Hybrid Power Plant			
VESSEL TYPE	Power (kW)		
	DE	Adv-Hybrid	% Reduction
18 m CM-SWAS(S)H	1650.00	1467.00	11.09
21 m CM-SWAS(S)H	2100.00	1711.00	18.52
24 m CM-SWAS(S)H	2850.00	2425.00	14.91

RESITANCE AND POWER COMPARISON

