40m Sailing Yacht Design

EEN702 - SUPERYACHT DESIGN PRINCIPLES

ABSTRACT

The following report outlines the design proposal of a race oriented 40 metre cruising sailing yacht. The portfolio covers the initial design stage of the vessel, with particular consideration into completing critical aspects of the preliminary design work. Following the data collected during the parametric study, the initial parameters concerning the hull, rig and weight specification are established. The space plan of the boat can accommodate up to 8 guest and 4 crew as required by the design brief. All the design aspects covered on the portfolio ensure full compliance with the REG Ensign Group Yacht Code - Part A.

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1. Introduction

The following report represents the design proposal of a 40-metre sailing yacht. The yacht is intended to be a lightweight race-oriented sailing vessel with world cruising capabilities. Similar size and service vessels are considered to establish the main design parameters. Moreover, the design is established to meet the rules and regulation provided by the yacht code. An initial weight estimation analysis is presented, followed by an intact and damage stability study. Furthermore, the hull form and the general arrangement details are presented in the drawings.

2. Initial Considerations

2.1. Parametric study

The parametric study consists on initially analysing vessels relevant to the design, to establish the initial parameters of the yacht. The vessels considered in the parametric study shared a similar size and intended use. As the data was mainly collected from manufacturer's publications, multiple external sources such as ORC rating certificates were employed to ensure the accuracy of the parameters. However, the information was not considered to be entirely accurate and was therefore employed with great care due to its limitations. The use of a very large number of yacht parameters in such a study could lead to inaccurate result due to high number of scatters in the data. Therefore, 25 yachts were considered in the study, categorized as fast cruisers or performance cruisers. The yacht category was established based on the slenderness ratio and sail area displacement ratio of the yacht.

The determination of the fully loaded displacement of the yacht was one of the key aspects of the study. The yacht was considered to be a performance cruiser, since it was a lightweight race-oriented boat. A fully loaded displacement of 130 tonnes was established based on the data collected from the parametric. Based on the displacement, an engine power of 410 kW and an upwind sail area of 815 square metres were established. Moreover, the study specified a draft of 5.8 metres for the established sail area. Since no trends were identified on the study regarding fuel and fresh water capacities, a vessel with a similar intended use was used as reference to establish the capacities. The black and grey tank capacities were established following the regulation for sewage waste given by the MARPOL Annex IV [Ref.1]. Moreover, an average of 0.004 m^3 of sewage was considered to be produced per person per day [Ref.2]. Assuming a maximum of 4 days before discharge, 1.7 m^3 tanks were required to satisfy the requirements for 12 people onboard. Further parametric data can be found in Appendix 6.1.

2.2. Design Parameters

• Gross Tonnage	193.0	GT	• Sail Area	815	m^2
• Displacement:	130.1	tonnes	• Air Draft:	55.0	m
• Ballast Weight:	49.5	tonnes	• Fuel Capacity:	6000	liters
• Length Overall:	40.2	m	• Fresh Water Capacity:	3000	liters
• Breadth Overall:	8.2	m	• Engine Power:	410	kW
• Draft Keel Down:	5.8	m	• Range:	2000	nm

2.3. Regulatory Framework

The yacht was designed in accordance with the design criteria established by the REG Ensign Group (REG) - Part A [Ref.3], for yachts which are 24 metres and over in load line length, are in commercial use for sport or pleasure, do not carry cargo and do not carry more than 12 passengers. As required by the tender document, the yacht is intended for world cruising capabilities. Therefore, the design criteria was established for unrestricted geographical operation excluding Polar Regions. Since no reference is made in the tender document regarding operation in Polar Regions, the yacht was not required to meet the IMO Polar Code.

2.4. Initial Stability

The stability of the yacht is governed by the position of the centre of gravity. Since the weight and centres of the yacht were initially unknown, a limiting KG analysis was completed. This analysis considered a range of displacements (lightship 120T to full load 130T) and for these, the highest vertical position of KG was calculated ensuring the intact stability criteria provided by the code [*REG Part A, 11.2*] was met. The cockpit hatch was considered along the analysis as the critical down flooding point. The results are showed in Table 1.

Displacement [tonnes]	LCG $_{FOFP}$ [m]	VCG [m]	KG $_{LIMIT}$ [m]	GM $_{MIN}$ [m]	Criterion	Name
120	-18.795	1.076	2.397	1.743	11.2.2.1 Monohulls	11.2.2.1.2 Range of positive stability
125	-18.87	1.069	2.39	1.728	11.2.2.1 Monohulls	11.2.2.1.2 Range of positive stability
130	-18.945	1.062	2.383	1.715	11.2.2.1 Monohulls	11.2.2.1.2 Range of positive stability

Table 1: Limiting KG results.

The location of the forward and aft collision bulkheads were arranged so that if any damage would cause either of the two compartments to flood, the vessel would float at a waterline no less than 75 millimetres below the weather deck [*REG Part A, 11.3(3)*]. Furthermore, the length of the aft compartment was also guided by the garage length required to fit a tender.

The maximum compartment lengths located within the forward collision bulkhead and the aft collision bulkhead were established using a floodable length calculation assuming a higher than expected VCG of 0.75 metres above the DWL. With reference to the designed bulkhead position, the actual compartment lengths were in a maximum of 69% of the allowable length. This ensured that each compartment when flooded passed the required damage stability criteria. Table 2 shows the percentage of maximum allowable length each compartment is and also the freeboard when each compartment is flooded.

Compartment	Compartment L. [m]	Floodable L. [m]	Margin %	Freeboard $_{MIN}$ [mm]
Collision	2.69			2097
Crew Accomodation	8.51	12.35	69%	1686
Guest Living Spaces	7.23	14.01	52%	1887
Engine Room	5.40	22.49	24%	1858
Guest Accomodation	9.21	17.14	54%	1515
Garage	6.00			2018

Table 2: Compartment distribution for damage stability.

3. Outline Specification

3.1. General Arrangement

Guest accommodation is located aft of the engine room compartment, and it is accessed from the centreline staircase located on the compartment above the engine room. Guest accommodation is divided in 4 double cabins; comprising a master cabin, a VIP cabin and two double cabins: overall accommodating the 8 guests. Guest accommodation was placed aft of the engine room to provide a greater comfort while on passage, as the motions are considerably smaller closer to the longitudinal centre of flotation (LCF).

The specifications for the crew accommodation was established following the rules and requirements provided by the REG Ensign Part A for vessels of 200GT (gross tonnage) and over.

Provided a headroom requirement of 203 centimetres on crew accommodation areas given by the code [*REG Part A, 21B.3(1)*], a headroom of 210 centimetres was established to ensure full and free movement in all seafarer accommodation.

With regard to the means of escape on crew accommodation, two means of escape are provided from every restricted space or group of spaces. As the accommodation arrangement is accessed through another compartment, the escape routes were located as remote as possible from the main route and accessible through hatches of adequate size leading to the open deck, as required by the code [*REG Part A, 14A.3(2)*].

Sleeping accommodation was established to ensure the compliancy with the requirements provided by the code for vessels of 200GT and less than 500GT [*REG Part A, 21B.8(3)*]. Because locating the sleeping rooms amidships or aft was impracticable, sleeping rooms were located in the fore part of the vessel, aft of the collision bulkhead and under areas not subjected to excessive noise or vibration during operation. All accommodation was located above the deepest waterline as required. The yacht was required to accommodate 4 crew members; therefore, 4 berths in two cabins were required to ensure a separate berth for each seafarer. Berth and clothes locker dimensions were established ensuring the minimum permitted size for each seafarer was met. Since the cabins are occupied by two seafarers with en-suite sanitary facilities, a floor area of 6.2 square metres is required. Moreover, an adequate mess area was designed. As the vessel was under 200GT, no minimum mess area was required. As shown in Appendix 6.5, crew areas meet the crew accommodation requirements given by the code.

3.2. Weight Estimate

The weights and centres of the structure were estimated by analysing the scantling requirements of the vessel in accordance with a classification society, as required by the code [*REG Part A, 4.2*]. Lloyds Registers Classification of Special service Crafts [Ref.4] was established as the Classification society concerning the structural strength of the yacht. Due to the world cruising capabilities of the yacht a G6 service area was considered, which covers yachts with unrestricted service. In order to achieve the light structure required for the yacht, carbon fibre and SAN A core sandwich construction was employed. Due to the early stage of the design, the scantling requirements were only analysed for hydrostatic pressure loads and sized accordingly. In order to account for greater scantling requirements due to the local and global loads not considered in the analysis, the scantlings were dimensioned with great compliance margins. Initial scantling results are showed in Appendix 6.6.

Although the accommodation spaces are specified in Drawing 2, the detailed list of the components onboard were unknown at this stage. In order to complete the weight estimate of the interior spaces, the compartments were analysed per areas. The area boundaries were established based on the use of the space. Therefore, the compartments were divided in accommodation spaces, service spaces and public spaces, as defined by the code [*REG Part A, 2.1].* The following weights per area were assumed based on previous weight and centres estimation results:

Space	Definition	Weight / Area Kg/m^2
Accomodation	Spublic spaces used for corridors, lavatories, cabins and offices.	50.0
Public	Portions of the accomodation used for halls, dining rooms and lounges.	100.0
Service	Spaces used for galleys, lockersa and store-roms.	200.0

The rig dimensions and weight were provided by a rig distributor, for a yacht of a similar size. Although the rig dimensions provided were established for a similar size boat, the air draft and sail area were slightly lower than what required. Therefore, the weight of the rig and the centre of gravity of the components were raised to account for the increase in sail area and mast tube length.

The weight estimate resulted with a lightship displacement of 91 tonnes, which was a 23% lower than the target fully loaded displacement. Due to the early design stage the systems and individual items onboard were not considered, which would later increase the lightship displacement. The unknown weight was assumed to be distributed along the length of the vessel at 0.7 metres above the design waterline (DWL). The resulting VCG was established at 0.366 metres above the DWL. The full weights and centres analysis are shown in Appendix 6.4.

3.3. Stability Results

The final stability analysis was completed for the lightship displacement with the VCG established on the weight study. Lightship condition was employed for the analysis, as it was the displacement condition that resulted with the highest vertical centre of gravity. The stability analysis showed that the vessel at the established VCG would comply with the intact and damage stability requirements given by the code [*REG Part A, 11.1*]. Further stability results are shown in Appendix 6.7.

4. Conclusion

The parametric study provided the relevant data required to establish the main parameters of the yacht. Although a short range of data was employed, the collected data was checked with multiple sources to ensure a reasonably accurate data was employed on the study. The weight estimate was completed as accurate as possible, given the weight and the components known to be onboard the yacht. However, a 23% of the overall displacement resulted unknown on the study. Although the lightship displacement limitation, the weight estimate results were considered to be relevant for the study considering the early stage of the design. The scantling dimensions were only employed for the weight study, due to the uncertainties and limitations associated with the analysis. As the scantling dimensions were stablish based on local hydrostatic pressures, further work shall be done to evaluate the structure under local and global loads. All in all, the design proposal meets the requirements provided by the client in the design brief.

5. REFERENCES

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REF 2. Marineinsight.com. (2019). MARPOL ANNEX 4 Explained: How to Prevent Pollution from Sewage at Sea. [online] Available at: https://www.marineinsight.com/maritime-law/marpol-annex-4-explained-how-to-prevent-pollution-from-sewage-at-sea/ [Accessed 21 Nov. 2019].

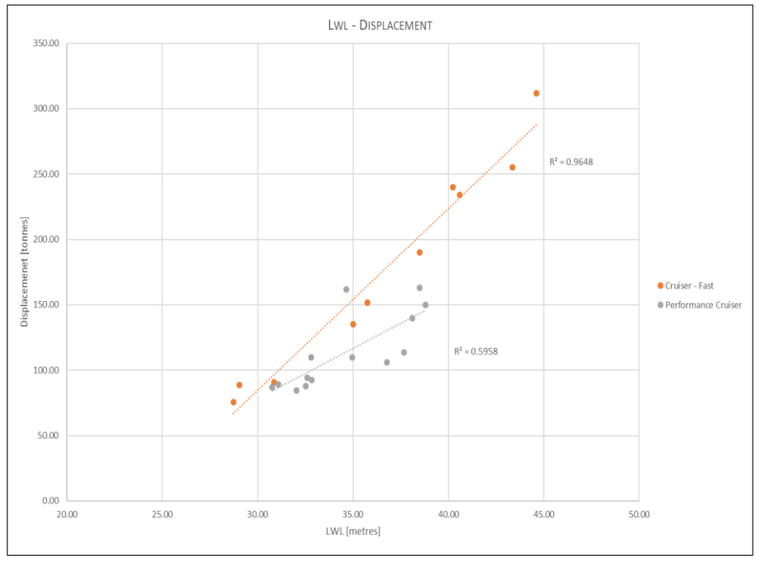
REF 3. Red Ensign Yacht Code - Part A. (2019). 1st ed. [pdf] Red Ensign Group. Available at: https://www.redensigngroup.org/media/1094/reg-yacht-code-january-2019-edition-part-a.pdf [Accessed 21 Nov. 2019].

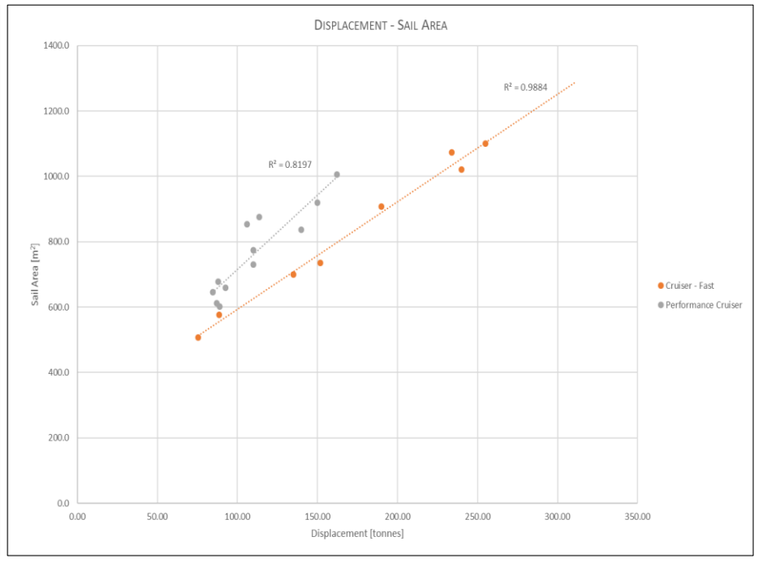
REF 4. Rules and Regulations for the Classification of Special Service Craft. (2019). [pdf] London: Lloyd's Register Group Limited. Available at: https://www.lr.org/en/rules-and-regulations-for-the-classification-of-special-service-craft/ [Accessed 21 Nov. 2019].

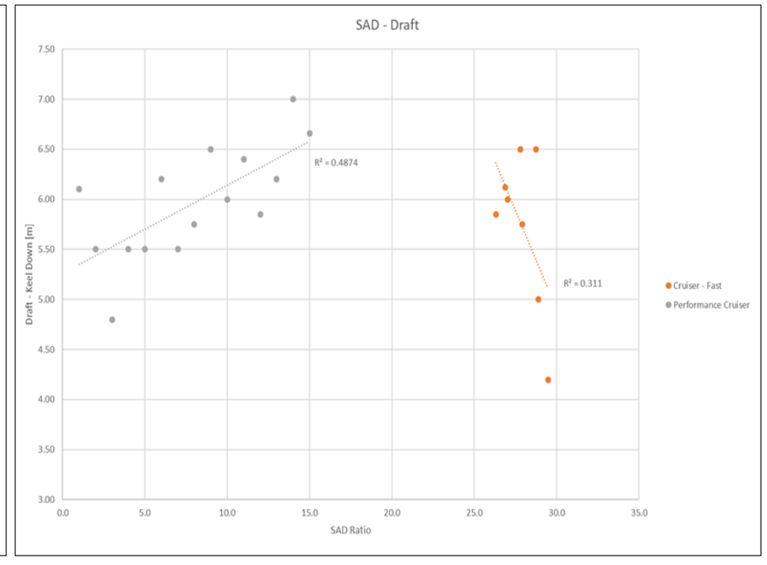
6. Appendix

Appendix 6.1. Parametric Study

Category	Brand	Model	LOA [m]	LWL [m]	BOA [m]	D (KEEL UP) [m]	D (KEEL DOWN) [m]	Displ. [tonnes]	Ballast [tonnes]	SA [m^2]	Hull Material	Max. Speed [Knots]	Range [Nm]	Sr	SAD	E. Power [kW]	Generators [kW]	Fuel Cpty. [L]	F.Water Cpty. [L]
Cruiser - Fast	Vitters Yachts	S/Y NINGALOO	44.70	40.23	9.04	4.10	6.12	240.00	45.00	1021.0	Aluminium	14	2000	6.5	26.9	533	#N/A	6320	2200
Cruiser - Fast	Wally Yachts	S/Y KENORA	32.72	29.05	7.92	#N/A	4.20	88.50	#N/A	576.0	GRP	18	4000	6.6	29.5	287	55	4200	2400
Cruiser - Fast	Fitzroy Yachts	S/Y ZEFIRA	49.69	44.60	10.00	#N/A	4.90	312.00	#N/A	#N/A	Aluminium	12	1500	6.6	#N/A	644	#N/A	9000	5500
Cruiser - Fast	Vitters yachts	S/Y GANESHA	46.00	40.60	9.00	4.50	6.50	234.00	48.00	1074.0	Aluminium	14	#N/A	6.6	28.8	533	#N/A	20000	5400
Cruiser - Fast	Vitters Yachts	S/Y MYSTERE	43.20	38.50	8.80	3.70	5.75	190.00	40.00	908.0	Aluminium	15	1800	6.8	27.9	610	130	12700	5800
Cruiser - Fast	Baltic Yachts	S/Y CANICA	42.93	35.75	8.34	3.50	5.85	151.70	56.37	736.0	GRP	14	3000	6.8	26.3	745	65	9500	3000
Cruiser - Fast	Wally Yachts	S/Y WALLY B	32.72	28.72	7.92	#N/A	5.00	75.50	#N/A	507.6	GRP	14	#N/A	6.9	28.9	313	45	4300	2500
Cruiser - Fast	Vitters Yachts	S/Y CINDERELA IV	39.00	35.00	8.40	3.80	6.00	135.00	#N/A	700.0	Carbon F.	12	#N/A	6.9	27.0	335	#N/A	8000	3000
Cruiser - Fast	Vitters Yachts	S/Y UNFURLED	46.00	43.36	9.80	5.04	6.50	255.00	54.50	1100.0	Alu. 5083	14	2461	6.9	27.8	690	#N/A	19600	6946
Cruiser - Fast	Holland Jachtbouw	S/Y A SULANA	37.00	30.86	8.25	#N/A	1.56	91.00	#N/A	#N/A	Aluminium	12	#N/A	6.9	#N/A	368	110	14000	4000
Cruiser - Fast	Vitters Yachts	S/Y LADY D	44.70	40.20	9.00	4.40	6.10	#N/A	45.00	1021.0	Aluminium	#N/A	#N/A	#N/A	#N/A	533	110	22000	6320
Performance Cruiser	Perini Navi	S/Y DAHLAK	38.00	34.66	8.38	3.50	5.50	162.00	#N/A	1005.0	Aluminium	14	1700	6.4	34.4	418	#N/A	7000	3200
Performance Cruiser	Vitters Yachts	S/Y GHOST	37.40	32.80	7.45	#N/A	4.80	110.00	40.00	730.0	Carbon F.	15	1800	6.9	32.3	366	58	8300	4500
Performance Cruiser	Baltic Yachts	S/Y NILAYA	34.14	30.76	7.52	3.50	5.50	87.00	34.00	612.0	Carbon F.	10	#N/A	7.0	31.7	265	#N/A	6000	2800
Performance Cruiser	Baltic Yachts	S/Y PATH	35.77	31.10	7.98	3.50	5.50	89.00	34.80	601.3	Carbon F.	14	3300	7.0	30.7	302	80	6000	2800
Performance Cruiser	Vitters Yachts	S/Y SARISSA	42.65	38.50	8.30	4.00	6.20	163.00	38.00	#N/A	Carbon F.	10	#N/A	7.1	#N/A	366	#N/A	37380	10440
Performance Cruiser	Baltic Yachts	S/Y DORYAN	35.50	32.60	8.25	3.50	5.50	94.35	32.00	#N/A	Carbon F.	13	#N/A	7.2	#N/A	280	#N/A	8000	3000
Performance Cruiser	Nautor's Swan	115 FD	35.20	32.84	8.12	3.50	5.75	92.50	32.00	659.8	GRP	13	#N/A	7.3	32.8	331	64	5500	3000
Performance Cruiser	Wally Yachts	S/Y BLACK SAILS	39.95	34.95	7.90	4.50	6.50	110.00	#N/A	774.0	Carbon F.	13	#N/A	7.4	34.3	331	95	12000	10000
Performance Cruiser	Southern Wind	SW115	35.05	32.04	8.16	4.00	6.00	84.50	#N/A	645.0	GRP	13	2000	7.4	34.1	265	#N/A	#N/A	#N/A
Performance Cruiser	Wally Yachts	S/Y SAUDADE	45.19	38.80	8.57	4.40	6.40	150.00	#N/A	920.0	GRP	13	#N/A	7.4	33.1	533	110	14000	6000
Performance Cruiser	Baltic Yachts	S/Y NIKATA	35.00	32.52	8.07	3.65	5.85	88.00	33.00	678.0	GRP	15	1300	7.4	34.8	405	#N/A	12700	5800
Performance Cruiser	Wally Yachts	S/Y ESENSE	43.70	38.10	8.57	4.20	6.20	140.00	#N/A	836.0	GRP	14	2200	7.4	31.5	410	#N/A	14000	6000
Performance Cruiser	Baltic Yachts	S/Y MY SONG	39.65	36.78	8.60	#N/A	7.00	105.90	36.25	854.4	Carbon F.	16	#N/A	7.8	38.8	480	#N/A	7000	2400
Performance Cruiser	Baltic Yachts	S/Y VISIONE	44.85	37.66	8.28	4.10	6.66	113.65	53.47	875.7	GRP	15	1300	7.8	37.9	515	66	6000	2500

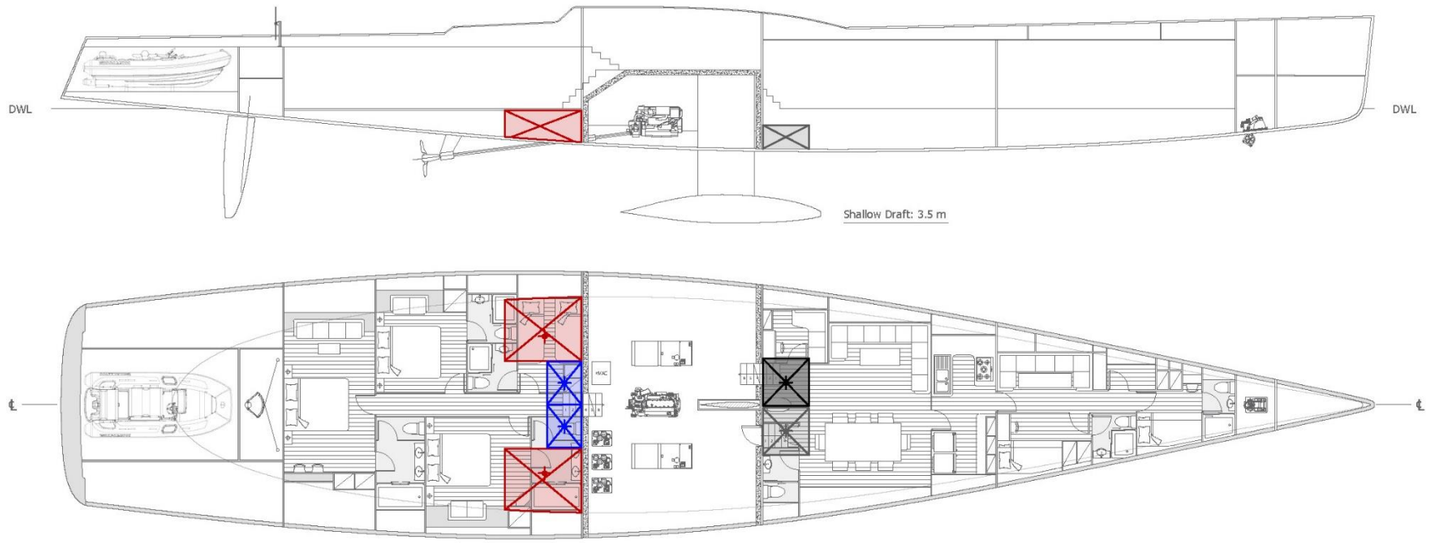






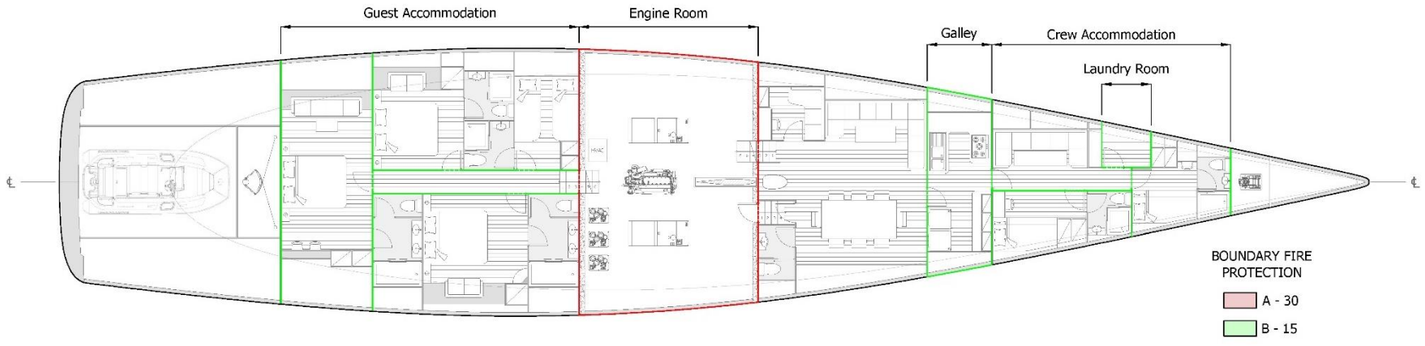
The graphs shown represent the trends for the cruiser fast and performance cruisers yachts employed to establish the main parameters of the yacht. Yacht categories were established as follows: Cruiser fast (6.5< Sr < 7; 27< SAD < 30), Performance Cruisers (Sr > 7; SAD > 30). All trends employed achieved a minimum R^2 value of at least 50%, to ensure relevant results were achieved. Although further data was employed on the study, no relevant trends were established. And therefore, are not represented on the document.

APPENDIX 6.2. TANKS ARRANGEMENT



Tank	Label	Total Mass [tonnes]	Total Volume [m3]
Port Water Tank		1.501	1.501
Stb Water Tank		1.501	1.501
Port Fuel Tank		2.523	3.004
Stb Fuel Tank		2.523	3.004
Black Water Tank		1.708	1.611
Grey Water Tank		1.708	1.611

APPENDIX 6.3. FIRE SAFETY



STRUCTURAL FIRE PROTECTION

Following the structural fire protection requirements given by the code [*REG Part A, 14A.2(3)*], the fire divisions were established. The machinery spaces were totally enclosed by A-30 Class boundaries and the galley by B-15 Class boundaries. Totally enclosed boundaries are considered when bulkheads, sides shells and decks are required to be fire protected. Corridors are also B-15 protected, in order to ensure the safe access of the passenger to the escape exits. Laundry room walls were also insulated with B-15 class.

APPENDIX 6.4. WEIGHT ESTIMATE - LIGHTSHIP

ITEM	VALUE		UNIT WEIGHT	Total WEIGHT	LCG	TCG	VCG
	Quantity	[m^2]	[t/m^2]	[tonnes]	[m]	[m]	[m]
Hull Shell		416.454	0.018	7.467	-20.307	0.000	0.287
Transom		10.321	0.018	0.185	-39.442	0.000	1.361
Deck		234.357	0.009	2.041	-22.999	0.000	2.405
BHD A		4.402	0.011	0.048	-2.656	0.000	1.245
BHD B		18.881	0.011	0.206	-13.209	0.000	0.811
BHD C		23.440	0.011	0.255	-18.395	0.000	0.756
BHD D		23.736	0.011	0.259	-23.895	0.000	0.815
BHD E		15.916	0.011	0.173	-33.051	0.000	1.113
Hull Stiffeners		192.410	0.007	1.437	-20.307	0.000	0.287
Deck Stiffeners		128.733	0.007	0.965	-22.999	0.000	2.405
Coachroof		48.023	0.008	0.365	-22.107	0.000	3.128
Total Structure				13.403	-21.250	0.000	0.896
Keel Finn	1		14.85	14.85	-19.503	0.000	-0.814
Bulb	1		34.653	34.653	-19.503	0.000	-3.091
Total Keel				49.503	-19.503	0.000	-2.408
Office		3.793	0.05	0.19	-17.270	-2.140	0.700
Day Toilet		1.899	0.1	0.19	-17.850	2.120	0.700
Saloon		22.264	0.05	1.113	-15.520	0.000	0.700
Galley		9.321	0.2	1.864	-12.240	-0.250	0.700
Crew Cabin 1		5.15	0.05	0.257	-9.820	1.090	0.700
Crew Cabin 1 Toilet		2.237	0.1	0.224	-7.660	1.030	0.700
Crew Cabin 2		5.681	0.05	0.284	-6.010	-0.240	0.700
Crew Cabin 2 Toilet		1.958	0.1	0.196	-4.550	-0.120	0.700
Crew Mesh		6.847	0.05	0.342	-9.660	-0.790	0.700
Laundry		1.91	0.2	0.382	-7.730	-1.040	0.700
Total Fwd Spaces				5.042	-11.871	-0.142	0.700
Port Double Single Cabin		7.099	0.05	0.355	24.893	2.200	0.700
Port Double Single Cabin Toilet		2.29	0.1	0.229	26.663	1.120	0.700
Starboard Double Cabin		11.634	0.05	0.582	27.073	2.190	0.700
Starboard Double Cabin Toilet		4.327	0.1	0.433	24.683	1.820	0.700
Port Double Cabin		10.004	0.05	0.5	28.853	2.130	0.700
Port Double Cabin Toilet		2.336	0.1	0.234	26.763	2.630	0.700
Master Cabin		20.801	0.05	1.04	31.623	0.000	0.700
Master Cabin Toilet		5.258	0.1	0.526	29.463	2.130	0.700
Total Accomodation Spaces				3.898	28.332	1.513	0.700
Engine	1		1.45	1.45	-21.506	0.000	-0.348
Genset	2		1.167	2.334	-21.448	0.000	-0.348
Hydraulic Power Sytem	3		0.112	0.336	-23.492	1.746	-0.191
HVAC System	1		0.25	0.25	-23.456	-0.963	0.100
Total Engine Room				4.37	-21.739	0.079	-0.310
Tender	1		1.08	1.08	37.133	0.000	1.290
Aft Platform Sytems	1		0	0	-0.007	0.000	0.000
Tender Winch	1		0	0	-0.007	0.000	0.000
Total Garage				1.08	37.133	0.000	1.290
Interior Saloon		19.569	0.05	0.978	-20.837	0.000	1.813
Exterior Saloon	1		0	0	0.000	0.000	0.000
Winches @ First Row	2		0.075	0.15	-29.333	0.000	2.099
Winches @ Second Row	3		0.075	0.225	-31.709	0.000	2.099
Weels + Systems	2		0.1	0.2	-33.306	0.000	2.239
Teak		2.504	0.641	1.605	-20.497	0.000	2.448
Teak Glue		3.339	0.655	2.187	-20.497	0.000	0.000
Total Cockpit				5.346	-21.758	0.000	1.298
Anchor	1		0.3	0.3	-1.234	0.000	2.590
Anchor Chain	1		1.079	1.079	-1.234	0.000	1.928
Windlass	1		0.204	0.204	-1.686	0.000	2.575
Bow thurster	1		0.173	0.173	-3.279	0.000	0.000
Total Forepeak				1.756	-1.488	0.000	1.926
Carbon Mast & Spreaders	1		3.831	3.831	-19.521	0.000	17.372
Carbon Standing Rigging	1		0.593	0.593	-19.521	0.000	17.372
Electrical Antenas & Cable	1		0.291	0.291	-19.521	0.000	17.372
Carbon Furling Boom	1		1.611	1.611	-19.521	0.000	17.372
Mast base Platform	1		0.271	0.271	-19.521	0.000	17.372
Total Rigging				6.597	-19.521	0.000	17.372
Unknown	1		27.641	27.641	-26.060	-0.179	0.700
Total 23% of Fully Loaded D.				27.641	-26.060	-0.179	0.700
TOTAL LOADGROUP				118.636	-18.735	0.005	0.366

Appendix 6.5. Crew Accommodation Areas

Compartment	Required	Actual
Mess Area	-	3.90
Crew Cabin 1	6.20	7.26
Crew Cabin 2	6.20	6.25

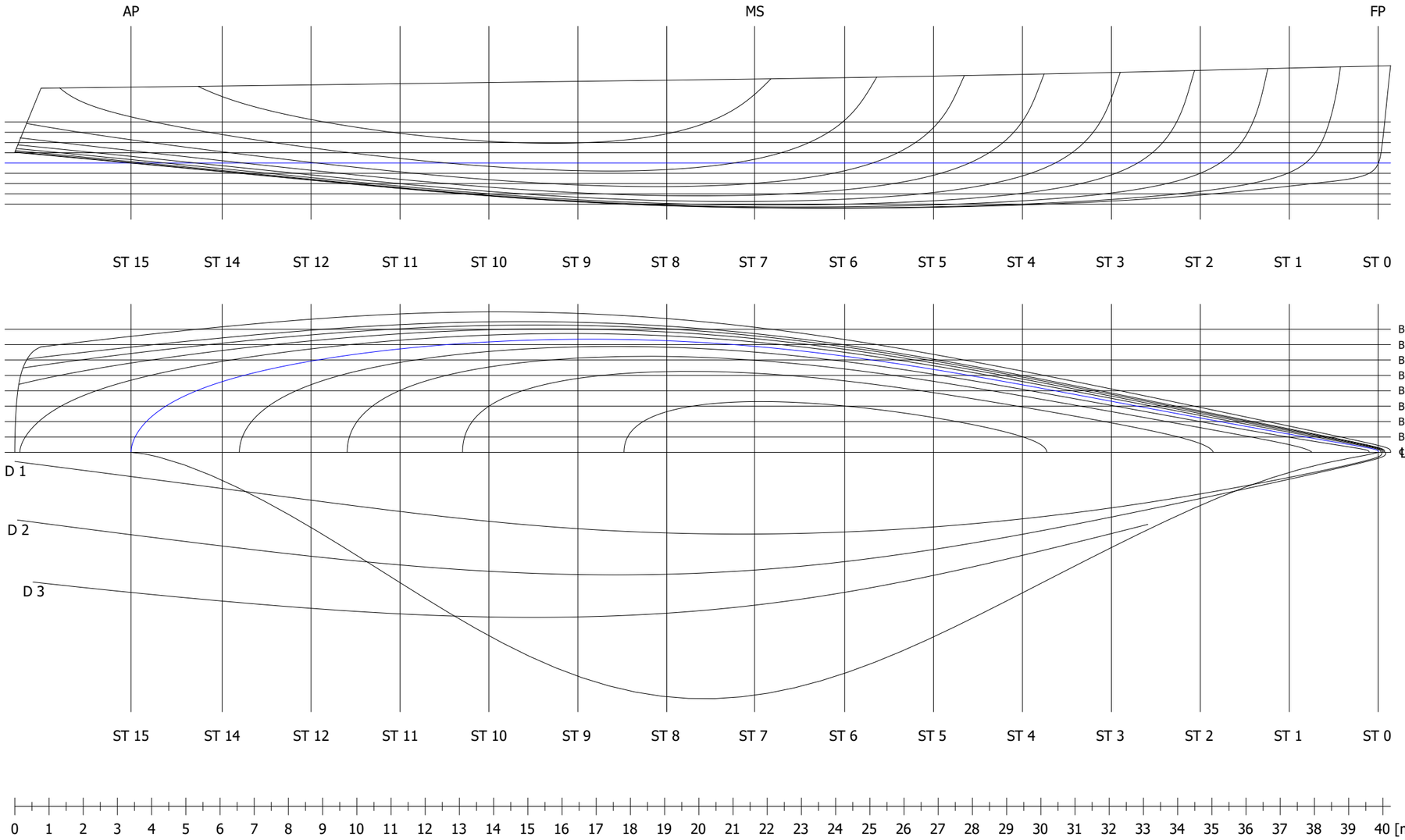
Appendix 6.6. SSC Composite Panels Results

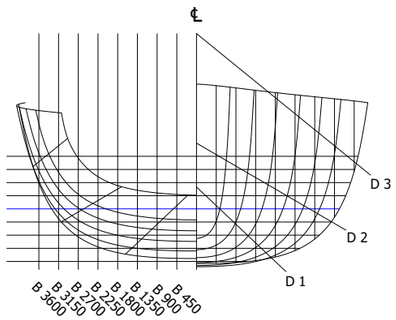
Panel	Layout	Thickness [mm]	Weight [kg/m^2]
Bottom	7 x XCT411	78.8	17.9
	60 mm CORECELL		
	7 x XCT411		
BHDs	5 x XCT411	53.4	12.5
	40 mm CORECELL		
	5 x XCT411		
Deck	4 x XCT411	30.7	8.7
	20 mm CORECELL		
	4 x XCT411		
Coachroof	4 x XCT411	20.7	7.6
	10 mm CORECELL		
	4 x XCT411		

Property	Units	BOTTOM		BHD		DECK		COACHROOF	
		Entered	Required	Entered	Required	Entered	Required	Entered	Required
Weight of inner skin	g/m^2	2,870.00	2,100.00	2,050.00	1,300.00	1,640.00	1,300.00	1,640.00	1,300.00
Weight of outer skin	g/m^2	2,870.00	2,700.00	2,050.00	1,300.00	1,640.00	1,300.00	1,640.00	1,300.00
Direct Core Shear Stress	N/mm^2	0.316	0.441	0.482	0.441	0.203	0.441	0.356	0.441
Deflection	mm	2.623	8.1	11.836	39	2.009	8.1	4.782	8.6
Wrinkling Stress for inner skin	N/mm^2	4.056	62.222	22.629	73.333	4.559	73.333	7.252	66.666
Wrinkling Stress for outer skin	N/mm^2	2.766	62.222	12.185	73.333	3.109	73.333	4.256	66.666
X-ply rule compliance		PASS		PASS		PASS		PASS	
Design Pressure	kN/m^2	54.206		24.912		12.728		13.728	

Appendix 6.7. Final Stability Results

Stability Criteria [*REG Part A, 11*]				Intact			Damage Condition																
							FWD Collision			Crew Accomodation			Guest Living Spaces			Engine Room			Guest Accimodation			Tender Garage		
Code	Criteria	Value	Units	Actual	Status	Margin	Actual	Status	Margin	Actual	Status	Margin	Actual	Status	Margin	Actual	Status	Margin	Actual	Status	Margin	Actual	Status	Margin
LARGE ANGLE STABILITY ANALYSIS																							
11.2.2.1 Monohulls	11.2.2.1.2 Range of positive stability	90.0	deg	113.30	Pass	25.9																	
11.2.2.1 Monohulls	11.2.2.1.3 Angle of equilibrium	15.0	deg	37.00	Pass	146.9																	
11.2.2.1 Monohulls	11.2.2.1.3b Angle of downflooding	40.0	deg	113.30	Pass	183.3																	
11.3 Damage Stability	11.3.4a Equilibrium angle	7.0	deg				0.10	Pass	98.4	0.10	Pass	98.3	0.10	Pass	98.2	0.10	Pass	98.3	0.10	Pass	98.0	0.10	Pass	98.4
11.3 Damage Stability	11.3.4b Range of positive stability	15.0	deg				114.70	Pass	664.7	111.30	Pass	642.3	117.70	Pass	684.9	118.20	Pass	687.9	115.00	Pass	666.9	114.40	Pass	662.5
11.3 Damage Stability	11.3.4c Value of max. GZ	0.1	m				1.28	Pass	1181.0	1.30	Pass	1202.0	1.21	Pass	1106.0	1.21	Pass	1109.0	1.16	Pass	1063.0	1.28	Pass	1179.0
11.3 Damage Stability	11.3.4d GZ area under curve	0.9	m.deg				92.49	Pass	10662.4	89.53	Pass	10317.5	88.92	Pass	10246.7	89.38	Pass	10300.2	82.22	Pass	9466.9	91.85	Pass	10588.2
EQUILIBRIUM STABILITY ANALYSIS																							
11.3 Damage Stability	11.3.1 Equilibrium waterline	0.1	m				2.28	Pass	2938.7	1.79	Pass	2281.3	2.04	Pass	2613.3	2.02	Pass	2594.7	1.71	Pass	2180.0	2.23	Pass	2877.3



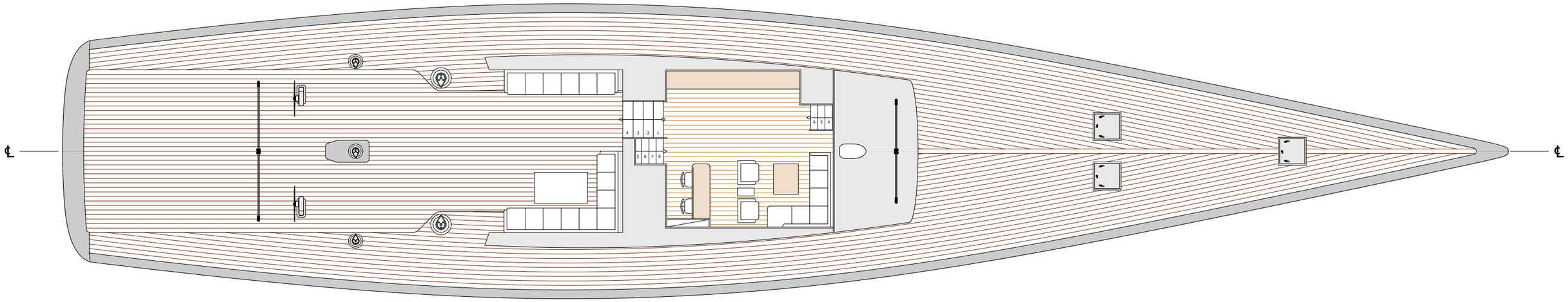


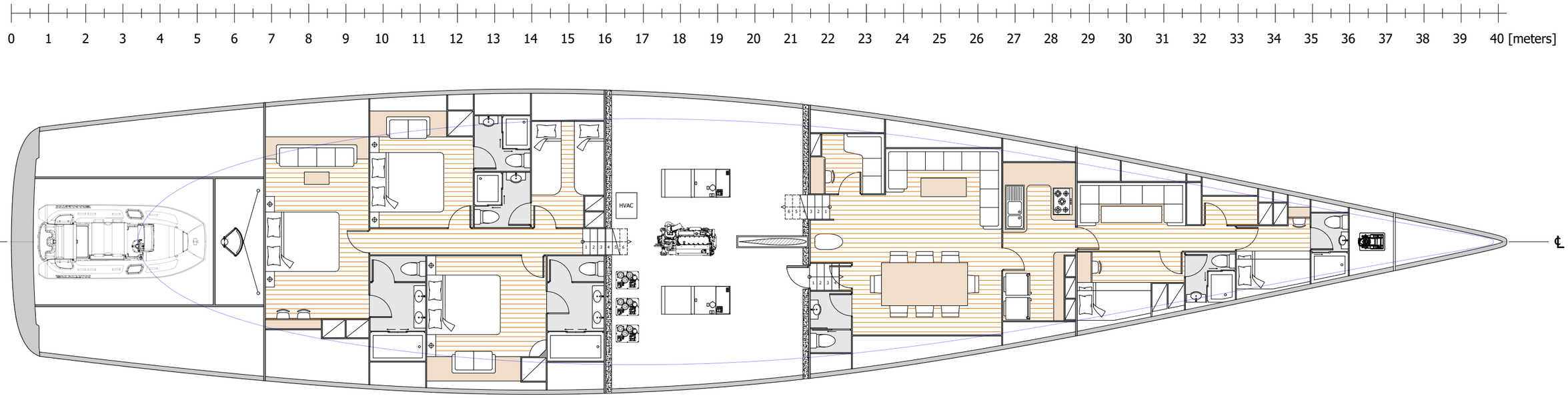
HYDROSTATICS		
ITEM	**VALUE**	**UNIT**
Displacement	130.1	t
LOA	40.23	m
LWL	36.47	m
BOA	8.21	m
BWL	6.62	m
TC	1.32	m
WSA	190.1	m^2
LCB (From FP)	51.93	%
LCF (From FP)	57.26	%
CP	0.53	-
CWP	0.68	-

DRAWING NOTES

- Station spacing: 2605 mm

Completion date: 21/11/2019	Scale: 1:140 @A3	Project name: 40-45m Sailing Yacht Design
Drawn by: Inigo Fuertes	Units: mm	Projection method: n/a
Drawing number: 01		**Drawing title: LINES PLAN**
Edition: vol 01	Sheet: 1 of 1	





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Drawn by: Inigo Fuertes	Units: mm	Projection method: n/a
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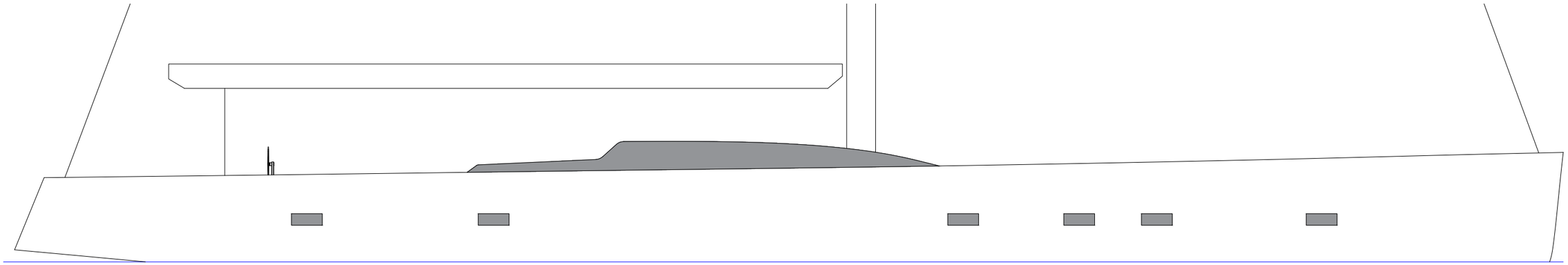
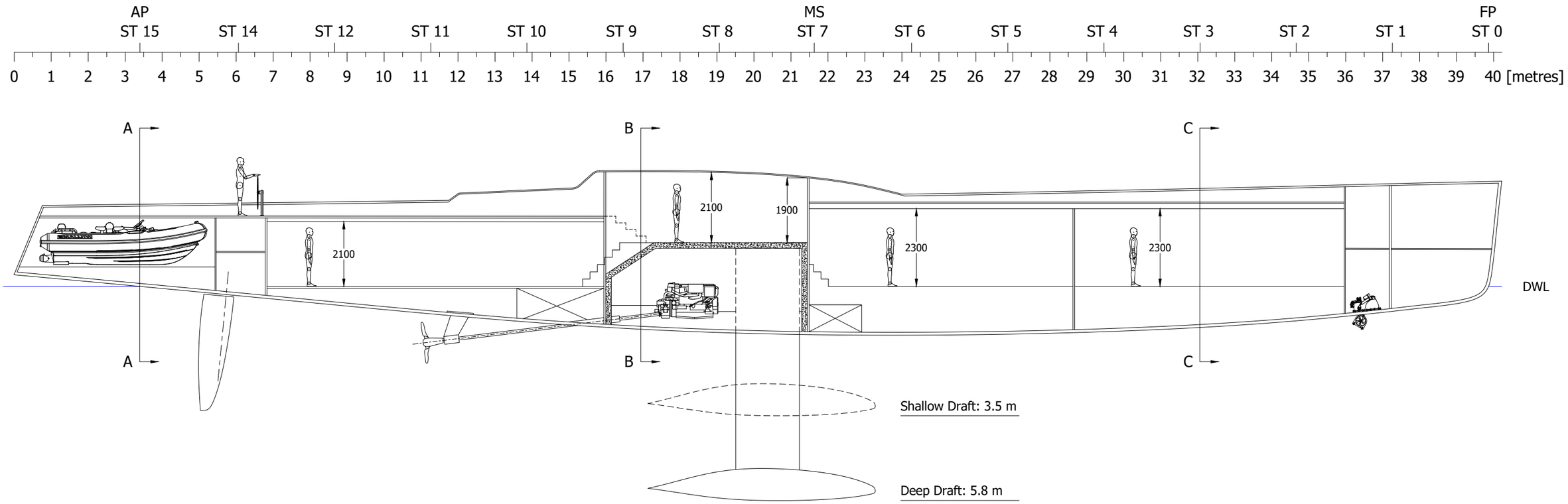
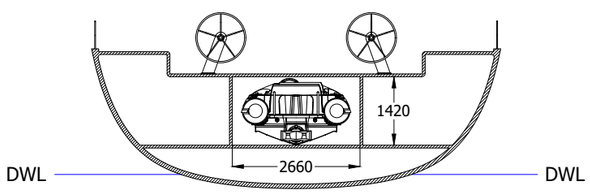
Edition: vol 01	Sheet: 1 of 1	





Section A-A



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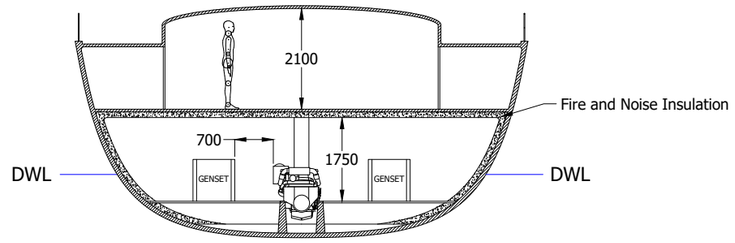

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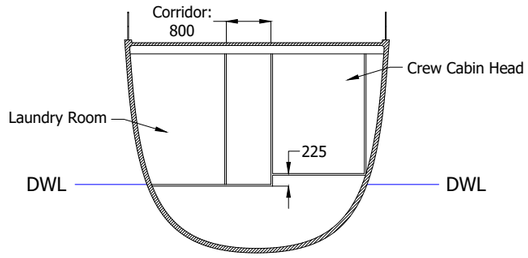

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Drawn by: Inigo Fuertes	Units: mm	Projection method: n/a
Drawing number: 03		**Drawing title:**
Edition: vol 01	Sheet: 1 of 1	**PROFILE PLAN**