

GRENDL – Green and efficient Danube Fleet

Work Package 4 – Preparatory Actions

Activity 4.1 – Individual advanced vessel concepts & energy efficient navigation

Consulting Service No. 2 – Engine room adaptation

Background

Regulation (EU) 2016/1628 of the European Parliament and of the Council on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery (NRMM-Regulation) introduced stringent emission limits (Stage V) for exhaust gases and particulate matter from propulsion engines (IWP) and auxiliary engines (IWA) for inland waterway vessels.

For engines of categories IWP and IWA having a reference power that is greater than or equal to 300 kW a type-certification for Stage V is required for the placing on the market of such engines as of 01.01.2020.

In order to achieve the required emission limits it is technically unavoidable to apply exhaust after-treatment systems, in particular diesel particle filters (DPF) and selective catalytic reaction catalysts (SCR). Although recent developments have led to considerable reductions of the size of these systems the space requirements are still significantly higher than for ordinary exhaust/silencer installations. In addition, SCR installations need “Ad Blue”-supply, so additional tanks and pipelines have to be installed for that purpose.

In accordance with the transitional requirements (Chapter 32) of the European Standard laying down Technical Requirements for Inland Navigation Vessels (ES-TRIN) engines which were in compliance with the type-approval and installation provisions in force at the date of installation may stay unchanged.

However, Article 9.01 (4) of ES-TRIN explicitly prohibits the installation of replacement engines. Hence, in case of an engine damage after 01.01.2020 only Stage V-compliant engines may be installed as a replacement. This requirement may pose some challenges as the new engine including mandatory exhaust after-treatment systems has to be fitted into the existing engine room. The technical feasibility and economic impacts of such replacement shall be examined in a study to be conducted by the contractor.

As an alternative the conditions for replacing an old main engine by a diesel-electric propulsion system using marinised EURO 6-truck engines as generator sets shall be examined.

Furthermore, Danubia Kreuzfahrten GmbH is envisaging improving the environmental performance of its fleet in general. Therefore possible options of retrofitting exhaust after-treatment systems to existing main engines shall be examined.

Technical Specification

The supplier shall conduct a technical study comparing three alternatives for a 110 m model vessel as described in **Annex A** of this Technical Specification.

The comparison of the alternatives shall consider

- a) Technical feasibility of the respective option
- b) For those alternatives where technical feasibility can be established, total cost of ownership (TCO) over a period of 15 years of operation

Alternatives to be considered:

1. Replacement of an existing Caterpillar C32 main engine by a new main engine with NRMM-Stage V-type-certification of comparable power characteristics (reference power, rpm-curve, torque curve). In any case the new main engine has to be selected with a view to the best possible adaptation to the existing gearbox and propulsion unit. If necessary, a replacement of the gearbox has to be represented in the TCO-calculation. The existing propulsion unit shall remain unchanged.
2. Replacement of an existing Caterpillar C32 main engine by a diesel-electric propulsion system using a marinised EURO 6-truck engine as a generator set and an electric motor. The existing propulsion unit shall remain unchanged.
3. Retrofitting of an existing Caterpillar C32 main engine with exhaust after-treatment systems necessary to achieve NRMM-Stage V-emission levels.

Technical feasibility assessment shall in any case include:

- General arrangement plan of engine room (conceptual design), taking into account all necessary additional equipment (DPF, SCR, Ad-Blue-supply)
- Connections to existing propulsion system as well as to existing supply and exhaust lines shall be respected as far as possible
- Estimation of changes in exhaust emissions and energy consumption
- Access to existing equipment and installations shall be ensured
- No changes to the watertight subdivision of the vessel
- Loss of passenger or crew cabins shall be avoided as far as possible
- Reduction of space concerning other rooms only after approval by Danubia Kreuzfahrten GmbH

Calculation of total cost of ownership shall in any case include:

- Investment costs for replacement/retrofitting
- Operational costs over 15 years based on operational profile (running hours, fuel consumption etc.) to be provided by Danubia Kreuzfahrten GmbH

- Maintenance costs over 15 years, including replacement of Euro-6-truck engine if necessary with a view to expected maximum operating hours
- In case of loss of passenger cabins due to space requirements: loss of income on the basis of data to be provided by Danubia Kreuzfahrten GmbH

In addition, for alternatives 1 and 2 the estimated cost of time out of service has to be calculated separately, assuming an unanticipated damage of a main engine and setting in motion of replacement procedures on the day of the damage.

The technical report shall include:

- Interim progress report end of August 2019 (7 – 12 slides ppt-presentation)
- Draft technical report end of September 2019
- Comprehensive final technical report mid of January 2020
- Publishable report with main facts and lessons learnt (Deliverable 4.1.3 of the GRENDL project) mid of January 2020

OPTION 1:

Second technical report (same characteristics and conditions as above) for a 110 m model vessel with Caterpillar 3508 main engines (see **Annex B**).

OPTION 2:

Third technical report (same characteristics and conditions as above) for a 135 m model vessel with Caterpillar C32 main engines (see **Annex C**).

OPTION 3:

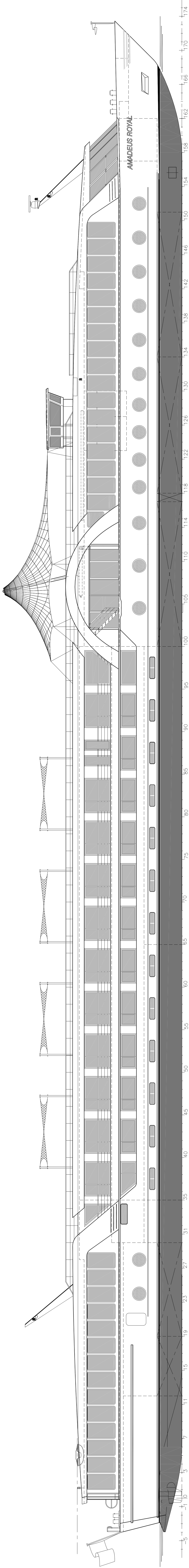
Second technical report (same characteristics and conditions as above) for a 135 m model vessel with Caterpillar 3508 main engines (see **Annex D**).

ANNEX A

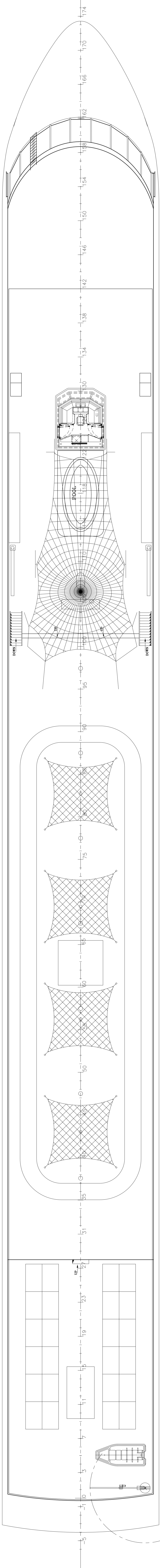
General Arrangement Plan Amadeus Brilliant

ANNEX B

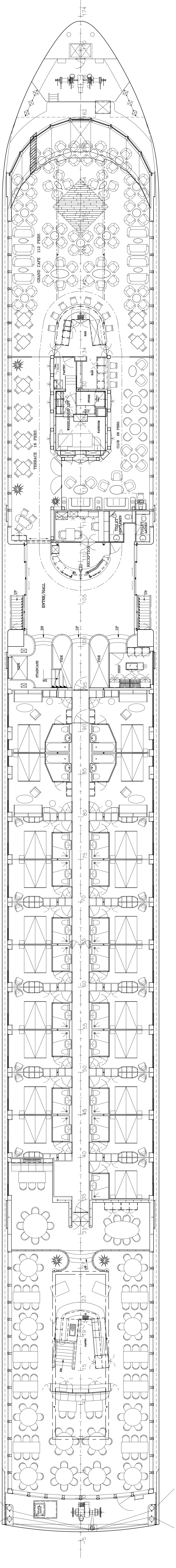
General Arrangement Plan Amadeus Royal



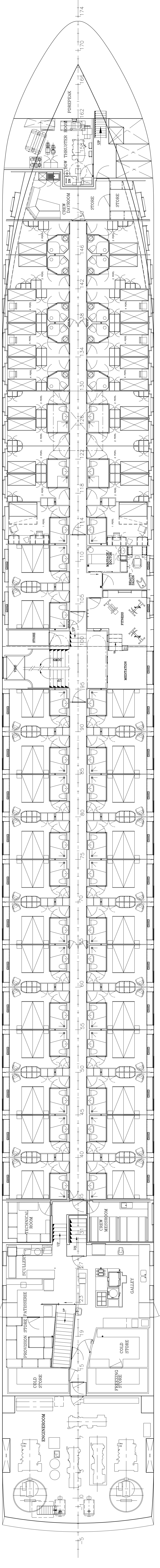
TOPDECK



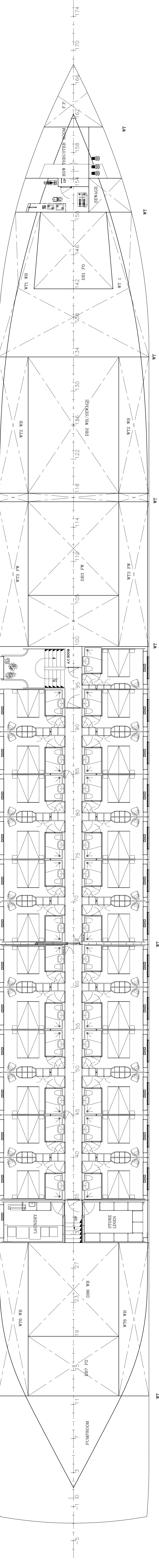
UPPERDECK



MAINDECK



LOWERDECK



MAIN DIMENSIONS	
LENGTH	o.a. 110.00 M.
LENGTH	l.p.p. 105.50 M.
BREADTH	o.a. 11.40 M.
BREADTH	m.i.d. 11.00 M.
DEPTH	2.75 M.
DRAFT	(50% bunkers) 1.30 M.
DRAFT	(ballast) 1.60 M.
AIR DRAFT	(T=1.60m) 6.00 M.

CAPACITIES	
CABINS	68 PAX. + 4 SUITES + 20 CREW
PASSENGERS	144
FUEL	100 M ³
FRESH WATER	200 M ³
SEWAGE	100 M ³
BALLAST	450 M ³
SPEED	22 KM/H. (H= 5.00 M.)
POWER	2 x 735 KW.

APPROVED BY
CLIENT

APPROVED BY
CLASSIFICATION

CHECKED BY

SCALE

DATE
25 OCT 2004

CLIENT
: Liffert Reisen

SUBJECT
: GENERAL ARRANGEMENT
PASSENGERSHIP

PROJECT REF.
: CLIENT'S DOC. No.

FORM. No.
408-01301-C

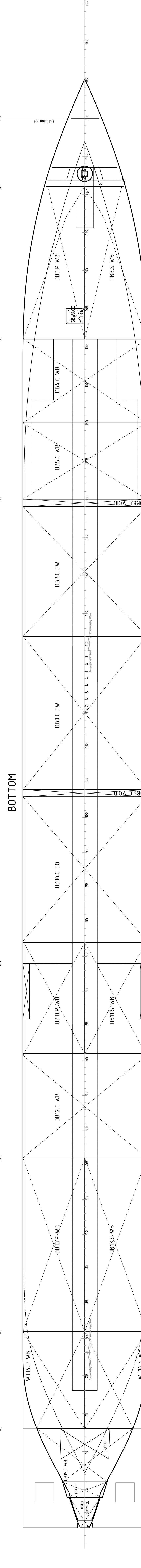
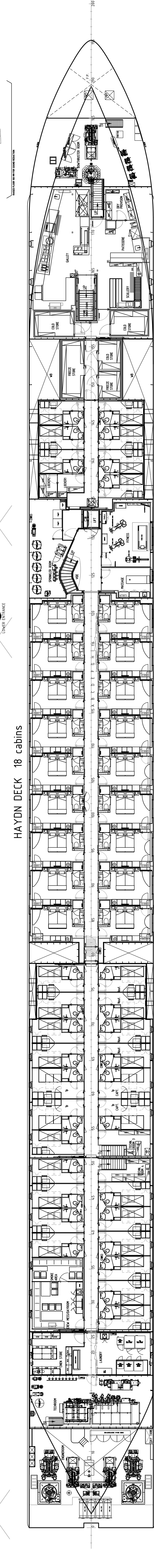
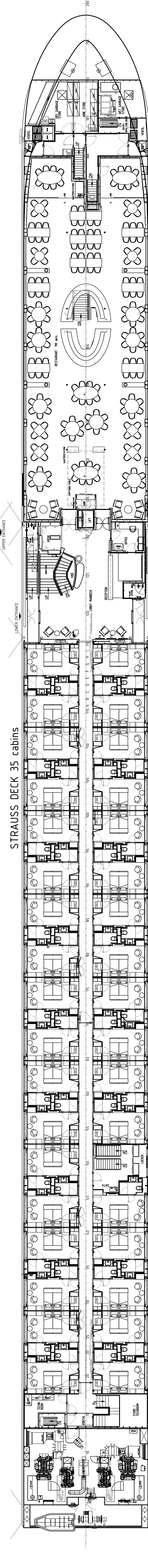
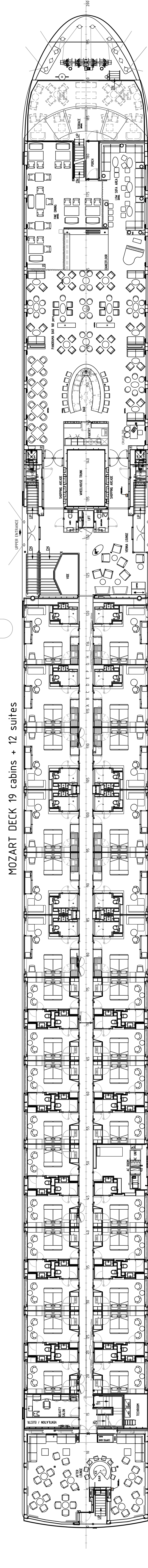
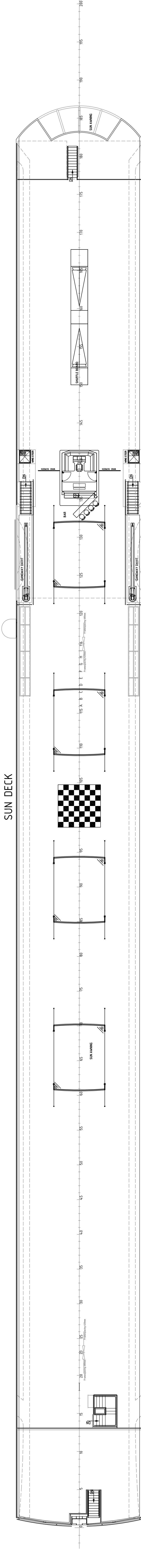
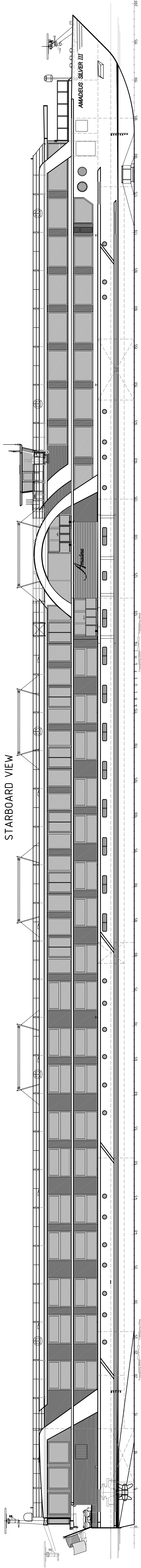
DELAUWING

Lobith b.v.

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ANNEX C

General Arrangement Plan Amadeus Silver 3



MAIN DIMENSIONS	
LENGTH	135.00 M
BREADTH	11.00 M
DEPTH	3.35 M
DRAFT	1.45 M
AIR DRAFT	2.00 M
OVERALL	135.00 M
OVERALL	11.00 M
PLD	3.35 M
(OPERATIONAL)	1.45 M
(BALLAST)	2.00 M
TRZ (Tm)	6.00 M

CAPACITIES	
CABINS	224 PERIS
CREW	100 PERIS
CREW SINGLE	764
CREW DOUBLE	44

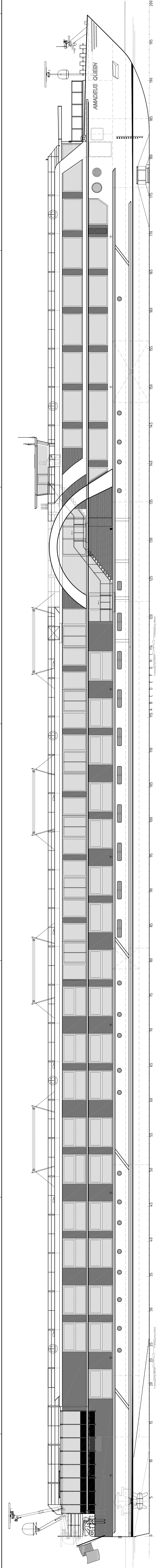
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CLIENT	GENERAL AB	PROJECT REF.	P2022	CLIENT'S DEC.	GENERAL AB	DRAWING	DB 100

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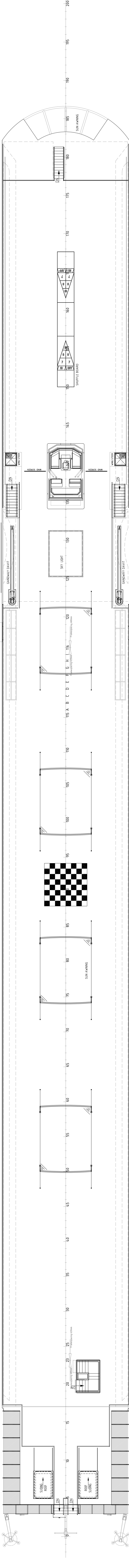
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ANNEX D

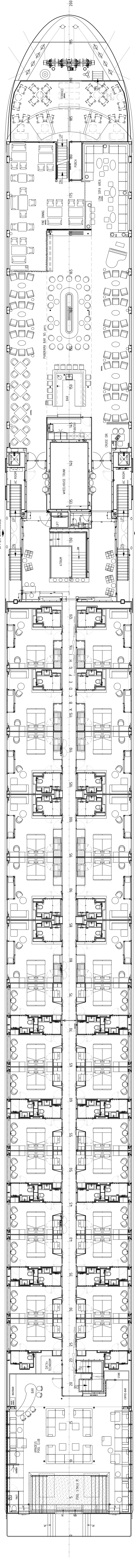
General Arrangement Plan Amadeus Queen



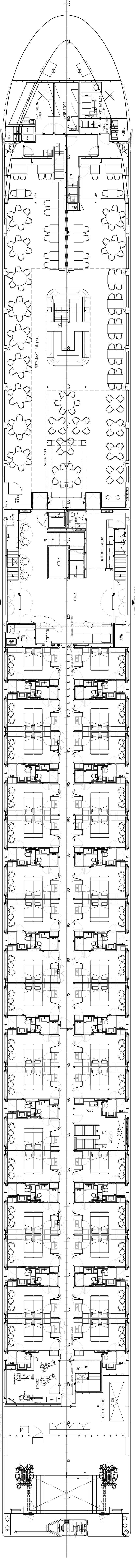
SUN DECK



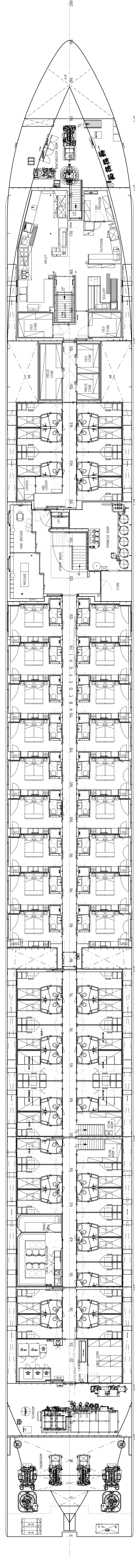
MOZART DECK 18 cabins + 12 suites



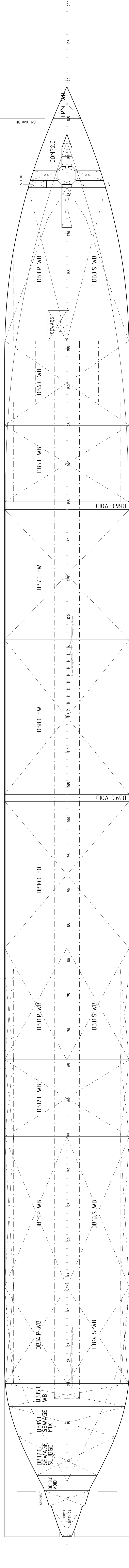
STRAUSS DECK 33 cabins



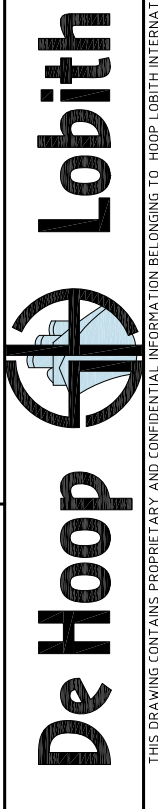
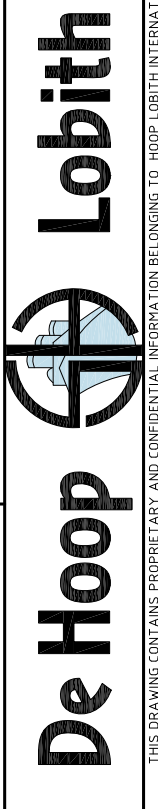
HAYDN DECK 18 cabins



BOTTOM



MAIN DIMENSIONS				CAPACITIES			
LENGTH	135.00 M	OVERALL	135.00 M	CABINS 21	210 PER	CREW 21	210 PER
BREADTH	11.50 M	OVERALL	11.50 M	CREW SINGLE	254	CREW DOUBLE	44
DEPTH	3.25 M	M.L.D.	3.25 M	APPROVED BY	1:100	APPROVED BY	1:100
DRAFT	1.45 M	(OPERATIONAL)	1.45 M	CLIENT	De Hoop	CLIENT	De Hoop
DRAFT	2.15 M	(BALLAST)	2.15 M	PROJECT REF	P1002	PROJECT REF	P1002
AIR DRAFT	5.85 M	(T+2.15m)	5.85 M	CLIENT'S SCALE	1:100	CLIENT'S SCALE	1:100
				GENERAL ARRANGEMENT			
				PASSENGERSHIP			
				GENERAL ARRANGEMENT			
				PASSENGERSHIP			



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