# Creation of River-Sea Cruise Passenger Vessels of New Generation

Alexander Egorov(✉), Gennadiy Egorov, and Igor Ilnitskiy

Marine Engineering Bureau, Tenistaya 15 Str., 65009 Odessa, Odessa Region, Ukraine
{egorovag, egorov, ilnitskiy}@meb.com.ua

**Abstract.** The choice is grounded and concepts of river-sea cruise passenger vessels including for the Caspian, Black and Mediterranean Seas with taking into account requirements of main operators of the market are developed.

New concepts are not only new vessels, but also new tourist product. For example, perspective Caspian cruise attracts not only citizens of Caspian countries (Iran, Azerbaijan, Kazakhstan), but also tourists from the USA, Australia, Europe and China. In market of sea and river cruises there are practically no offers on earlier popular cruises between ports of Black, Mediterranean and Baltic, and also Caspian seas. Thus, absence of offers is connected, first of all, with lack of river-sea cruise vessels. For the solution of problem of connection of sea and river routes modern cruise vessels of PV09 and PV300, PV300VD projects developed by Marine Engineering Bureau are offered. Researches have shown that generally for native conditions traditional single hull type passenger vessel can be recommended. CFD-modelling tests were executed to optimize hull form. Module principles of creating inner living space were used widely. Standard module cabins usage let alternate passenger capacity by using passenger cabin modules with different area in accordance with required comfort level.

PV09, PV300, PV300VD concepts are the safe, ecologically "pure" passenger vessels which are completely satisfy to all International Conventions including SOLAS, MARPOL, COLREGS and also to all national requirements (Sanitary Rules, Technical Regulations of Safety of Inland Transport Objects).

**Keywords:** River and River-Sea cruises · River-Sea passenger vessels · Design · Level of comfort · Innovation · Ecology · Safety

## 1 Introduction

Today river and river-sea cruise vessels (CV) transport about 350–400 thousand tourists on Russian and Ukrainian rivers, which includes 75 thousand foreigners. Realities of native tourism are that to favorite river cruises of "entry" tourists from the USA, Germany, Australia on route Moscow – St. Petersburg, "partly" sea lines Moscow – Sochi, "Kiev" – Constanta", "circular" cruise on Caspian Sea were added.

At this moment in Russia, Ukraine and in general in world practice of operation of CV there is practically no fleet of river-sea cruise vessels.


T. Okada et al. (Eds.): PRADS 2019, LNCE 65, pp. 120–136, 2021.
https://doi.org/10.1007/978-981-15-4680-8_9

From 254 river cruise passenger vessels built in Soviet period 98 (38.6%) have been written off (6.7% – 17 vessels were lost in accidents, 31.9% – 81 vessels were utilized). There were 32 vessels out of operation (12.6%) with middle age of 57.7 years. In operation – formally 124 vessels (48.8%) with middle age of 45.2 years. Mean age of utilization – 47.1 year. In the next decade this fleet most likely will be decommissioned and we will have only about 50 vessels [1] (without vessels which can be built during these years but which are not ordered yet).

By some expert estimates the market size will make 1.0 million tourists by 2030.

The market assessment including previous years experiment on operation of first-class vessels PV08 "Alexander Grin" and "Victoria" with native tourists allows to draw conclusion that, with taking into account the predicted reduction of vessels of old series, not less than eight new cruise vessels will be required by 2025.

Thus, problem of creation of river and river-sea cruise vessels became actual and important for native water transport and tourist industries.

## 2 Aim of the Paper

Aim is grounding on basis of 2010–2017 Marine Engineering Bureau (MEB) researches of concepts of modern river CV which are of interest for native shipping companies: PV300, PV300VD, PV09 projects. These vessels will be operated on classical river lines, and also make episodic cruises in coastal zones in accordance with assigned class.

## 3 Review of Existing River-Sea Vessels in Researched Area

Operation of river CV on lines with sea parts is widespread in Ukraine. "Chervona Ruta" and "Viking River Cruises" cruise companies use river CV which earlier have worked along Black Sea coast [2]. The first cruises in Post-Soviet time on river CV in Black Sea became possible after executed by MEB work about expansion of sailing area of 302 project river passenger vessel of "T.G. Shevchenko" type. Work included grounding of assignment of river-sea "M-PR" class of Russian River Register (RRR).

Since then and till 2014 following vessels had been successfully operated both in Dnieper and Black Sea:

- two CV of 302 project ("General Vatutin" and "Zvezda Dnepra" of 1988 year built) of "Chervona Ruta" cruise company;
- two CV of 301 project ("Princessa Dnepra" of 1976 year built and "Mikhail Lomonosov" of 1979 year built of "Chervona Ruta" and "Viking River Cruises" cruise companies respectively).

In 2014 all Ukrainian river-sea lines were stopped. As for 2019 only two vessels are into operation on those routes: "Princessa Dnepra" of "Chervona Ruta" company and "Viking Sineus" (ex "Mikhail Lomonosov") of "Viking River Cruises" company of 301 project. "Viking Sineus" was modernized in accordance with MEB PV17 project in 2013–2014.

After modernization it is four-deck, triple-screw motor vessel with overall length of 125.00 m, breadth of 16.70 m, with four-level superstructure along whole vessel's length, with ER located aft, with wheelhouse located fore, with double bottom, with inclined stem and cruiser aft end (see Fig. 1). Passenger capacity is 196 passengers.

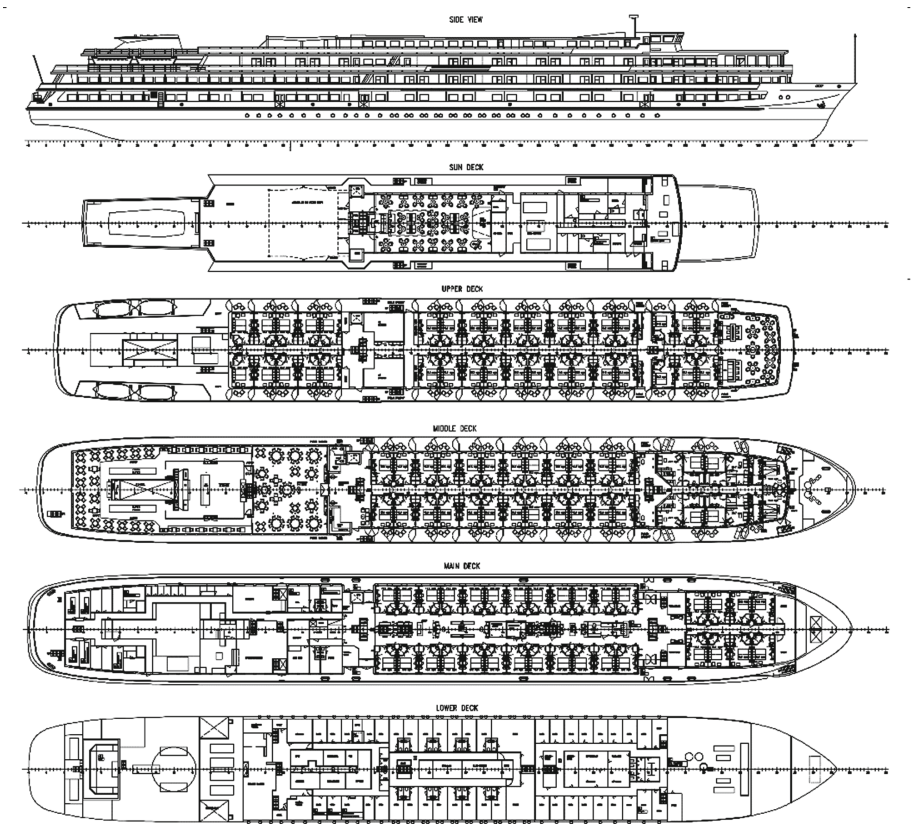


**Fig. 1.** General arrangement of PV17 river-sea modernized cruise vessel.

98 double-place cabins for location of 196 passengers are foreseen, including: 4 suites with balcony with area 30.1–31.6 $m^2$; 2 "Deluxe" cabins with balconies with area 24.2 $m^2$; 60 cabins with balconies with area 13.5–16 $m^2$; 32 cabins with balconies with area 11.1–12.9 $m^2$.

Passenger accommodations are located onto 3 decks: main deck, middle deck and boat deck.

The restaurant which allows feeding all the passengers in one shift is located onto the upper deck with area of 350 $m^2$ for 212 places.

Panoramic bar with area of about 100 $m^2$ for 55 places is located in the fore part on the boat deck.

Music salon with bar with area of 150 $m^2$. for 100 places and large opened area with beach chairs and tents are located on the shade deck.

Lifesaving gear consists of four life boats and 46 inflatable freefall droppable rafts.

Vessel satisfies an increased ecological safety standard. Closed sewage and domestic water systems are foreseen. All sewage and domestic waters are forwarded to collector tanks. There is also sewage water treatment plant.

The next example of river-sea CV is Russian "Rus' Velikaya" vessel. She was built in 2013 with usage of elements of existing vessel of 588 project "N.F. Vatutin". Vessel's length – 95.6 m, breadth – 13.5 m, draught – 2.45 m. Passengers' capacity – 196 persons, crew – 66 persons.

But all these vessels are modernized.

## 4 Design Features of New Generation River and River-Sea Cruise Passenger Vessels

New generation of cruise vessels for Russian inland waterways, designed by MEB, is characterized by the following design features.

### 4.1 Maximization of Main Dimensions

Restrictions of way conditions of vessel's operational region are determinative (e.g. depths, dimensions of vessel's navigation pass, dimensions of hydraulic engineering facilities, etc.) – "Volga-Balt Max", "Volga-Don Max"/"Dnipro Max", "Belomor-Baltiysk (BBK) Max", "Danube Max" classes. Main dimensions of CV concepts are accepted depending on data, which are shown in Table 1. For further details see [3]. It is clear that river-sea concept will have restrictions on passengers' capacity as length and breadth of the vessel appointed in accordance with way conditions will limit useful area which can be allocated for cabins and for passenger serving spaces (restaurants, salons etc.). The number of decks is defined by air draught.

**Table 1.** General information about possible main particulars of river-sea CV.

| Vessel's class | | Overall length $L_M$, m | Overall breadth $D_M$, m | Draught $d$, m | Air draught $H_{AD}$, m |
|---|---|---|---|---|---|
| "Volga-Balt Max" | | $\leq 185$ | $\leq 16.95$–$20.1$ | 2.90–3.80 | $\leq 13.2$ |
| "Volga-Don Max"/"Dnipro Max" | | $\leq 140$ | $\leq 17.0$ | 3.20–3.70 | $\leq 13.2$ |
| "BBK Max" | | $\leq 132$ | $\leq 13.63$ | 2.90–3.80 | $\leq 11.9$ |
| "Danube Max" | Danube – Passau | $\leq 135$ | $\leq 13.40$ | 2.00–2.50 | $\leq 6.7$ |
| | Upstream Passau[a] | $\leq 135$ | $\leq 11.45$ | 1.70–2.00 | $\leq 6.03$ |

[a]Including pass-through to Northern Sea (Danube-Main-Rhine system)

### 4.2 Architectural and Constructive Vessel's Type

Due to architectural and constructive vessel's type new CV can be as follows [4]:

- so called "floating hotels" with superstructure at all vessel's breadth without passages by sides (with full-grown balconies/terraces or with French balconies at cabins for CV that are oriented to foreign tourists. Upper "sun" deck is equipped with swimming pool and tents;
- with promenade gallery by sides on all decks; such arrangement provides all-round view for tourists. This variant is used rarely for new projects because many tourists don't like when other people are close to the windows of their cabins;
- with fore saloon that provides both-sides view;
- interim option (for CV oriented on Russian tourists) is applied. This option combines variants mentioned above in different degrees. Practically all new CV (sea and river) built abroad are foreseen with maximal number of balconies.

### 4.3 Inner Compartments Design and Level of Comfortableness

New CV are characterized by following features:

- module principles of forming living blocks in total and cabins themselves (standard cabins) and vertical zoning of living and public compartments were used;
- restaurant, salons and bars are arranged in vertical zones separate from living compartments;
- noise spaces are not arranged above passenger or crew cabins. Total cabins area is 16–43 $m^2$ including balcony/French balcony (cabins are double usually);
- restaurants with total places equivalent to passengers' number, conference hall, bars, internet-salon, baby rooms, beauty salon, souvenir shop, fitness salon, solarium are located on the open sun deck;
- lifts connected all decks, communications and toilets are foreseen for physically challenged people.

It is unequivocally that in process of design of new vessels one should start from the comfort level set by the customer as a quantity of conditional stars or comfort factor which will serve as the regulating factor of the future vessel's efficiency as function that determines required areas of decks and compartments, overall vessel's dimensions, vessel's propulsive characteristic, and vessel's economic efficiency as a result.

As a criterion of an estimation of passenger vessels design comfortableness it is possible to apply the five-stars scale informally used practically by all tour operators. The quantity of stars increases according to increase of service quality and comfort. It is necessary to emphasize especially CV with enhanced comfort (per se, yachts) and vessels for single-day cruises (cabinless).

Such vessels often don't relate to CV due to their significant differences in the approaches to passenger zone and a number of special questions (availability of additional opportunities for water types of activity, etc.). However, such vessels are often become platform for development including for classical cruise transportations. Example of this thesis is shown on Fig. 2 (comparison of side views of PV09 and

PV300, PV300VD projects). Already realized in 2017 PV09 river-sea cruise passenger vessel became the first in "line-up" of new generation cruise vessels (see Fig. 3).

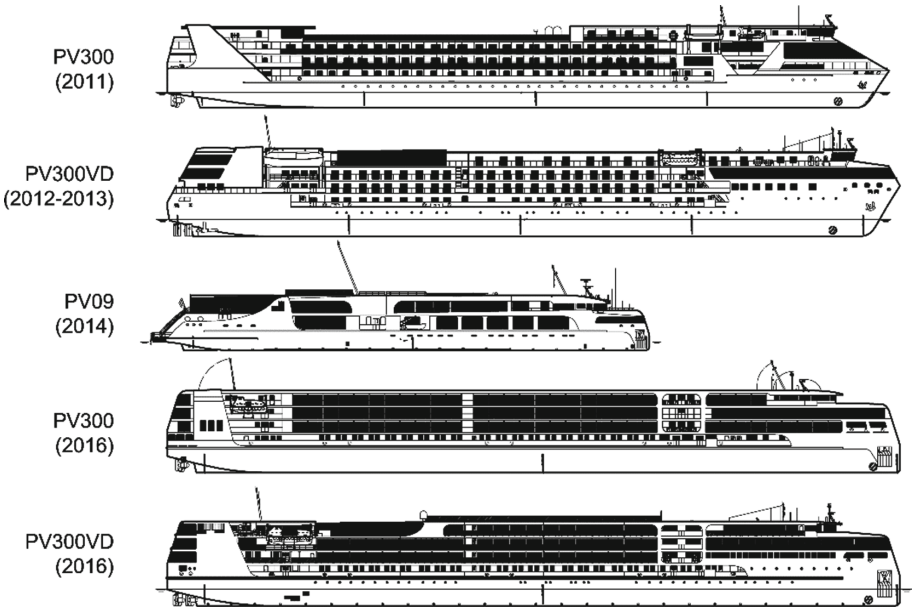


**Fig. 2.** Comparison of side views of PV09 and PV300/PV300VD concepts.

### 4.4 Other Design Features

Choice of classification society class of perspective cruise passenger vessel assumed following:

- assignment of class based on sailing areas in accordance with planned directions of transportations;
- definition of ice class in accordance with saved-up experience and tendencies to extension of the navigation period including winter operation;
- assignment of economically reasonable life-time cycle of the vessel.

For safe and accelerated process of passengers' evacuation modern evacuation systems consisting of sleeve and accepting platform (sometimes landing of passengers can be carried out straight on rescue device) on which passengers during evacuation go down and with which passengers move on rescue vessel boats and rafts can be used.

Crew has to be formed with taking into account ship power plant automation, automation of deck works (automatic anchor mooring winches), automation of process of loading of supplies and mechanization of process of cleaning of decks (washing machines, etc.) and with taking into account usage of specialties combination.

**Fig. 3.** General view of river-sea cruise vessel of PV09 project.

### 4.5 Theoretical "Line-up"

Choice of main particulars of river and river-sea CV is defined by way conditions, tour operator strategy and his position in the market, adherence to those or other lines and comfort level in view of necessities, propensities and interests of passengers for which these vessels are built.

Such external subjective choice should be carried out basing on discrete number of the alternatives which quite objectively have arisen in the domestic tourist market as a result of the compromise due to choice of way restrictions and sizes of tourist groups (400–500 people, 250–300 people, 200–250 people, 100–150 people).

Analysis of such alternatives has allowed to build parametrical line-up of river and river-sea cruise vessels objectively demanded by native shipowners and on its basis to develop in MEB projects of new river-sea vessels.

The most attractive are "Volga-Don Max"/"Dnipro Max" PV300, PV300VD concepts (dimensions are defined by way conditions of Volga-Don Ship canal, Dnipro River, passengers' capacity is about 300 people).

Such vessels are planned to be operated on lines connecting St. Petersburg port and Moscow port, on Volga-Don Ship Canal with exit in Azov and Black Seas, on Volga with exit in Caspian Sea, on Volga-Baltic waterway with exit in Baltic Sea or on Kiev – Kherson – Nikolayev – Odessa – Izmail – Constanta line.

### 4.6 Description of "Volga-Don Max"/"Dnipro Max" PV300VD and PV300 Concepts

PV300VD concept architectural-structural type is as follows (see Fig. 4): steel, triple-screw motor ship, with slopping stem and transom stern, with excess freeboard, with extended forecastle, with four-tiers living superstructures through the whole vessel's length located amidship, with wheelhouse located fore and engine-room located aft. Comfort level on PV300VD vessel will correspond 4–5* hotel standard.

**Fig. 4.** General view of PV300VD river-sea cruise vessel.

PV300VD "Volga-Don Max" class vessel will work on lines Moscow – St. Petersburg and also will make voyages Moscow – Sochi, Astrakhan – Caspian ports.

The vessel's class will allow also to visit ports at Black and Mediterranean seas.

PV300 "Volga-Don Max" class vessel will work on lines Moscow – St. Petersburg, and also will make voyages in coastal zones in accordance with assigned RRR class ✠ M-PR 3,0.

PV300 concept architectural-structural type is as follows: steel, self-propelled river-sea motor ship with two full-rotated rudder propellers, with plumb stem and transom stern, with excess freeboard, with extended forecastle, with four-tiers living superstructures through the whole vessel's length, with wheelhouse located fore and engine-room located aft (see Fig. 5). Comfort level on PV300 vessel will also correspond 4–5* hotel standard.

**Fig. 5.** General view of PV300 river-sea cruise vessel.

PV300 river-sea cruise vessel "Mustay Karim" will be operated on long cruise lines Moscow – St. Petersburg, Moscow – Astrakhan and Moscow – Rostov-on-Don with

replacing classical cruise vessels of 301 and 302 projects. The vessel was laid down in 2017 and is planned to be built in the beginning of 2020.

PV300VD river-sea cruise vessel "Petr Velikiy" is intended for work on lines Moscow – St. Petersburg, Moscow – Rostov-on-Don – Sochi, Astrakhan – the ports of the Caspian Sea, and in Black and Mediterranean Seas. The vessel was laid down in 2016 and is planned to be built in 2021. She was launched in May, 2019 (see Fig. 6). PV300VD will be the only (as for 2019) river-sea vessel in Russia which meet requirements of International Conventions.


**Fig. 6.** Launch of PV300VD river-sea cruise vessel "Petr Velikiy".

**General Arrangement**

General arrangement of PV300VD vessel is presented on Fig. 7. Vessel's main particulars are as follows: length overall 141 m; length between perpendiculars 135.56 m; breadth overall 16.82 m; breadth 16.60 m; depth 5.50 m; draught maximal 3.20 m; air draught from BL 16.25 m; crew and service staff 90 people; autonomy by fuel 15 days; autonomy by other stores 10 days.

General arrangement of PV300 vessel is presented on Fig. 8. Vessel's main particulars are as follows: length overall 141 m; length between perpendiculars 135.36 m; breadth overall 16.80 m; breadth 16.60 m; depth 5.00 m; draught maximal 3.00 m; air draught from BL 16.25 m; crew and service staff 144 people; autonomy by fuel 15 days; autonomy by other stores 5 days.

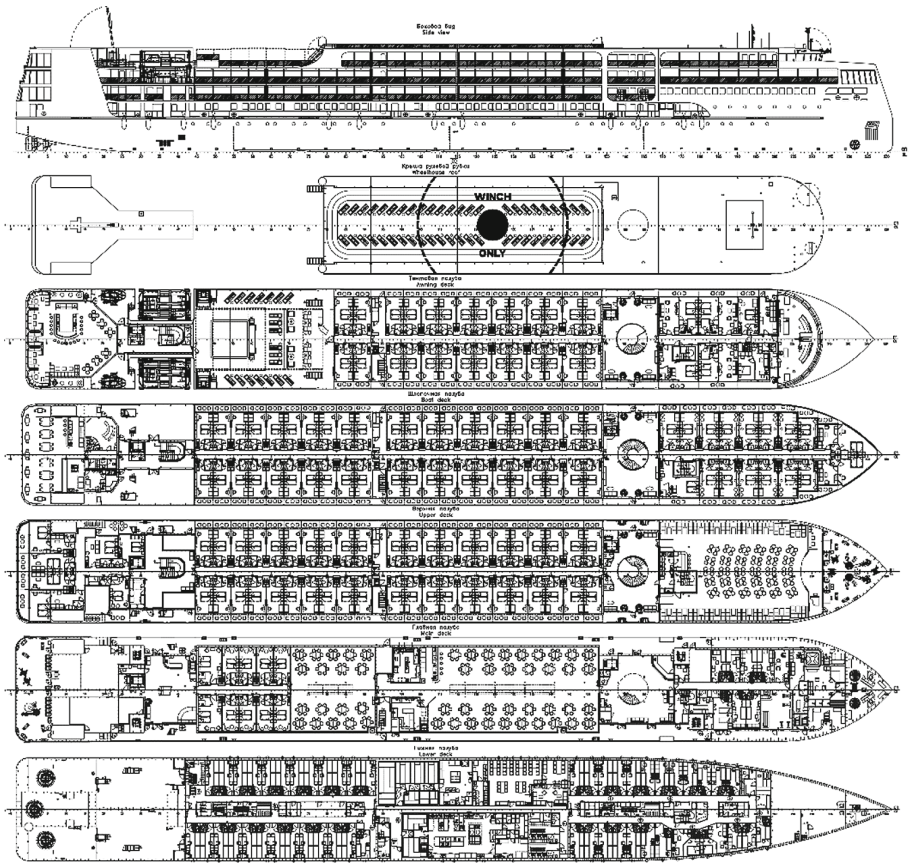


**Fig. 7.** General arrangement of PV300VD river-sea new generation cruise vessel.

**Passenger's Accommodation and Public Rooms**

Arrangement of the PV300VD cruise vessel in the variant of the Moscow River Shipping Company (shipowner) foresees 310 passengers who travel in 155 comfortable cabins of different classes: 7 luxury apartments with a balcony of about 36–43 $m^2$ area (33–35 $m^2$ without considering balcony); 3 luxury cabins with a balcony of about 26 $m^2$ area (21 $m^2$ without considering balcony); 2 luxury cabins for disable people with a balcony of about 33 $m^2$ area (27 $m^2$ without considering balcony); 133 standard cabins with a balcony of about 19–21 $m^2$ area (16–18 $m^2$ without considering balcony), see Fig. 9; 8 standard cabins of about 16 $m^2$ area; 2 standard cabins for disable people of about 21 $m^2$ area.

Passenger cabins are located in the middle vertical zone on 4 superstructure decks. Cabins on three upper decks have own balconies with sliding sections that provide through deck pass at emergency situations.

Arrangement of the PV300 cruise vessel in the variant of "Vodohod" shipping company (shipowner) foresees 342 passengers who travel in 171 comfortable cabins of

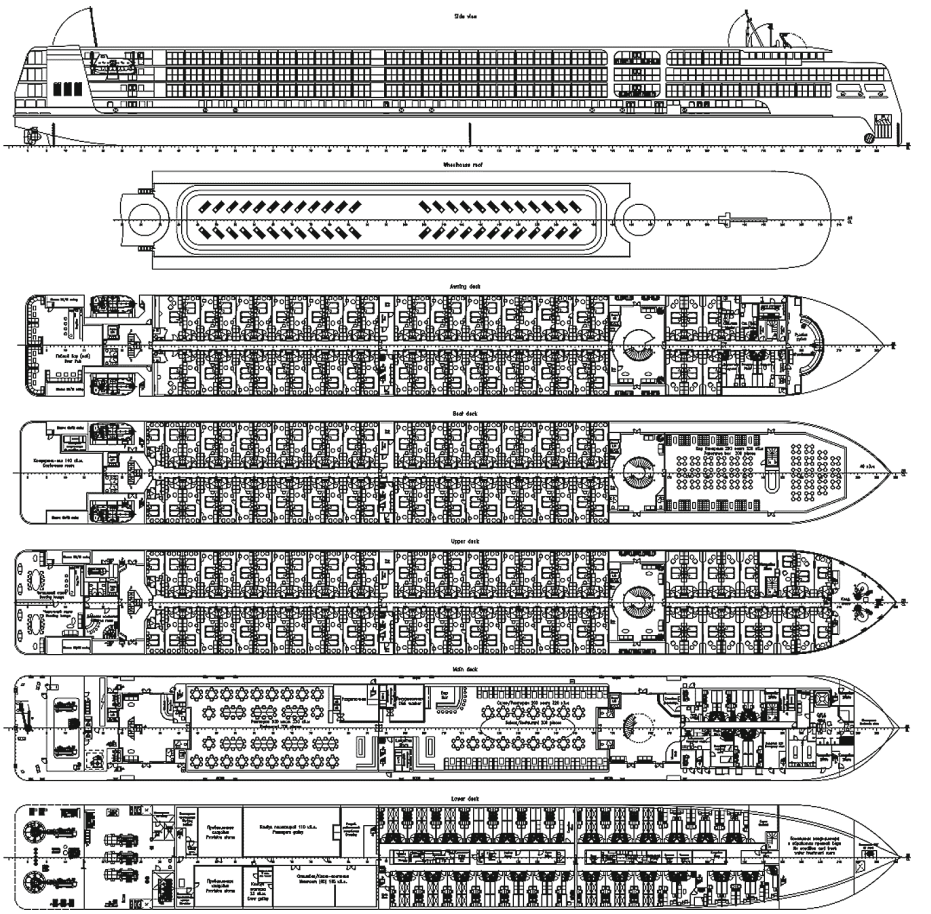


**Fig. 8.** General arrangement of PV300 river-sea new generation cruise vessel.

different classes: 1 luxury cabin of about 29 $m^2$ area; 1 luxury cabin of about 26 $m^2$ area; 168 standard cabins of about 19 $m^2$ area (see Fig. 10); 1 standard cabin for disabled people of about 29 $m^2$ area.

Passenger cabins are located in the middle vertical zone on 3 superstructure decks.

All passenger cabins on both vessels are equipped with double beds, lavatory and douche, air-conditioner, wardrobe, safe, TV set with satellite and internal vessel's channels, hairdryer, sockets 220 V and 110 V, wireless Internet (Wi-Fi), vessel's radio translation, external and internal telephone connection. Fore, middle and aft vertical zones are used for providing rest of passengers on the vessels.

Forward vertical zone on PV300VD vessel includes as follows: 380 $m^2$ panoramic theatrical music saloon with a bar, gift shop, hairdressing saloon, a spa saloon with sauna, fitness center, massage room and rest room with jet tub.

Middle vertical zone includes as follows: double level solarium with grill-bar, 530 $m^2$ main restaurant.

**Fig. 9.** Design view of standard passenger cabin on PV300VD river-sea cruise vessel.

**Fig. 10.** Design view of standard passenger cabin on PV300 river-sea cruise vessel.

Aft vertical zone includes as follows: 170 $m^2$ 24 days bar/disco, restaurant with 110 $m^2$ opened kitchen. One change meal period for passengers is foreseen on the vessel. Two restaurants are applied for this purpose: main restaurant and restaurant with opened kitchen. All restaurants have maximal available glass cover that enables to take pleasure not only in tasty meal but also in window's view.

6 persons passenger lifts for moving passengers between decks are installed (1 in fore hall and 1 in aft hall).

2 cargo lifts for moving cargoes between galley and restaurant are foreseen. Cargo lift from laundry complex on lower deck connecting all decks of the vessel is provided.

**Fulfillment of Safety Requirements**

PV300VD is not only up-to-date high comfortable and handy vessel but also safe, ecology "clear" passenger one that fully meets requirements of all International Conventions (IC), including IC for the Safety of Life at Sea (SOLAS), IC for the Prevention of Pollution from Ships (MARPOL), International Regulations for Preventing Collisions at Sea (COLREGS). Additionally, the vessel meets all Russian requirements such as Sanitary Regulations and Norms, Fire Safety Regulations, Technical Regulations for Safety of Inland Water transport Objects.

The vessel fully satisfies SOLAS norms and Class requirements of damage stability, including probability assessment of hull subdivision, special requirements for passenger vessels of Russian Maritime Register of Shipping, and all normative requirements of Russian River Register Rules.

PV300 vessel is planning to be operated on internal waterways without international voyages, so she only meets Russian requirements.

Fire safety of new concepts is provided by division of vessels into main vertical zones with constructive and thermal barriers; subdivision of accommodation spaces from other spaces with thermal and constructive barriers; exception of application of inflammable materials; detection of any seat of fire in zone of its emergence; restriction of distribution and fire extinction in places of its emergence; protection of means of escape and accesses to them for fight against the fire and readiness of fire-protection equipment to fast application.

From each waterproof compartment located below bulkhead deck two outmost from each other exits are made.

Special requirements to equipment of ventilation systems of vessels were revealed on design stage. Spaces which are in different vertical fire zones are not connected between each other through vent ducts. Vent ducts are arranged in way so that they could be blocked from the outside of ventilated spaces.

Ventilation control is executed from two posts located on maximal outmost from each other.

Except meaningful measures of fire protection, complex of actions for fit out of accommodation, public and service spaces by automatic systems of fire detection and automatic sprinkler systems in local vertical fire zones is executed.

**Hull Structure**

Main 7 watertight transverse bulkheads are installed on both vessels. They divide hull into 8 impermeable compartments. At the aft part of vessels from each side two fast 150 persons' capacity life-boats and two workboats are installed. For safe and

accelerated process of passengers' evacuation 2 evacuation systems with closed inflatable self-righting rafts (4 rafts on 101 persons each) are installed on vessels. Earlier such systems on river and river sea vessels were not applied.

Middle part of vessel's hull is constructed by mixed framing system (see Fig. 11). Main and upper decks are constructed by longitudinal framing system on whole length. Lower, boat and tent decks are constructed by transverse framing system on whole length. Bottom and double bottom are constructed by longitudinal framing system in middle part and transverse framing system in ends and in ER. Outer side is constructed by transverse framing system on whole length. Constructions of ends are constructed by transverse framing system.

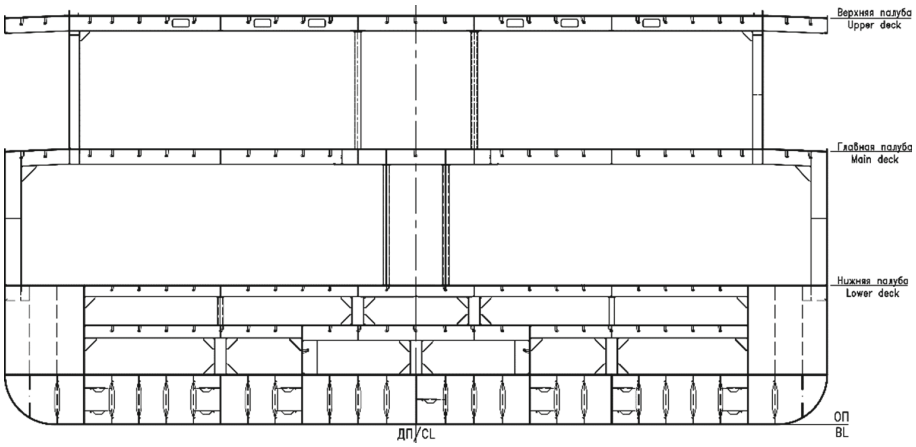


**Fig. 11.** Transverse cross-sectional view of PV300VD vessel's hull.

Construction of sides and bottom is reinforced in accordance with RRR rules and ice class "Ice 30".

For ensuring of maximal glazing execution of cuts for windows and doors practically from deck to deck required solution of number of problems connected with strength of attachment fittings and material of windows.

Construction of vessel's decks in area of big cutaways under atriums is reinforced with thickened sheets and additional connections.

### CFD Optimization of Hull Form

CFD-modelling tests were executed to optimize hull form (underwater part of hull is the same on PV300 and PV300VD projects), see Fig. 12 and Fig. 13. Researches have shown that traditional single hull type passenger vessel can be recommended. According to received results of calculation full speed makes 26.3 km/h (14.2 knots).

### Choice of Main Engine Type

Main power plant on PV300VD vessel is diesel-electric. It consists of four main diesel-generators of alternative current 690 V, 50 Hz with electrical power 1140 ekW each,

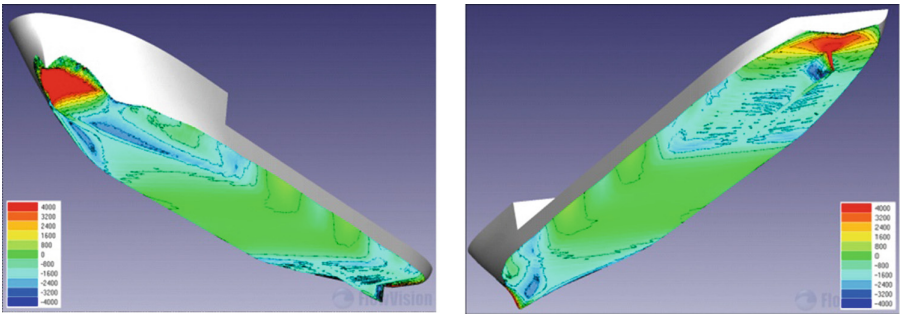

**Fig. 12.** CFD modelling in flowvision software. Pressure distribution. Fore and aft view.

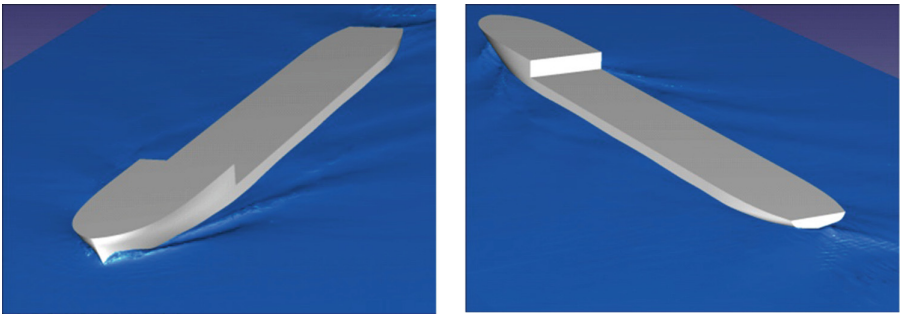

**Fig. 13.** CFD modelling in flowvision software. Free surface. Fore and aft view.

feeding electric propulsion plant and other customers. Classic river vessels in Russia have diesel power plant.

For cruise passenger vessel, for which needs of passenger part for energy are commensurable with needs for energy for the movement, use of electric propulsion provides considerable advantages on building stage and, especially, in operation. Electric propulsion has allowed to exclude on building stage one diesel-generator on power and to reduce in general number of diesels –4 main diesel-generators are installed instead of 3 main engines and 3 diesel-generators. During standard operation two main diesel-generators are providing power to propulsion motors and other vessel consumers. The third diesel-generator is in reserve or works when speed is increased or under bad weather conditions. And it is possible to carry out technical maintenance on the fourth diesel-generator. Diesel-electric power plant provides higher profitability on low and half speeds, and also during vessel voyages with frequent stops and maneuvers. Electric drive allows to apply screw-propellers with the best performance coefficient and to use primary engines in the most economy mode because between primary engine and screw practically any gear ratio can be chosen.

Auxiliary power plant consists of: emergency diesel-generator of 214 kW electrical power; auxiliary boiler plant consisting of two oil fired thermal oil heaters with heat

power 800 kW each, fore thermal oil exhaust gas heaters with heat power 250 kW each; auxiliary mechanisms and apparatus working for power plant.

On PV300 vessel main power plant is classic diesel one. It consists of two main diesel engines Wartsila 6L20 of maximal continuous power 1200 kW each. Auxiliary power plant consists of: three diesel-generators of electrical power of 760 ekW each; emergency diesel-generator of 214 kW electrical power; auxiliary mechanisms and apparatus working for power plant. Auxiliary boiler plant consists of: one oil fired thermal oil heater with heat power 800 kW; three thermal oil exhaust gas heaters with heat power 170 kW each.

As fuel for main engines IFO380 with viscosity 380 cSt at 50°C and low sulfur content is used. For emergency diesel-generator MDO with low sulfur content with flash point over 60°C is used.

**Improvement of Maneuverability and Grounding of Propulsion Complex Type**

In aft part of PV300VD vessel three full-rotate fixed pitch rudder propellers (FPRP) with mechanical power on input shaft is of 1000 kW each are installed. Two FPRP with 1200 kW power each are installed on PV300 vessel. For improvement of controllability at low speeds, at passing narrow waters and at moorings bow thruster is foreseen. Traditionally three-shaft unit was used on big Russian river CV as propulsion complex.

As special researches have shown better maneuverability of the vessel is provided on wide angles at FPRP turn. In process of decrease in motion speed of the vessel advantage of FPRP increases up to the most low speed <3 kn when the vessel with rudders becomes almost uncontrolled and FPRP allow to carry out vessel turn in pos.

Usage of FPRP is especially effective while vessel's operation in river when passing narrow places and numerous river turns the vessel cannot move with maximum speed and efficiency of rudders falls down. Thus, the vessel equipped with FPRP can pass the same way section faster. If to operate vessel on one FPRP there is no loss of controllability and thus vessel speed falls slightly to 7.5–8.0 kn. In economy mode of operation on one FPRP considerable fuel saving exists.

Purchase value of FPRP is approximately equal to the total cost of speed-reduction gear, shaft line, stern gear, screw, nozzle, steering gear and rudder.

Therewith FPRP installation is simpler: there is no need for laying of shaft line, thus less qualified personnel can be used, time of FPRP installation is less than time of mechanical transmission installation. All this allows to cut down expenses on mounting. FPRP installation can be carried out afloat after vessel's launching. Delivery and installation of equipment of rudder propeller system can be made for some months later that also lead to economy of funds.

For providing full control over the vessel's movement while maneuvering on slow speed, mooring operations and docking installation of vessel's control system which unites all propulsion units of the vessel (FPRPs and bow thrusters) in integral module is provided and thus control of all these propulsion units is executed by means of one joystick. Therefore, FPRPs have been applied on PV300 and PV300VD concepts.

## 5 Conclusions

The most serious restraining factor of growth of native cruise tourism industry is lack of modern river and river-sea cruise vessels. For the solution of problem of updating it is offered to connect river and some coastal sea routes on the basis of modern cruise vessels of PV300, PV300VD and PV09 projects. PV09, PV300 and PV300VD vessels are not only up-to-date high comfortable and handy vessels but also safe, ecology "clear" passenger carriers that fully meet requirements of all International (PV300VD vessel) and Russian requirements (PV09, PV300, PV300VD vessels).

PV300 and PV300VD concepts are the first native cruise vessels which were designed in accordance with maximization of main dimensions methodology and module principles of forming living blocks and public places. These decisions allowed to increase comfort level for passengers and to make river-sea passengers' transportations economically reasonable. For ensuring of maximal glazing execution of cuts for windows and doors problems connected with strength of attachment fittings and material of windows were solved.

Application of FPRP allowed to improve maneuverability of PV300 and PV300VD vessels. On existing native river and river-sea vessels triple-screw propulsion complex is installed.

Hull form was specially designed and optimized by means of CFD.

## References

1. Egorov, A.G., Egorov, G.V.: Analysis of decommissioning trends of river cruise vessels and prognosis of river fleet structure with definition of most demanded types of vessels for conversion and modernization (in Russian). J. Morskoy Vestnik **1**(69), 21–27 (2019)
2. Egorov, G.V., Ilnitskiy, I.A., Kalugin, Ya.V.: River-sea cruise passenger vessels for Russian IWW (in Russian). Science-technical collected book of Russian Maritime Register of Shipping, vol. 36, pp. 255–276 (2013)
3. Egorov, G.V., Ilnitskiy, I.A., Kalugin, Y.V.: "Line-up" of river cruise passenger vessels (in Russian). J. ONMU Report. **2**(38), 20–40 (2013)
4. Egorov, G.V.: Analysis of European river cruise experience and its influence on native cruise vessels of new generation (in Russian). J Morskoy Vestnik **3**(43), 23–28 (2012)