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Design experience of conversions of river-sea cargo vessels

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UNECE
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Backgrounds of vessels' conversions

Aging of water transport vessels represents a serious problem for all transport system of the Russian Federation. As a result of physical and moral aging, cost of the safe state keeping of vessels significantly grew; vessels' operational qualities and competitiveness are steadily de-creased especially in the conditions of the "low" crisis market.

Certainly, the shipbuilding has to be the main cure of such problem; but the leading shipping companies that built vessels a lot of in 2010-2013, now have many credits to pay. And there are no financing of new commercial shipbuilding by the acceptable percent and reasonable term during crisis conditions.

Therefore it is necessary to pay the closest attention to the compromise technical solutions for prolongation of a life term of the existing vessels. First of all it concerns vessel hull (general overhaul, re-new, modernization, conversion, vessel's construction with use of donor vessel's elements).

Backgrounds of vessels' conversions

Conversion occupies the special place among different variants of essential modernizations; it means considerable, as a rule, dimensional modernization of the vessel with survey of all her parts as new ones, i.e. on compliance to requirements of the International Conventions and rules of Classification Society for date of survey. Necessity of the conversion is defined by the following reasons: change of vessel's functions according to alternation of cargo flows structure, orientation to other cargo types, the unification of cargo places, orientation to other navigation areas, etc.; the morale ageing of vessels caused by change of technology of goods transportation and handling in ports, hardening of the international and national requirements, changing in fuel cost, neediness of change of the commercial or other processing equipment, etc.; physical ageing of vessels and their elements; the considerable vessels' dam-ages received as a result of accidents.

Conversion of vessels allows to solve problems of essential prolongation of life term and increase of safety at reasonable speed and with smaller expenses than at usual shipbuilding. Some vessels become outdated morally long before appearance of limit physical wear of hull or mechanisms. As a rule, the early ageing is not result of miscalculations at design or construction of vessels; often it is too early to discard such vessels, so modernization or re-equipment may become a solution of such situation.

Main types of conversions of existing vessels

Analyzing concrete examples of vessels conversion, it is possible to allocate the following main technological directions:

- increase of the vessel's main particulars by replacement of hull's part by new larger one (e.g. the 005RSD06 and RSD11 dry-cargo vessels of "Chelsea" type; the RSD08 m/v "Ommaks"; the RSD60 m/v "Ediniy"; the CNF06 ferryboat "Avangard"; the PV01 passenger vessel "Imperia"; the RST05 tankers of the "Narva" type and the RST26 tankers of the "Gloster" type);

- increase of the vessel's main particulars by means of insertions or additions while using of the whole old hull (e.g. the CNF03 ferryboats of "Smat" type and the CNF09 ferryboat "Slavyanin", the BC14 bulk carriers of "Grumant" type);

- replacement of inter constructions (the PV08 passenger ship "Alexander Grin", passenger auxiliary vessels PV01M "Imperia", PV02 "Neva", PV05 "Bars" and PV07 "Caucasus").

Example of conversion with part of hull replacement. Vessel of 005RSD06.01 prj “Chelsea-4”

Example of conversion with internal reequipment. Passenger vessel of PV08 prj. “Alexander Grin”

(photo – Mosturflot cruise company)

Basic principles of conversion

1. The scientific-based approach of definition of border between installation of new elements and usage of the old ones.
2. The full meeting of the international and national requirements for building date of the new vessel.
3. The actual ensuring reliability for the set operational term of the vessel.
4. The new quality of the vessel from the point of view of a basic purpose.
5. The application of modern calculation methods and technologies.

Accounting of defects which were accumulated during operation of the initial vessel

Conversion requires the accounting of the following defects which were accumulated during operation of the initial vessel:

- corrosion and mechanical wear of hull constructions and welded joints, especially local thinning which are badly documented and not considered at the traditional strength calculations;
- deformations of the inner bottom and inner side as a result of contact with cargo and cargo handling gauges in ports; deformation of the outer shell as a result of contact with ground at shallow water, with walls of locks or channels, with berthing facilities or ice;
- accumulated fatigue damages at the zone of stress concentration, especially microcrack and violations of crystal structure of material which cannot be found at surveys;
- possible alternation of physical-mechanical properties of material of the hull (ageing).

Example of vessel-donor “Volgo-Don 145”

Principal conditions of adaptability of old structures

The elements of the operated vessels allowed for usage at building of the new vessel have to undergo procedures of fault detection, repair and confirmation of compliance to requirements of RRR Rules from the point of view of suit-ability on technical condition of hull constructions, as well as by properties of the materials which are earlier used in the operated elements.

The reserve of life term or wear degree of the specified elements are determined by strength calculation and durability on the basis of the carried-out analysis of an actual state. The recovery work capacity for such constructions is determined by estimated life term and also depending on the shipowner's opportunities.

The mostly loaded hull constructions that consumed fatigue resource are not allowed to use for former functions at conversion. Application of the operated hull elements is allowed, first of all, when forming assembly units which do not participate in ensuring the vessel's general strength, i.e. 3D and flat sections which were placed in peaks (not far than $0.3L$ from perpendiculars); section of a superstructure or its parts; transverse hull members, etc.).

Principal conditions of adaptability of old structures

The listed restrictions exclude from application for new shipbuilding the main constructions that could consume fatigue resource but damages of which (in the form of micro-cracks) can be not founded at the hull fault detection.

The reason for issuing of the certificate of compliance to the Rules requirements for a hull element is: compliance of mechanical properties and a chemical composition of material of the used old hull element to requirements imposed to shipbuilding steel that demands carrying out the corresponding tests and analyses; compliance of the used old element to the Rules requirements taking into account the estimated vessel's operational term that was set according to mechanical properties of material of old elements; and hull element's suitable technical condition.

The listed restrictions allow to use most effectively elements of the discarded vessel, namely: if these elements have a sufficient reserve of life term, vessel's building is conducted according to the planned 20 years' operation; if these elements are worn in a bigger degree, vessel's building is conducted for 15 years' operation.

Vessel's building with usage of elements of the existing donor vessels

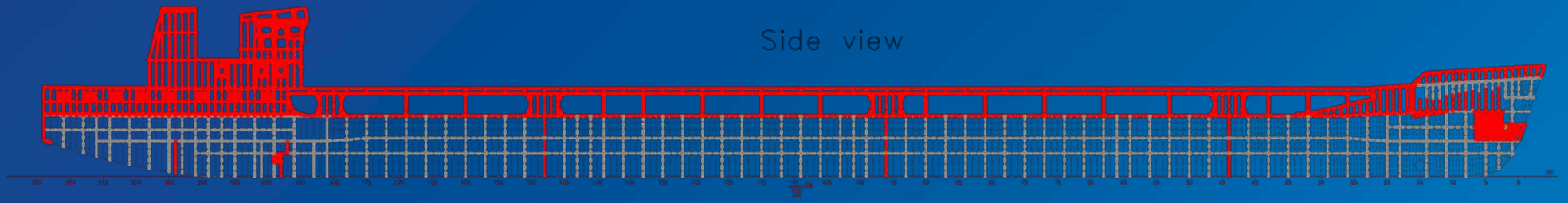
Thus it is essentially important not only providing a resource of the vessel and her elements, but changing of her technical-economic properties, creation of new opportunities and, as a result, increase in efficiency due to new quality.

The new quality can be provided due to change of such cargo parameters as cargo capacity and deadweight, dimensions, free board, hull strength, capacity of power plant and ice strengthening. In turn such changes lead change of vessel's functions, her architectural and constructive type or areas of operation.

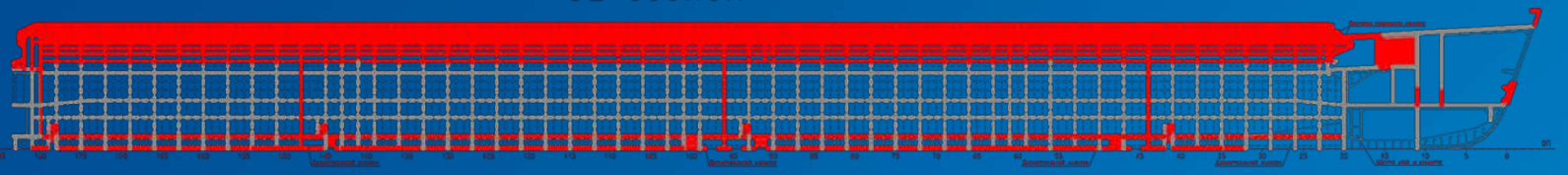
The most striking example of a vessel's building with usage of elements of the existing donor vessels is creation of a series of mixed river-sea dry-cargo vessels with a deadweight about 6000 tons of "Chelsea" type (005RSD06 and RSD11 MEB projects).

Scheme of construction of dry-cargo 005RSD06 vessel of “Chelsea” type

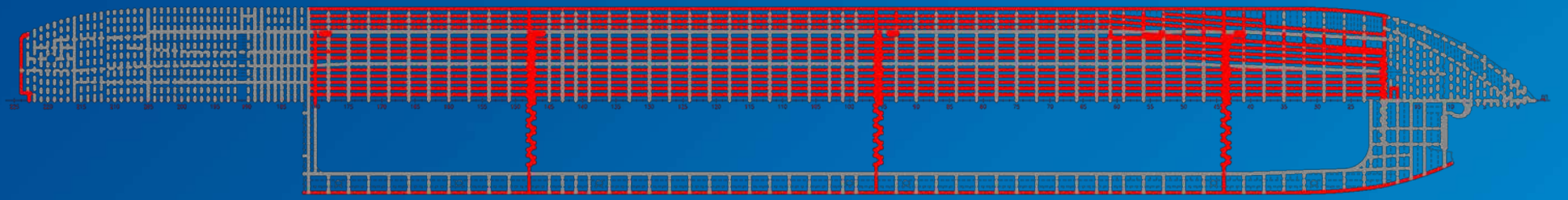
Side view



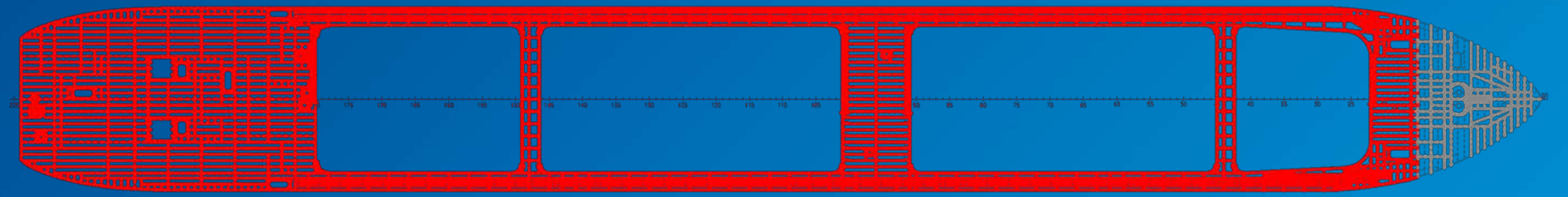
CL section



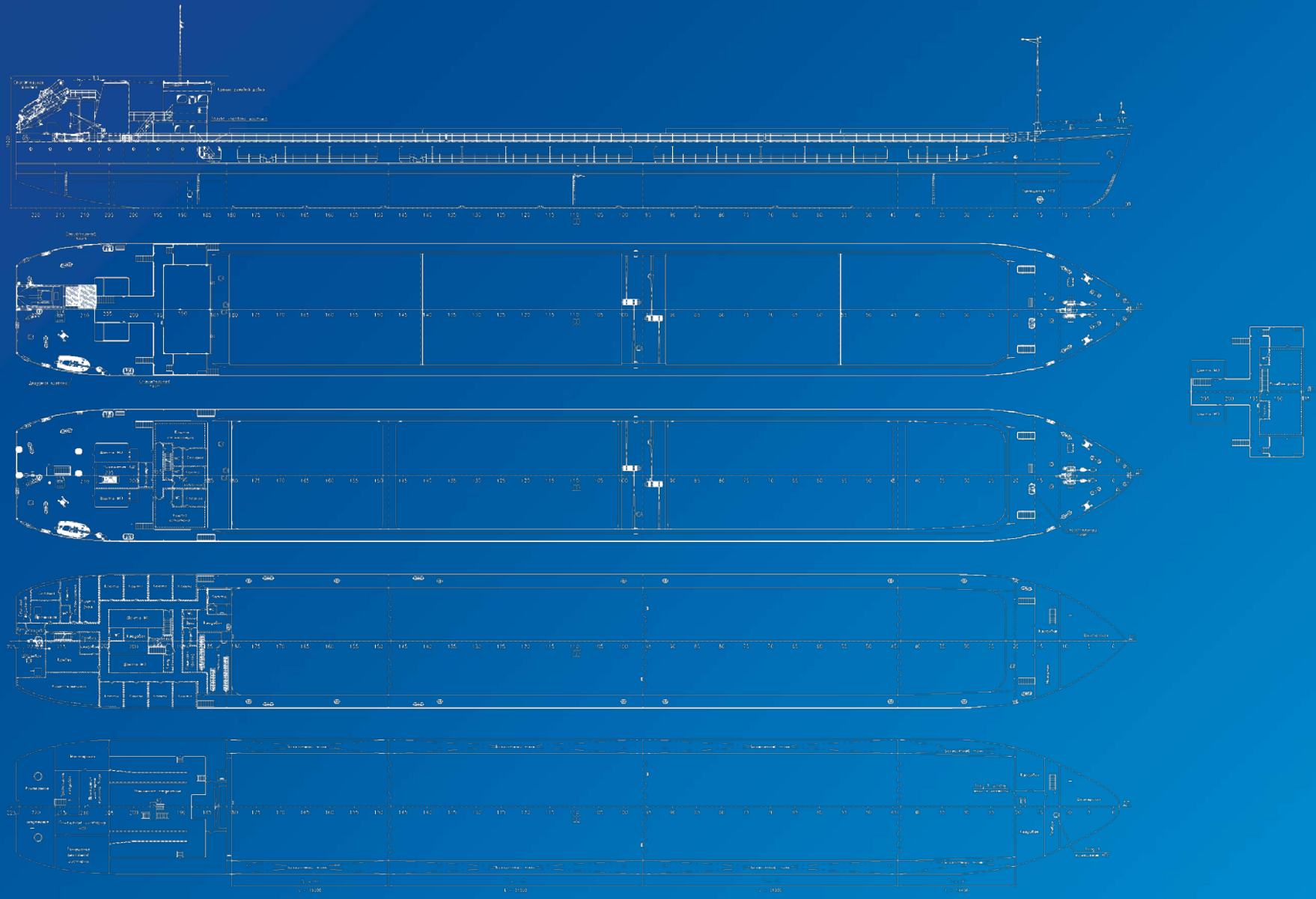
Inner bottom and main deck



Upper deck



General arrangement of 005RSD06 project vessel



Idea of building of new vessel of 005RSD06 project

005RSD06 and RSD11 projects are based on idea of usage of high continuous longitudinal hatch coamings (of 3.5 m height using existing coamings) that allow due to significant section height increase to enhance simultaneously standard of general strength of vessel's hull (by 112% !!!), cargo holds' capacity and dead-weight in accordance with requirements of International Load Lines Convention.

Existing coamings and previous upper deck were the most loaded elements that worked out their fatigue resource. These elements appear now in the zone closed to the neutral axis of the equivalent beam, so they are excluded from the general hull bending; such situation allows keeping them as hull elements. Inertia moment rise of the high transverse section (while keeping bottom thickness) increased bottom section modulus by 1.66 times.

Building of 005RSD06 project vessel

Vessel of 005RSD06 project after launch

Building of 005RSD06 project vessel

Total charges for constructing of single “Chelsea” type 005RSD06 vessel was about 5.2-5.5 million US dollars in the January, 2008.

Charges for hull were 2.4-2.7 million US dollars, charges for equipment purchase and major repair were 1.8 million US dollars and builder finishing cost about 1.0 million US dollars.

For information, construction cost of “Heydar Aliev” type 006RSD05 vessel was about 14-15 million US dollars in 2008.

Tug-supplier “Roose” is vessel-donor for train ferry of CNF03 project

Scheme of construction of train ferry of CNF03 project

Building of CNF03 project train ferry

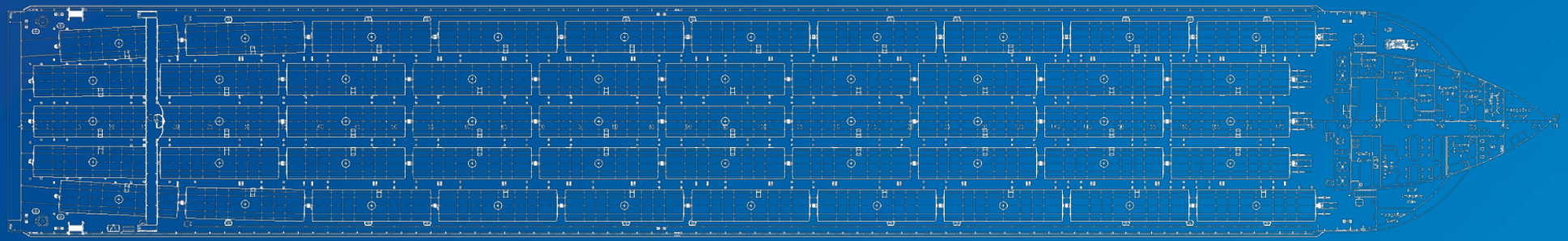
Building of CNF03 project train ferry

CNF03 project train ferry

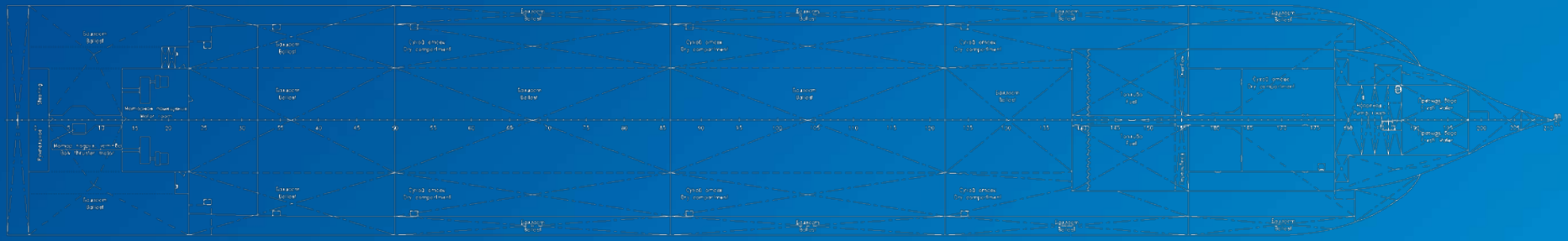
General arrangement of CNF03 project train ferry

БОКОВОЙ ВИД

ВЕРХНЯЯ ПАЛУБА

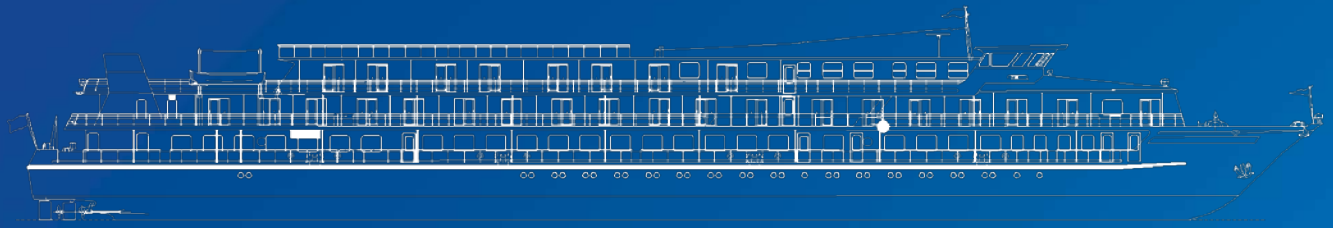


ДВОЙНОЕ ДНО



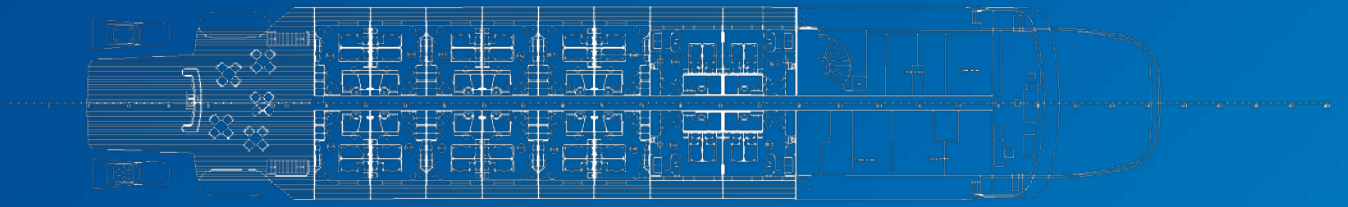
Vessel-donor «Alexander Blok» (Q-065 prj) in process of conversion according to PV08 MEB project

General arrangement of PV08 passenger vessel

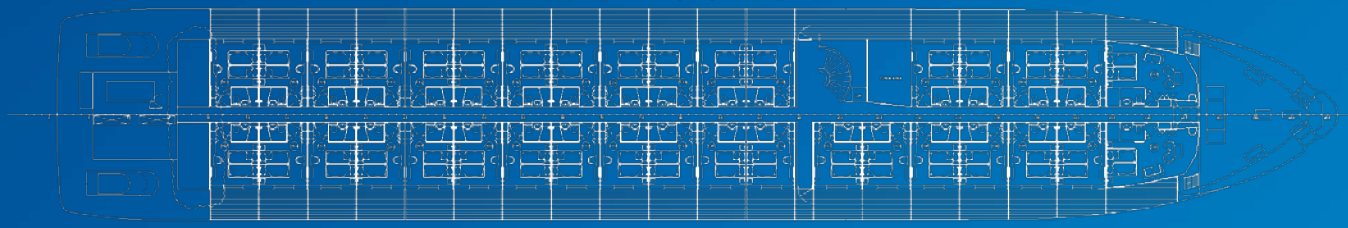


Onega deck

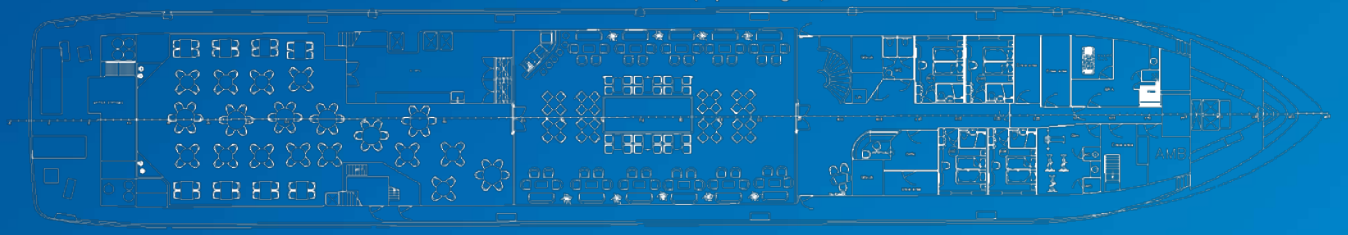
Neva deck (32 passengers)



Volga deck (72 passengers)



Moskva deck (8 passengers)



Process of conversion of passenger vessel

Process of conversion of passenger vessel

Process of conversion of passenger vessel

Process of conversion of passenger vessel

Vessel's building with usage of elements of the existing donor vessels

Design of constructions of a vessel that is to be built with usage of donor vessel elements should be based on the scientific-based approach of definition of border between installation of new elements and usage of the old ones; the full meeting of the international and national requirements for building date of the new vessel; the actual ensuring reliability for the set operational term of the vessel; the new quality of the vessel from the point of view of a basic purpose and the broad application of modern calculation methods and technologies. While presenting the vessel as a new one, the safety factors have to be increased in comparison with requirements of rules for new vessel.

It is necessary to understand clearly, that nowadays as before all vessel's life term prolongation schemes are not an alternative of new shipbuilding. These schemes allows providing transport necessity of national economy for nearest 10-15 years; in reality they close gap between lowering transportation rate of the fleet and rising demands of the national economy while financial and industrial resourced are limited.

General view of standard cabin

General view of suite

Restaurant on «Alexander Grin» river passenger vessel of PV08 project

Lounge-bar on «Alexander Grin» river passenger vessel of PV08 project

Cost of conversion and modernization of river passenger vessels

The cost of creation of new river passenger vessel constructed with usage of donor vessel elements on 56 cabins makes about 12 million dollars. For comparison - cost of modernization of river passenger vessel can be estimated (on the example of vessel of 301 project after modernization of 109 cabins) at 7.75 million dollars.

Specific expenses at modernization make about 60 thousand Euros for 1 cabin, at conversion – about 170 thousand Euros for 1 cabin.

Approximate payback of such conversed passenger vessel will make about 14-15 years, of modernization of 301 project – 7-8 years.

Thus conversed vessel will actually work 30-35 years, modernized – 20-25 years.

Technical condition of “Volgoneft” tankers

Ecological problems of “Volgoneft” tankers

The main ecological problem of "Volgoneft" type tankers is insufficient double bottom height that doesn’t meet MARPOL requirements. In accordance with Regulation 19 of MARPOL Annex I, double bottom height of such tankers should be not less than $h = B / 15 \geq 0.76$ m.

Transverse sections of vessels are shown for commence and completing of modernization works for fulfilling MARPOL requirements; these drawings describe main structural decisions that were accepted by Marine Engineering Bureau in order enhance "Volgoneft" type tankers to the international level.

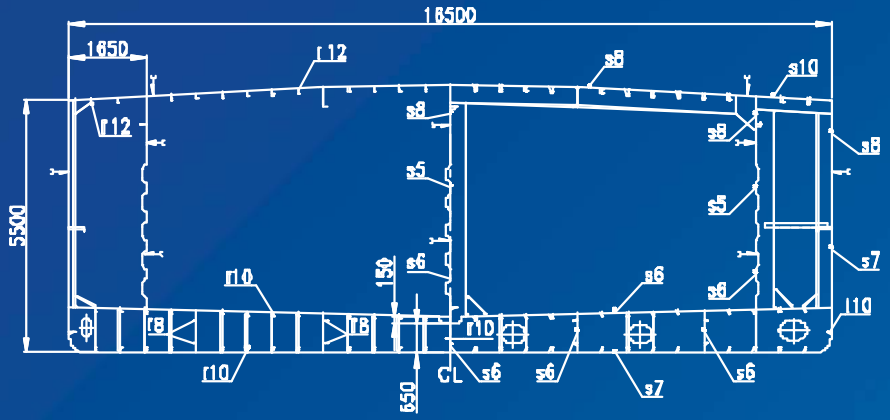
Such approaches allow to prolong service life of existing tankers for 5-15 years and to provide level of ecological safety accepted by international community.

Ecological problems of “Volgoneft” tankers

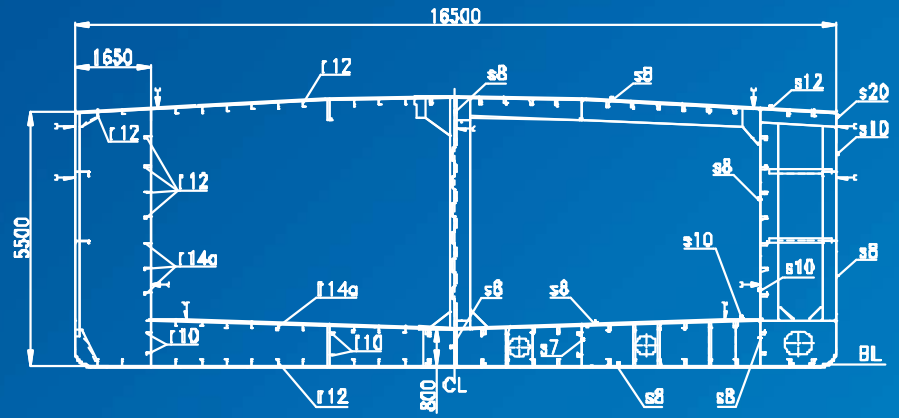
No.	MARPOL Annex I	Requirement	Actual fulfillment onboard vessel	Notes
1	Regulation 14.1	Any ship of 400 gross tonnage and above shall be fitted with oil filtering equipment	Oil filtering equipment with alarm indicated when oil content exceeds 15 parts per million is absent	Is required for vessels that operate out of special areas (Caspian Sea isn’t a special area so filtering equipment is necessary)
2	Regulation 20.4, forwarding to Regulation 19.6.1	Double bottom height at oil tankers of 5000 tons deadweight and above delivered before 6 July 1996 shall be not less than $B / 15 = 6.5 / 15 = 1.1$ m	Actual double bottom height at CL is of 0.8 m	Is fulfilled when double bottom height is increased
3	Regulation 21.4, forwarding to Regulation 19.6.1	Double bottom height at oil tankers of 600 tons deadweight and above but less than 5000 tons deadweight carrying heavy grade oil as cargo (SG more than 0.9 or viscosity more than 180 cSt) shall be not less than $B / 15 = 6.5 / 15 = 1.1$ m	Actual double bottom height at CL is of 0.8 m	Is fulfilled when double bottom height is increased
4	Regulation 26.4	The length of each cargo tank shall not exceed defined value of 21.96 m	Actual cargo tanks length is of 23.76 m	Main problem!!! It’s required either to install cofferdams or to move existant transverse bulkheads in the cargo tanks
5	Regulation 29.1 Regulation 29.2.1	Oil tankers shall be provided with slop tank arrangements and adequate means for cleaning the cargo tanks	Slop tanks and tanks’ washing system are absent	Main problem!!! It’s required to construct slop tanks
6	Regulation 31	Oil tankers of 150 gross tonnage and above shall be equipped with an oil discharge monitoring and control system	Oil Discharge Monitoring and Control Systems is absent	Is required for vessels that operate out of special areas (Caspian Sea isn’t a special area so oil discharge monitoring and control system is necessary)
7	Regulation 32	oil tankers of 150 gross tonnage and above shall be provided with effective oil/water interface detectors in slop tanks	see row 5	see row 5

Marine Engineering Bureau
variants of midship sections of “Volgoneft” tankers

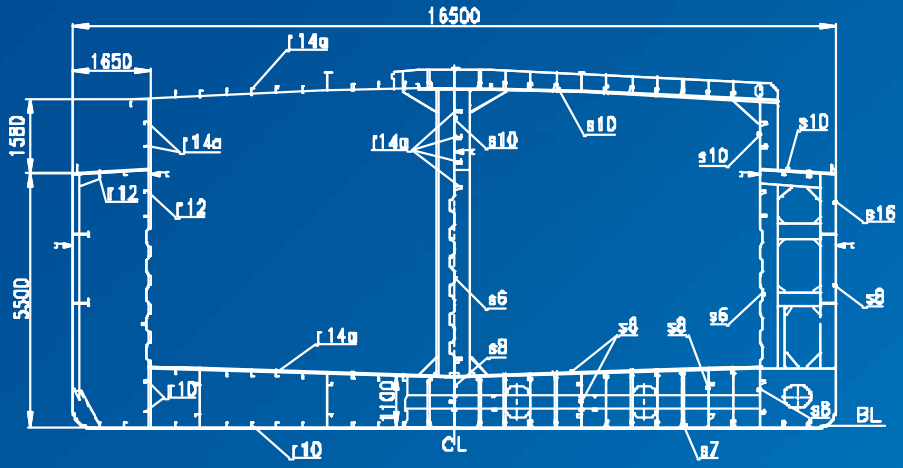
Initial condition



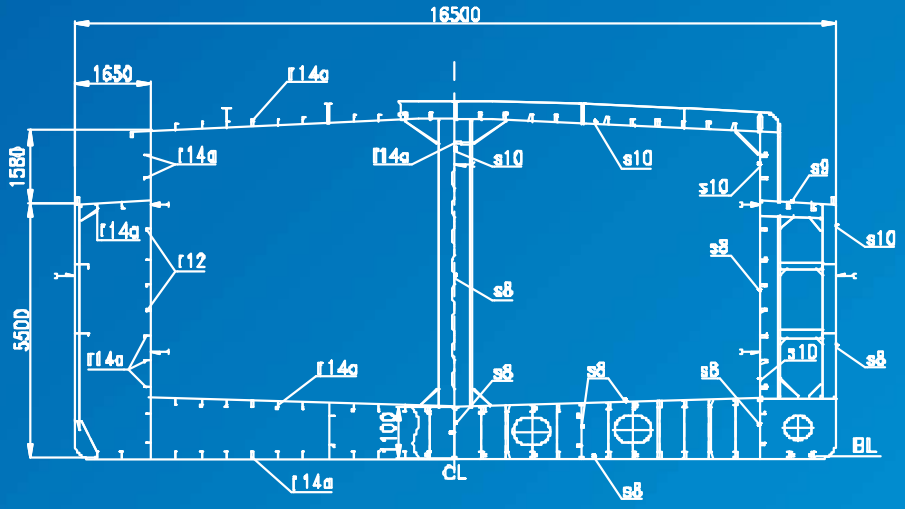
2003-2005 renewal



Modernization



Conversion



Ecological problems of “Volgoneft” tankers

There are several possible variants of "long-term" activity for providing safe operation of "Volgoneft" type tankers, as follows:

- transportation of the light oil products only, notably cargoes with SG = 0.9 and less;
- modernization tankers into dry-cargo vessels;
- rising double bottom without year of building changing (modernization);
- cargo zone replacement with year of building changing (conversion).

But it seems impossible to carry out such modernization works at tens of Russian tankers simultaneously.

Modernization of mv "Victor Astaf’ev" took about 2 years; less complicated work as tank top rising at mv "Mechanic Khachepuridze" is fulfilled during 90-120 days. Even if significant financial sums for modernization are available, there is no adequate number ship repairing or ship building yards.

Before beginning of 2013 tank top was risen at 23 tankers of "Volgoneft" type (prj. 1577/550A) and at 3 of prj. 630.

Other measures were not carried out at 20 vessels from mentioned 23 one of "Volgoneft" type tankers. So these 20 ones don’t correspond to the MARPOL requirements.

Only three vessels of 1577/550A prj. were modernized to meet in whole international requirements of ecological safety.

Example of “Volgoneft” tanker modernization which is met requirements of MARPOL

Example of “Volgoneft” tanker conversion
Marine Engineering Bureau RST11 prj (in progress)

Thank you for attention!