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BASED ON MARKET DEMAND LINE-UP OF RIVER-SEA DRY CARGO-VESSELS

Анализ рынка перевозок речных сухих грузов и существующего флота позволил построить параметрическую линейку сухогрузных судов смешанного река-море и морского ограниченного района плавания, которые были объективно востребованы отечественными судовладельцами и стали основой для разработанных и новых проектов Морского Инженерного Бюро.

Ключевые слова: проектирование, параметрическая линейка, суда внутреннего плавания, суда смешанного река-море плавания.

Аналіз ринку перевезень річкових сухих вантажів і існуючого флоту дозволив побудувати параметричну лінійку суховантажних суден змішаного ріка-море й морського обмеженого району плавання, які були об'єктивно затребувані вітчизняними судновласниками й стали основою для розроблених і нових проектів Морського Інженерного Бюро.

Ключові слова: проектування, параметрична лінійка, судна внутрішнього плавання, судна змішаного ріка-море плавання.

The analysis of dry-cargo river market and existing fleet allowed building a parametrical line-up of river-sea and marine dry-cargo vessels of restricted sailing region which were objectively demanded by domestic shipowners and became the basis of Marine Engineering Bureau developed and new projects.

Keyword: design, a parametrical line, vessels of internal navigation, mixed river-sea navigation vessels.

Problem statement. As it was noted in [1; 2], the Marine Engineering Bureau has solved earlier problem of justification the parametrical line of the modern multi-purpose dry cargo vessels taking into account the essential changes of economic conditions and way restrictions. These vessels should be interesting to the post-Soviet shipping companies operating at domestic ports and, respectively, to Russian shipbuilding. Those today such vessels are mixed river-sea vessels (RSV) and similar (due to cargo loading) vessels for work in European shore regions (European «coaster»), and also vessels of sea restricted navigation regions (RSNAV). During the time which has passed from the date of the first publication [3] about domestic dry cargo vessels of the XXI century, the number of the projects which are under construction has been increased practically twice while keeping the main classes. Up to July 2011, 70 new dry cargo vessels constructed due to the Marine Engineering Bureau pro-

jects since 2004, have been in the operation. «Volga-Don Max» type was the most demanded for design and construction. These vessels maximally correspond to dimensions of locks of the Volga-Don Navigation Canal; they have the increased range of opportunities from the RS R1 class till the RRR O-PR class. The number of the vessels intended for voyages in the conditions of the European cabotage without calling to RF inland waterways has considerably increased.

Aim of the paper is to specify parametrical line of the modern multi-purpose dry cargo vessels which are of interest for the post-Soviet shipping companies that operate at domestic ports and, respectively, for Russian shipbuilding. According to the increased cargo transportation from river and estuary ports, at the beginning of the century the task of creation of new universal dry-cargo ships and tankers with reliable hulls and equipment which would be economically effective at linear work on internal waterways of Russia and at the limited draughts in the Azov and Caspian seas has appeared [4]. Besides it, vessels should operate all-the-year-round with the minimal losses of running time in coastal areas of Europe, including transitions through Bay of Biscay during the winter period. Further on, during the process of these vessels construction, the additional aims on coverage of other segments of the market, on specialization, on accounting of local conditions have appeared from domestic customers.

Main text. Generally, accepting of main characteristics of RSNV is completely defined by way restrictions, strategy of the future shipowner, his position in the market, loyalty to those or other directions of transportations and types of cargoes.

Despite outward subjectivity, such choice should be realized from discrete number of alternatives which quite objectively have arisen in the Russian transportation market as result of the compromise at a choice of waterways limitations and consignments (2000 t, 3000 t and their variations in 4000 t, 5000 t, 6000 t $\pm 10\%$ according to uniform charters on transportations).

It is necessary to notice that the most «popular» cargo capacity of a ship (3000 t) corresponds to historically usual consignment on the Russian market which equal weight of the cargo transported by one train at 50-52 wagons. This circumstance allows to transport mass cargoes from river harbors of Russia to ports of Europe and Mediterranean Sea without intermediate storage in stores of a port and, accordingly, without additional flow rates on an overload and storage.

The analysis of such alternatives has allowed to make a parametric line of dry-cargo ships of the river-sea and marine restricted navigation areas objectively claimed by Russian shipowners and to make projects of new vessels on its basis in MEB.

The renewed version of such parametric line is shown in the table 1.

Table 1

Main types of dry-cargo RNAV, designed by Marine Engineering Bureau

Distinguative feature of a ship class, number of project of the Marine Engineering Bureau	Side view (see table 2)	Overall Length × Breadth × Depth, m	Deadweight at maximum draught, t	Deadweight at characteristic draught, t	Deadweight at draught 3.60 m. t (in river)	Capacity of cargo hold, m ³	Register Class
Cargo capacity approximately 7000 t in I category, "Azov mstr" class							
RSD12	1	142.00×18.20×6.00	8048 (4.77 m)	7155 (4.40 m)	5028	10929	KM# LUT I AI
"Volgo-Don mstr" class							
RSD19	2	139.95×16.70×6.00	6750 (4.60 m)	4343 (3.60 m)	4343	10956	KM# LUT I AI
RSD49	3	139.95×16.50×6.00	7154 (4.70 m)	4518 (3.60 m)	4518	10920	KM# LUT I AI
006RSD005	4	139.63×16.70×6.00	6933 (4.60 m)	4535 (3.60 m)	4535	11408	KM# LUT I AI
RSD20	5	139.22×16.50×6.20	7162 (5.00 m)	6065 (4.50 m)	3960	11401	KM# LUT II AI
006RSD002	6	139.63×16.70×6.00	7094 (4.60 m)	4696 (3.60 m)	4696	10870	KM# LUT I IESP AI
007RSD007	7	139.99×16.70×6.00	7215 (4.60 m)	4778 (3.60 m)	4778	11000	KM# LUT I IESP A3
RSD11	8	138.30×16.75×5.50	6135 (4.11 m)	4854 (3.60 m)	4854	9761	PM-SP 3.5
005RSD006.01	9	137.52×16.75×5.45	6041 (3.95 m)	5104 (3.60 m)	5104	9780	PM-SP 3.5
005RSD006	10	139.60×16.70×5.50	6081 (4.10 m)	4830 (3.60 m)	4830	9843	PM-SP 3.5
RSD44	11	139.99×16.80×5.00	5562 (3.53)	5543 (3.60 m)	5543	7090	PM O-PR 2.0 (see 20) A
Cargo capacity approximately 5000 t at draught 4.2-4.5 m, "Azov 5000"							
RSD32	12	133.17×16.70×5.50	5129 (4.20 m)	5129 (4.20 m)	3834	8790	KM# LUT I AI
RSD13	13	133.17×16.70×5.50	6125 (4.672 m)	5185 (4.20 m)	3930	9450	KM# LUT II A3
RSD17	14	121.70×16.70×6.20	6271 (5.06 m)	5260 (4.50 m)	3530	9370	KM# LUT I AI
Cargo capacity approximately 3000 t at draught 3.6 m, in substitution "Volgo-Balt" / "Sormovskiy"							
DCV29	15	111.75×15.02×6.00	3787 (3.96 m)	3116 (3.60 m)	3116	4973	PM-SP 3.5 A
005RSD003	16	108.33×16.70×5.50	5499 (4.792 m)	3840 (3.60 m)	3340	7833	KM# LUT I IESP A3
RSD08	17	107.57×15.02×5.00	3888 (3.89 m)	3258 (3.60 m)	3258	6388	PM-SP 3.5
RSD10	18	99.90×15.80×5.80	4505 (4.80 m)	2690 (3.60 m)	2690	6000	PM-SP 3.5 + 10045 "G" "EI" MC AUT 24 "EI" "SOLAS II-2, Reg 19"

Continued Table 1

Distinctive feature of a ship class, number of project of the Marine Engineering Bureau	Side view (see table 2)	Overall Length × Breadth × Depth, m	Deadweight at maximum draught, t	Deadweight at characteristically draught, t	Deadweight at draught 3.00 m, t (in river)	Capacity of cargo hold, m ³	Register Class
Cargo capacity approximately 3000 t at draught 4,2-4,5 m, "Azov three-thousandt"							
003RSD04	19	89.73×15.90×5.75	3756 (4.481 m)	3422 (4.20 m)	2584	4832	KM# LCI II AS
003RSD04/ALB01	20	89.85×15.60×5.75	3510 (4.464 m)	3176 (4.20 m)	2339	4491	KM# LCI II AS
003RSD04/ALB03	21	89.17×15.60×6.30	4416 (5.286 m)	3067 (4.20 m)	2243	5486	KM# Ics I AUTS
RSD16	22	89.73×13.50×6.10	3152 (4.50 m)	3152 (4.50 m)	2106	4300	KM# LCI II AS (ORH04)
"European Coasters" with cargo capacity about 5000-6000 t at draught 5.5 m, "Dumbe-army: 5000-6000" type							
DCV46	23	119.67×15.90×8.30	7443 (6.11 m)	4674 (4.50 m)		10111	Hull: E 100 AS EI G Multi-Purpose Dry Cargo Ship, SOLAS-II-1, Reg.19, Equipped for Carriage of Containers, DBC Machinery: P6 MC E1 AUT KM# LP11 AI
RSD09	24	109.12×16.70×6.50	6208 (5.50 m)	6208 (5.50 m)		8251	
DCV27	25	99.99×15.90×7.10	5018 (5.52 m)	3673 (4.50 m)		6673	KM# I
DCV56	26	89.96×14.50×7.20	5026 (6.40 m)	2748 (4.50 m)		6228	KM# Ics I AUTI
DCV33	27	89.99×14.00×7.15	4509 (5.812 m)	3019 (4.50 m)		5611	Hull: E 100 AS EI G, DBC, SOLAS II-2, Reg.19, General Cargo Ship, Equipped for Carriage of Containers Machinery: P6 MC E1 AUT
DCV43	28	89.99×14.00×7.15	4499 (5.81 m)	3009 (4.50 m)		5527	Hull: E 100 AS EI SOLAS-II-1, Reg.19, G, DBC, Multi-Purpose Dry Cargo Ship, Equipped for Carriage of Containers Machinery: P6 MC E1 AUT

The important feature of new projects is an excess freeboard for characteristic draught. That allows increasing vessel's cargo capacity for work at marine ports. For this purpose the minimal freeboard is appointed at designing.

The structure of this line of projects includes the following basic classes of dry-cargo RSV and RSNV which are claimed in the modern market of transport services:

- «Azov max»: type; this class is defined by waterways restrictions in Russian ports of the Sea of Azov; cargo capacity at maximum draught is about 8000 t, entry in Volgo-Don Shipping Channel (VDSC) locks is not stipulated;

- «Volgo-Don max» type; this class is defined by overall dimensions of VDSC locks and has the greatest possible cargo capacity up to 5000 t for character river draught of 3.60 m; cargo capacity at maximal draught is about 7000 t;

- «Azov-Caspian Coasters» type; this class has cargo capacity about 5000 t for character river draught of 4.20-4.50 m at Russian ports of the Azov and Caspian Seas; it also are able to pass through VDSC (for relocation);

- «Volgo-Balt / Sormovskiy» type; this class has cargo capacity about 3000 t at character river draught of 3.60 m;

- «European Coasters» type; this class has cargo capacity about 3000 t for character river draught of 4.20-4.50 m at Russian ports of the Azov Sea; conventional length is less than 85 m (that allows to place no life boats). There is single «box shape» cargo hold which is designed for long-length cargoes. These vessels can work on internal RF waterways [5];

- «European Coasters» type; this is estuary dry cargo vessels with cargo capacity 5000-6000 t at draught 5.5 m; they are intended to work at Ukraine Danube port (Izmail, Reni), Dnepr ports (Nikolaev, Kherson), Azov ports (Mariupol) and at Northern-Western RF ports if high ice class is presented;

- «European Coasters» type; this vessel have overall length less than 100 m; that allows working at European ports without pilot service;

- «European Coasters» type; these vessels are intended to work at Northern-Western RF ports and Ukraine Azov ports without entering the RF inland waterways. These vessels have cargo capacity about 4500 t at draught 5.5-6.5 m, conventional length less than 85 m and high ice class for winter work at St. Petersburg and Arkhangelsk.

Additionally, shipowners that work at Northern-Western RF ports, are interested for creating high ice class vessels (LU3-LU4) that require no ice conveyance in winter through Gulf of Finland and Gulf of Bothnia, White Sea. Such projects are: RSD32 (it is also an «Azov 5000» type; DCV33, DCV36, DCV43 and DCV46 types that are not intended for operation at RF rivers at all.

The extending participation of domestic shipowners in the worldwide trade requires construction of vessel that meet requirements of the international market, e.g. DCV33, DCV36 and DCV43 coasters that accepted for transportation between EC ports.

These vessels have conventional length less than 85 m and maximal available for such vessels deadweight (about 4500-5000 t). Also river-sea DCV29 vessel can be introduced as example; their dimensions correspond to Rhine River restrictions.





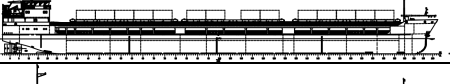
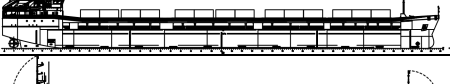
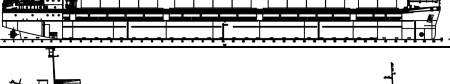
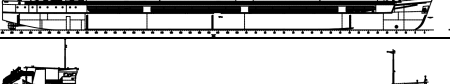

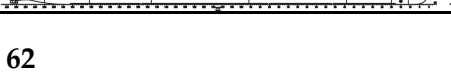
RSD16 vessels should be noted especially among the offered European «coaster»; these vessels have possibility to work through the Belomor-Baltic Canal keeping the cargo capacity about 2000 t.

New vessels have increased cargo holds' capacity and main engines' capacity comparing with existing RSV.



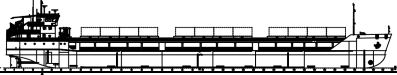




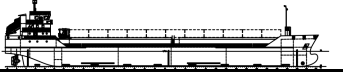



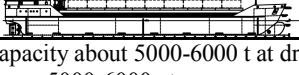


Schemes of side views of offered line of MEB dry-cargo vessels are resulted in uniform scale in the table 2.

Table 2

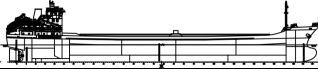

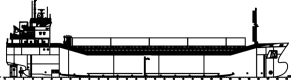

Schemes of side views of MEB dry-cargo vessels' parametric line

№	Design, maximum deadweight	Side view
1	2	3
Cargo capacity approximately 7000 t in Taganrog, «Azov max» class		
1	RSD12, 8048 t	
«Volgo-Don max» class		
2	RSD19, 6750 t	
3	RSD49, 7154 t	
4	006RSD05, 6933 t	
5	RSD20, 7162 t	
6	006RSD02, 7094 t	
7	007RSD07, 7215 t	
8	RSD11, 6135 t	
9	005RSD06.01, 6041 t	
10	005RSD06, 6081 t	

Continued Table 2

1	2	3
11	RSD44, 5562 t	
Cargo capacity approximately 5000 t at draughts 4.2-4.5 m, «Azov 5000»		
12	RSD32, 5129 t	
13	RSD18, 6125 t	
14	RSD17, 6271 t	
Cargo capacity approximately 3000 t at draught 3.6 m, in substitution «Volgo-Balts» / «Sormovskiy»		
15	DCV29, 3787 t	
16	005RSD03, 5499 t	
17	RSD08, 3888 t	
18	RSD10, 4505 t	
Cargo capacity approximately 3000 t at draughts 4.2-4.5 m, «Azov 3000»		
19	003RSD04, 3756 t	
20	003RSD04/ALB02, 3510 t	
21	003RSD04/ALB03, 4416 t	
22	RSD16, 3152 t	
«European Coasters» with cargo capacity about 5000-6000 t at draught 5.5 m. «Danube estuary 5000-6000» type		
23	DCV46, 7443 t	
24	RSD09, 6208 t	

Continued Table 2

1	2	3
«European Coasters» with overall length less than 100 m		
25	DCV27, 5018 t	
«European Coasters» with overall length less than 85 m		
26	DCV36, 5026 t	
27	DCV33, 4509 t	
28	DCV43, 4499 t	

Vessels were designed in accordance with different Rules, as follows: RS Rules (18 projects), RRR Rules (6 projects), GL Rules (3 projects), RU Rules (1 project).

Conclusions. All vessels are assigned for transportation of general, solid bulk, grain, timber, heavy and large-sized cargoes; ISO 8.5' and 9.0' containers, dangerous goods of 1.4S, 2, 3, 4, 5, 6.1, 8, 9 classes of IMDG Code and cargoes of category B of BC Code.

By 5 projects conform to the requirements of the unrestricted sailing area and RS sailing area R1, 10 ones conform to RS sailing area R2, 2 ones conform to RS sailing area R2-RSN, 5 ones conform to RRR sailing area M-SP (with fulfilment R2-RSN requirements), and single one corresponds to RRR sailing area O-PR.

10 vessels' series have 4 cargo holds, 8 series have 3 cargo holds, 3 series have 2 cargo holds. 7 series have single enlarged cargo hold, that allows to carry out voyages with equipment and other long-sized cargoes from European ports to roughly developing region of the Caspian Sea (RSD49 triple-hold vessels have such cargo hold).

7 of 28 developed projects use the full-turned rudder propellers (FRP) as the integrated running and manoeuvring unit. 14 projects have single-shaft propulsion, the others ones have double-shaft propulsion. Fourteen projects variable pitch propellers, including FRP ones (RSD12 and RSD10 projects), the others ones have fixed pitch propellers. 13 projects have propellers in nozzles. Main engines of 22 projects can use IFO 180-380 HFO (2 series in operation have been such modified). All propulsion units applied on the MEB projects belong to mid-speed diesels. Operational vessels' speed with full cargo at 85-90 % engines' loading makes 10.0-12.5 kn.

Full-turned rudder propellers usage provides enhanced manoeuvrability at restricted conditions, increasing the cargo zone, decreased for about 20 % ER length; expenses, necessary time for mounting, expected repair and service costs reducing. The last was most brightly reflected in terms of construction of vessels of the Armada series in Turkey.

Hull structures of 7 series correspond to RS Ice2 category (LU2 or L3 old notations), 6 ones correspond to RS Ice3 category (LU3 or L2 old notations), other ones correspond to RS Ice1 category (LU1 or L4 old notations).

For the series which are under construction it is observed the tendency of modifying up to ice category LU2 requirements, including replacement of main engines in order to increase their capacity required ice-passing criteria of Classification Society rules (prj. 003RSD04 «Caspian Express»).

23 projects have automation class. Crew consists of 8-14 people.

RS single-compartment unsinkability requirements were used additionally to SOLAS probability index requirements for 5 projects in accordance with owner demand.

As shown in the table 3, vessels of 28 projects of this parametric line of the Marine Engineering Bureau already are under constructions on various shipyards in Russia, Ukraine, Turkey and China. 70 vessels are handed over into operation in 2004-2011, 23 vessels are under construction now. The resulted data allows to make a conclusion about successful solution of the posed problem both in theoretical, and in the practical plan.

Table 3

Dry cargo RSV construction due to MEB projects

№	MEB design	Shipyards	Completed	Under construction	Ordered total
1	2	3	4	5	6
1	RSD12, «Rostov monstr» type	Gelibolu, Turkey	4		4
2	RSD19, «Khazar» type	Volgograd Shipyards	4		4
3	RSD49	Neva Shipyards, Lotos Shipyards		4	12
4	006RSD05, «Palmali Trader» type	Volgograd Shipyards	8		8
5	RSD20, «St. Nikolay» type	Kherson Shipyards	1		1
6	006RSD02, «Nadezhda» type	Oka Shipyards (Navashino)	1		1
7	007RSD07, «Tanais» type	Volgograd Shipyards	1		1
8	RSD11, «Chelsea-1» type	Kherson Shipyards	1		1
9	005RSD06.01, «Chelsea-3» type	Kherson Shipyards «Yuzhnyi Sevastopol» Shipyards	7		7
10	005RSD06, «Chelsea-2» type	Kherson Shipyards	1		1
11	RSD44, «Kapitan Ruzmankin» type	Oka Shipyards (Navashino)	3	7	10
12	RSD32	China, Huaxia Shipping-Business CO., LTD (Wuhan)			

Continued Table 3

1	2	3	4	5	6
13	RSD18, «UCF-1» type	China, Huaxia Shipping-Business CO., LTD (Wuhan), Hengyu Shipyard		6	8
14	RSD17, «Euro cruiser» type	Krasnoe Sormovo Shipyard	5		5
15	DCV29	Kherson Shipyard			1
16	005RSD03, «Kareliya» type	Onega Shipyard (Petrozavodsk)	12		12
17	RSD08, «Ommax» type	China, Xingang Shipyard	1		1
18	RSD10				
19	003RSD04, «Caspian Express» type	Turkey, Ceksan Shipyard	6		6
20	003RSD04/ALB02, «Helios» type	Turkey, Aksoy Shipyard Turkey, Ceksan Shipyard	3		3
21	003RSD04/ALB03, «Modulus» type	Turkey, Aksoy Shipyard	3		3
22	RSD16	Onega Shipyard (Petrozavodsk)			
23	DCV46	Onega Shipyard (Petrozavodsk)			
24	RSD09, «Danube Seamen» type	Kiliya Shipyard		2	2
25	DCV27, «Saxona» type	China, Taidzhou	1		1
26	DCV36, «Ametist» type	China, Qingdao Hyundai Shipbuilding Co. Ltd	2	8	10
27	DCV33	Onega Shipyard (Petrozavodsk)	6		6
28	DCV43	China			
Total			70	23	108

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