A new generation of inland modular vessels for polish east-west waterways with low depth

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ABSTRACT

A new generation of inland environmentally friendly ships destined for waterways with critical limited depth is presented. General project concepts are supported by push system idea of standardized, optional equipped hulls for desirable exploitation necessities. A few traditional motor ships and barges are described as the background for comparison.

Keywords : inland shipping, waterways with restricted depth, environment protection, modularized ships.

As a result of long term negligence and unfinished hydrological investment ventures, Polish system of inland waterways diminished step by step and has achieved a condition which is so bad that is impossible to run regular inland shipping. Simultaneously, accepted the Nature 2000 Program indicated environmentally protected corridors along the main rivers, which practically eliminate larger investments. As a result of these conditions, to enable inland shipping to be carried on, it is necessary to create a new generation of inland water ships adapted to slightly correct and controlled parameters of waterways permitted by Bird and Habitat Directives.

From this point of view draught of new inland ships must be sharply restricted to maximum 1m. Breadth and length are the result of existed old locks dimensions and waterway bends.

In the frames of European Eureka Project, "Environmentally friendly inland and coastal ships for Polish East-West Waterways" Σ!3065 INCOWATRANS, we undertook activities to create a family of inland ships with limited dimensions. There are :

- universal general cargo/container motor ship 18/36 TEU (SINE 207)
- traditional bulk barge (2 options) (SINE 208)
- basic barge (pontoon) for multipurpose application of modular functional convertible blocks (container vessel, ro-ro, ferry, house boat, passenger cruiser), push system (SINE 209)
- passenger two-unit luxury vessel [push system (EUREKA II)].

A project consortium was formed by the following participants :

- Technical Universities and Research Institutes :
  - Gdansk University of Technology, Faculty of Ocean Engineering and Ship Technology as coordinator of the whole project with involvement of Faculties of Civil Engineering as well as Architecture
  - Warsaw University of Technology, Institute of Environmental Protection, Faculty of Civil Engineering – environmental problems
  - Wroclaw University of Technology, Faculty of Mechanical Engineering, Institute of Machines Design and Operations (Waterways)
  - Maritime Institute, Gdansk, logistic problems.
- Companies from the small and medium size enterprises sector :
  - Design Office SINUS Ltd., performing design work based on ships conception projects
  - DesArt Ltd., Design Office, optional FEM analysis.
- Foreign Partners – INFERT GmbH – Rostock, (Germany).

The consortium performed the work in two stages.

Definition stage included studies of inland water transportation conditions and possibilities in direction east-west, environmental problems as results of shipping revitalization in the inland running "wild" Polish waterways, studies of existing technical possibilities of ship systems and machinery, analyses of inland harbours and hydrotechnical infrastructure of waterways, new concepts of passenger terminals and first ideas of multimodal inland harbours. The computer information system in the field of waterways technical and shipping conditions were proposed. At the design and testing stage, designs of the ships were carried out and hydromechanical investigations of selected model of ships were performed. Also appropriate calculations of different alternative solutions of ship machinery, propulsion systems and equipment were carried out.

Inland ship during the building processes and operation create some ecological hazards (Fig.1). Therefore a range of different solutions were applied in the designed ships :

- diesel electric, diesel hydraulic or water jet propulsion system
- POD propulsion and steering system
- two propulsion systems
- use of low sulphur content fuels
- use of exhaust gas catalyst
- ballast water and all waste to be discharged only to utilization service station in harbours
- minimizing of fuel margin
- specialized modular container blocks for arranging of passenger cabins, sanitary machinery, power station in the passenger cruiser or house vessel
- use only natural media in the fire fighting systems
- automatic limitation of the oil contents in bilge water
- use of environmental friendly painting materials and other production and repair processes
- use of special ship sewage processes.

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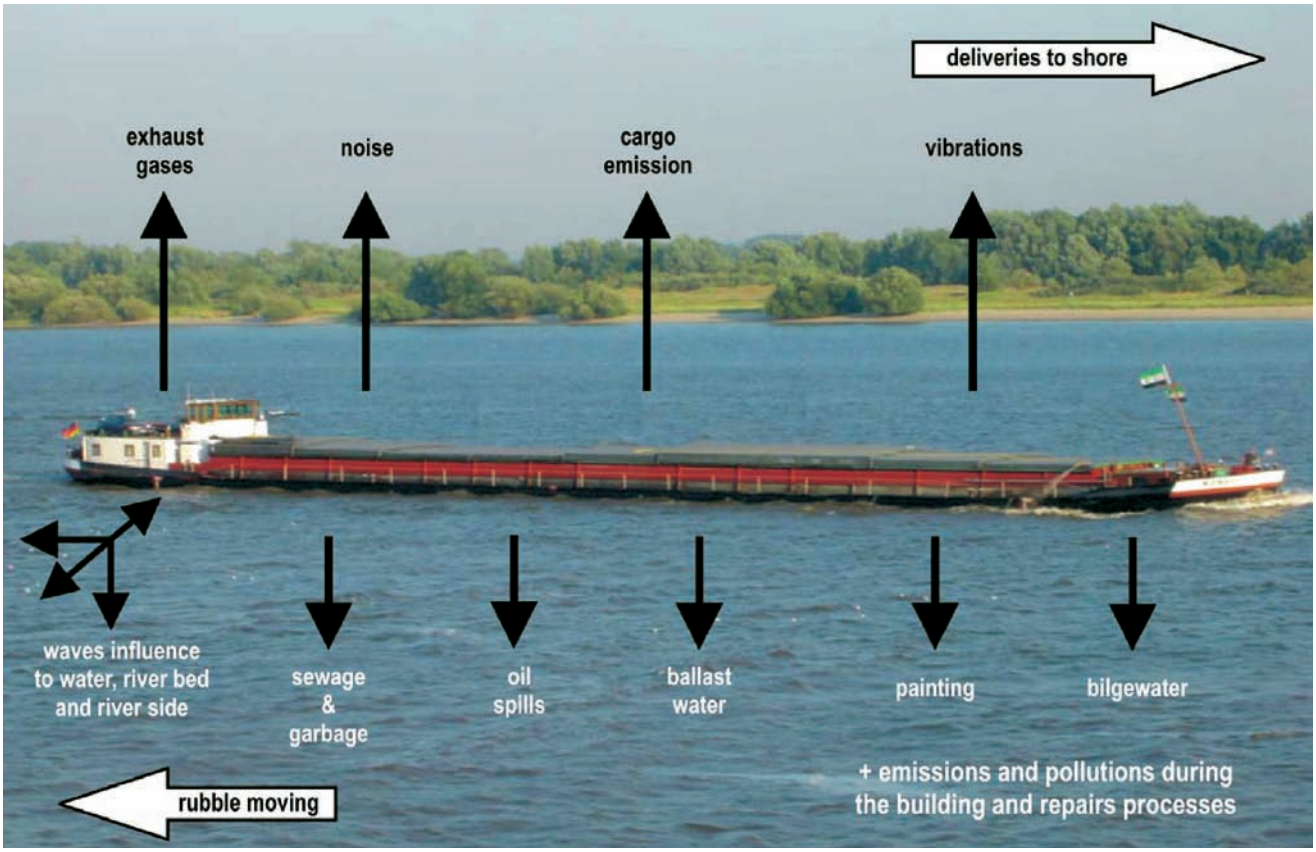

Fig. 1 Ecological hazards created by inland ship

The ships were designed according to Germanischer Lloyd and Polish Register of Shipping regulations. Additionally the vessels fulfil the requirements for class CLEAN DESIGN, what guarantees their harmless for environment.

Diesel-electric propulsion was applied to drive the ships. The propulsion consists of engines and generators Volvo Penta and also Schottel Pump-Jet propellers. This configuration is characterized by :

- ✶ fluent regulation of power consumption and achieved thrust
- ✶ low vibrations and noise
- ✶ very good manoeuvrability
- ✶ effective protection of propeller destruction on shallow water
- ✶ elimination of suction effect on shallow water.

In order to obtain the class CLEAN DESIGN there were applied the following solutions reducing hazardous influence of vessels on environment :

- ● addition of special substance "Urea" to limit NOx emission
- ● sewage tanks
- ● bilge tanks
- ● oil pollution tanks
- ● double bottom
- ● double sides
- ● ecological coatings for internal and external shell plating.

SINE 207 (inland general cargo/container 18/36 TEU) is adapted to transport 20' or 40' containers in three holds and on the hatch covers. The containers in holds are located in one layer in three rows. The same arrangement is provided for containers on hatch covers. In the holds the ship can transport also general cargo.

SINE 208 (inland general and bulk cargo push tow) consists of pusher tug and barges. The tug was designed in two options with different pull forces. Every of two types of barges, "Barge 1" and "Barge 2", occurs in two option with different high of coamings. Barges are adapted to transport general and heavy cargo (ore) in several arrangements.

SINE 209 (inland multi-purpose vessel) is composed of pusher tug and universal pontoon without own propulsion system. The pontoon is adapted to :

- ♦ carry house containers – the vessel becomes inland passenger ship in STANDARD or LUX version (house boat or cruiser)
- ♦ transport 20' or 40' cargo containers – the ship becomes inland container vessel
- ♦ transport wheeled vehicles – trailers, vans, lorries and cars – the ship becomes inland ferry or inland ro-ro vessel.

The following versions of vessel were designed :

VERSION IA – house boat for 34 passengers and 2 persons of crew
VERSION IB – cruiser for 28 passengers and 4 persons of crew
VERSION II – container vessel for 24 TEU or 6 TEU and 9 FEU
VERSION IIIA – ferry (in two configurations)
VERSION IIIB – ro-ro vessel (in two configurations).

Proposed modular solutions base on application of specialized functional containers. This equipment allows shipowner to change character of universal push tow depending on temporary market requirement and possessed transport orders. The innovation permits Shipowner, even the smallest one, to dispose of considerable transport potential with diversified structure without excessive development of inland fleet. The advantage of the multi-purpose vessel is economic

effectiveness of company. The solution allows operating in different sectors of market and indirectly improves environment protection conditions for inland waterways. Main parameters of the designed ships are given in the Table 1 and 2.

Table 1. *Traditional inland ships designed in the project*

Parameters	Type of ship			
	Coastal cargo/container SINE 207	**Pusher Tug SINE 208**	**Bulk Barge 1 SINE 208**	**Bulk Barge 2 SINE 208**
L_{OA}[m]	56.50	17.30	38.25	56.46
L_{BP} [m]	55.30	15.79	37.24	55.44
B [m]	9.0	9.0	9.0	9.0
T_1 [m]	1.0	1.0	1.0	1.0
T_2 [m]	1.6	1.6	1.6	-
H [m]	3.0	3.0	3.0	3.0
DWT (T_1) [T]	210	-	-	-
DWT (T_2) [T]	510	-	389	557
Holds capacity [m^3]	840	-	-	-
Container capacity	18/36 TEU	-	-	-
Engine power [kW]	620	2x240 or 2x294	-	-
Propulsion power [kW]	-	2x185 or 2x200	-	-
Propulsion system	Pump jet diesel electric	Pump jet diesel electric	-	-
Cruising speed [km/h]	15	15	-	-
Crew	max. 6 persons	6 persons	-	-
Total pull [kN]	-	25.9 or 40.8	-	-
GL-Class	GL ✠ 100A5 ✠ MCY	GL ✠ 100A5 TUG ✠ MC. CLEAN/D	GL ✠ 100A5 ORE. CLEAN/D	GL ✠ 100A5 ORE. CLEAN/D

Table 2. *Modular inland ships designed in the project*

Parameters	Type of ship					
	Basic barge (pontoon) SINE 209	**House boat version**	**Passenger ship version**	**Container version**	**Ferry version**	**Ro-Ro ship version**
L_{OA}[m]	56.55	=	=	=	=	=
L_{BP} [m]	56.0	=	=	=	=	=
B [m]	9.0	=	=	=	=	=
H [m]	1.20					
T [m]		0.7	0.7	0.9	0.9	0.9
Cruising range [days]	-	7	7	7	7	7
Container 20” [TEU]	-	-	-	24	-	-
Container 20”+40“ [TEU]	-	-	-	6 + 9	-	-
Passenger [persons]	-	34	28	-	-	-
Crew [persons]	-	2	4	-	-	-
Engine Power [kW]	-	-	-	-	-	-
Cruising range [days]	-	7	7	7	7	7
PRS class	PRS ✠ sk2 pas/pr/con/ro-ro “Clean Design”					

where :

L_{OA} – Length Over All of a Ship; L_{BP} – Length Between Perpendiculars of a Ship; B – Breadth of a Ship; T – Draft of a Ship; H – Height of a Hull; DWT – Dead Weight Tonnage; GL – Germanischer Lloyd; PRS – Polish Register of Shipping

The Fig. 2 ÷ 8 present general arrangement plans of ships. The ship documentation has been prepared to the level of preliminary design.

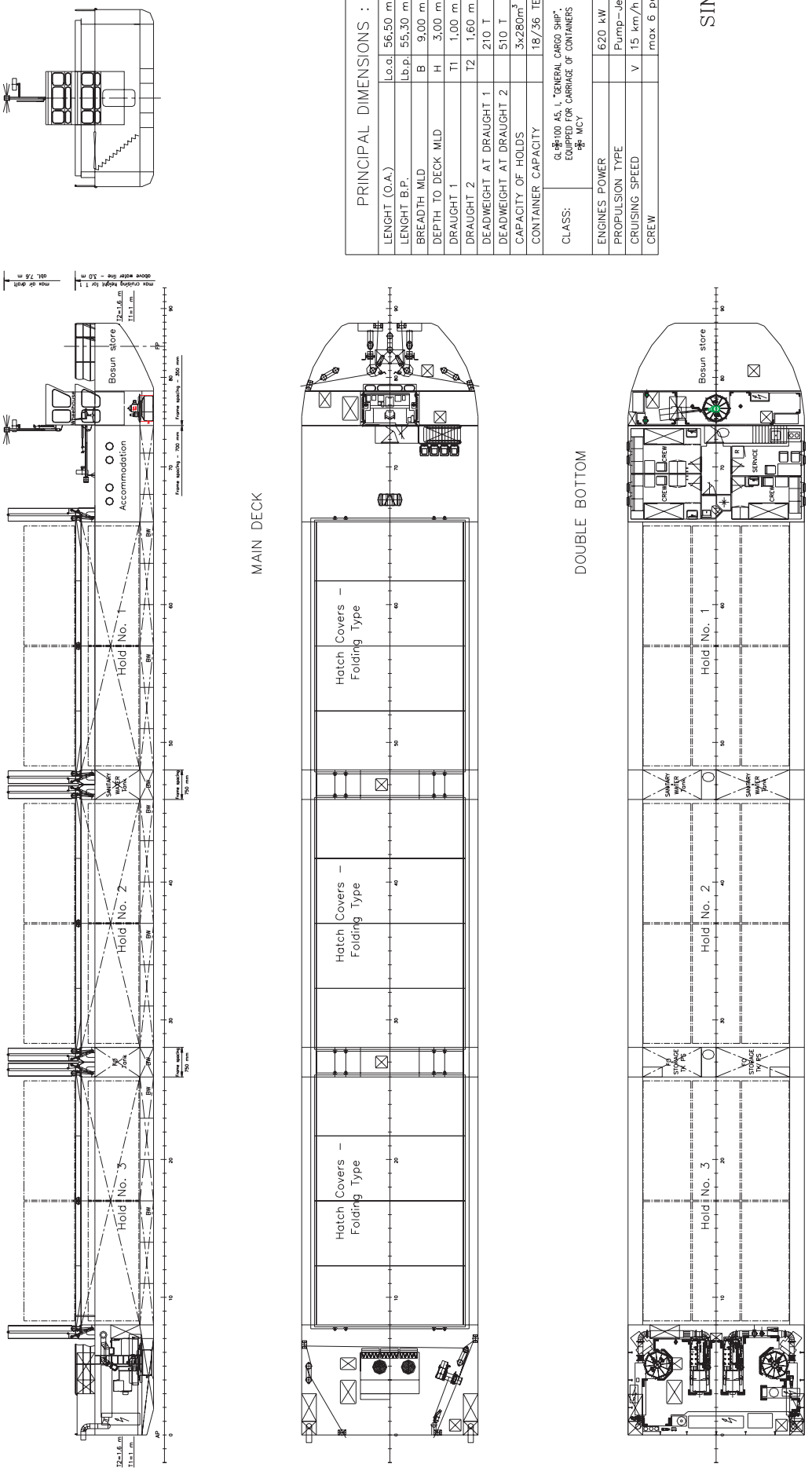

***Fig. 2.** Inland general cargo / container 18/36 TEU (SINE 207).*

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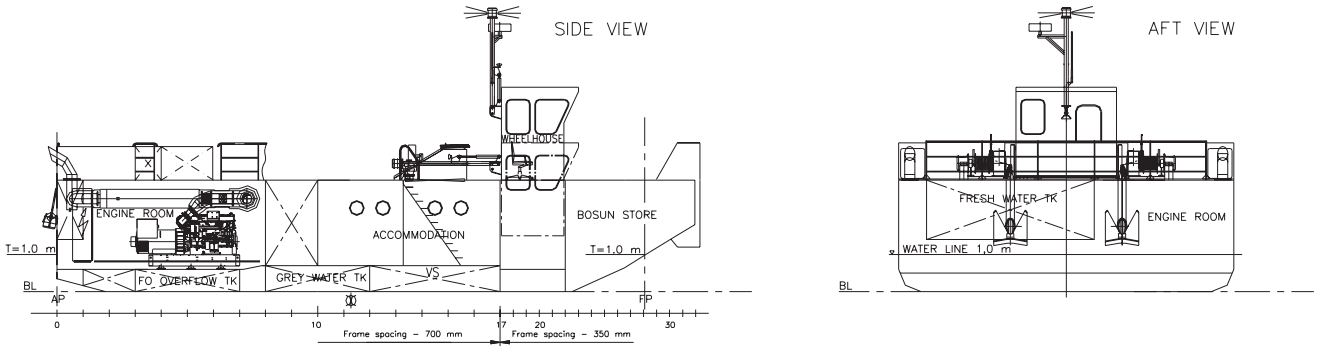

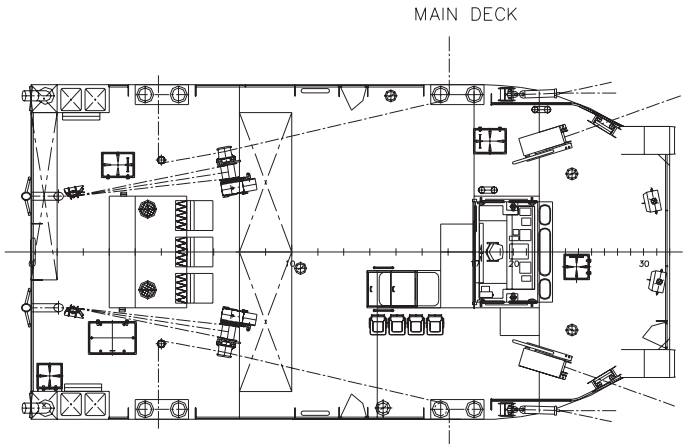

PRINCIPAL DIMENSIONS:		
LENGHT (O.A.)	Lo.a.	17,300 m
LENGHT (B.P.)	Lb.p.	15,786 m
BREADTH MLD	B	9,00 m
DEPTH TO DECK MLD	H	3,00 m
DRAUGHT	T	1,00 m
CLASS:	GL ✠100 A5, I, "TUG", ✠ MC CLEAN DESIGN	
DIESEL ELECTRIC POWER		2X240 kWe
PROPULSION TYPE		Pump–Jet SPJ57
PROPULSION POWER		2X185 kW
TOTAL BOLLARD PULL		25,9 kN /2,64 T/
TRIAL SPEED	V	max 15 km/h
CREW		max 6 pers.

SINE208

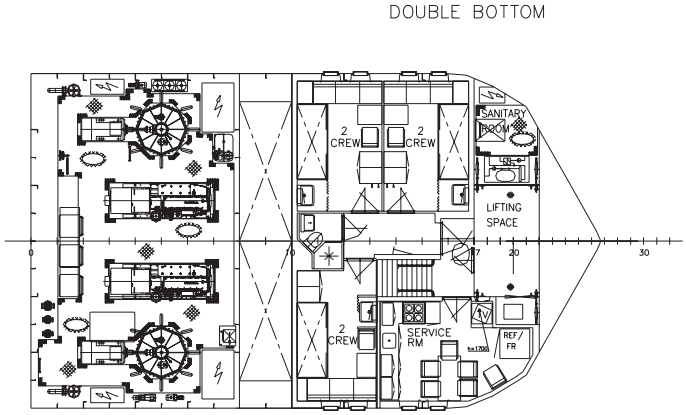

Fig. 3. *Pusher tug – first option (SINE 208).*

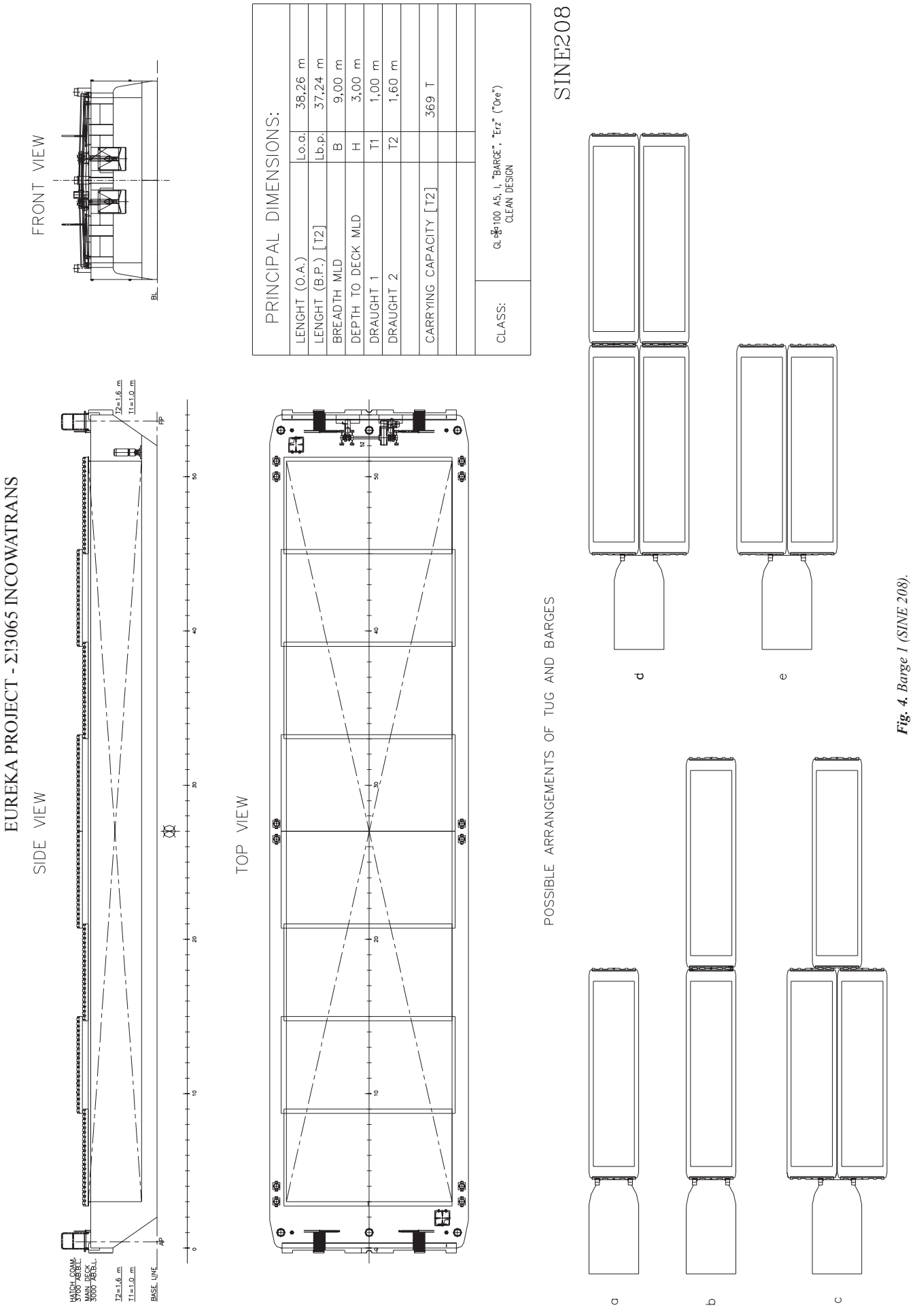

Fig. 4. Barge 1 (SINE 208).

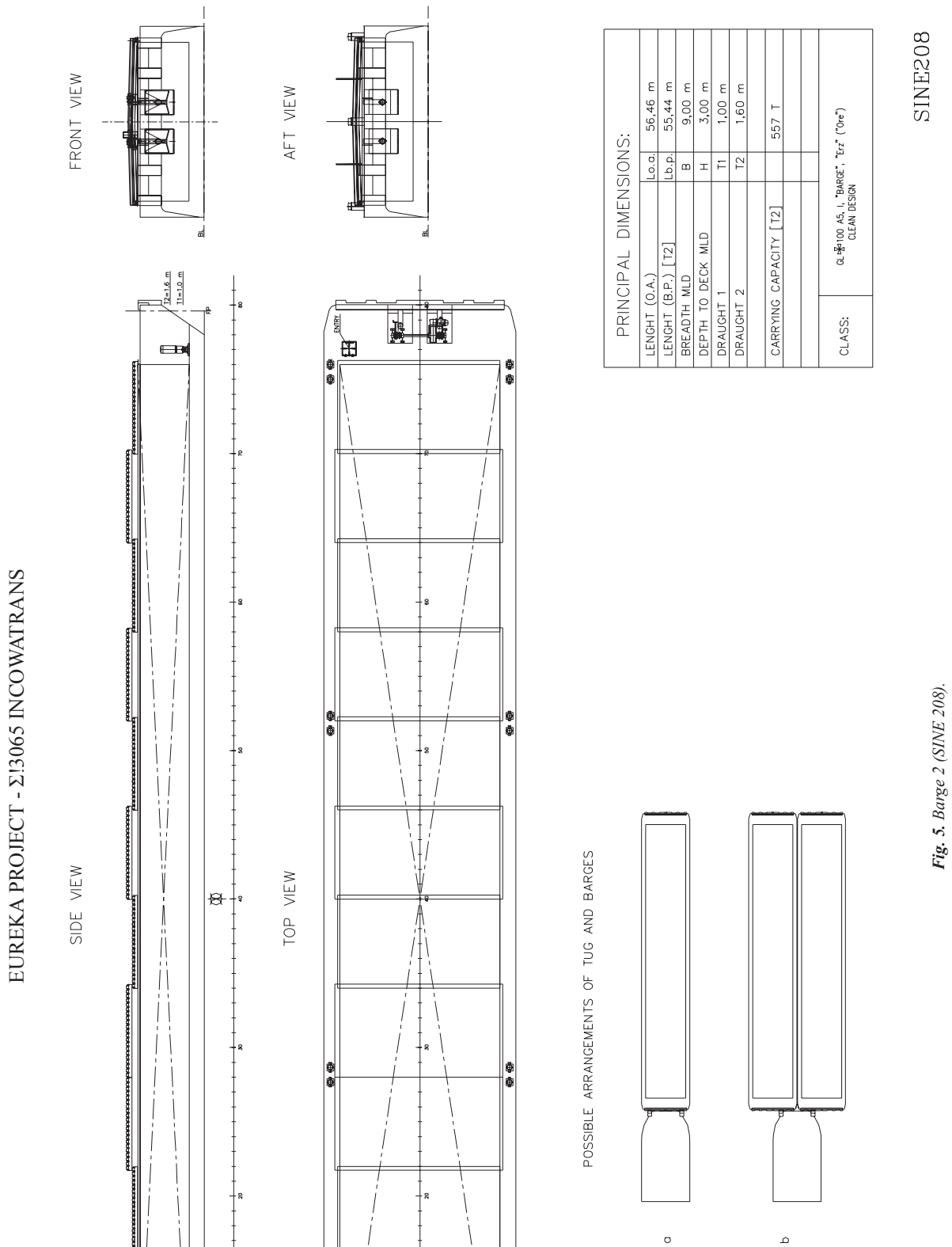

***Fig. 5.** Barge 2 (SINE 208).*

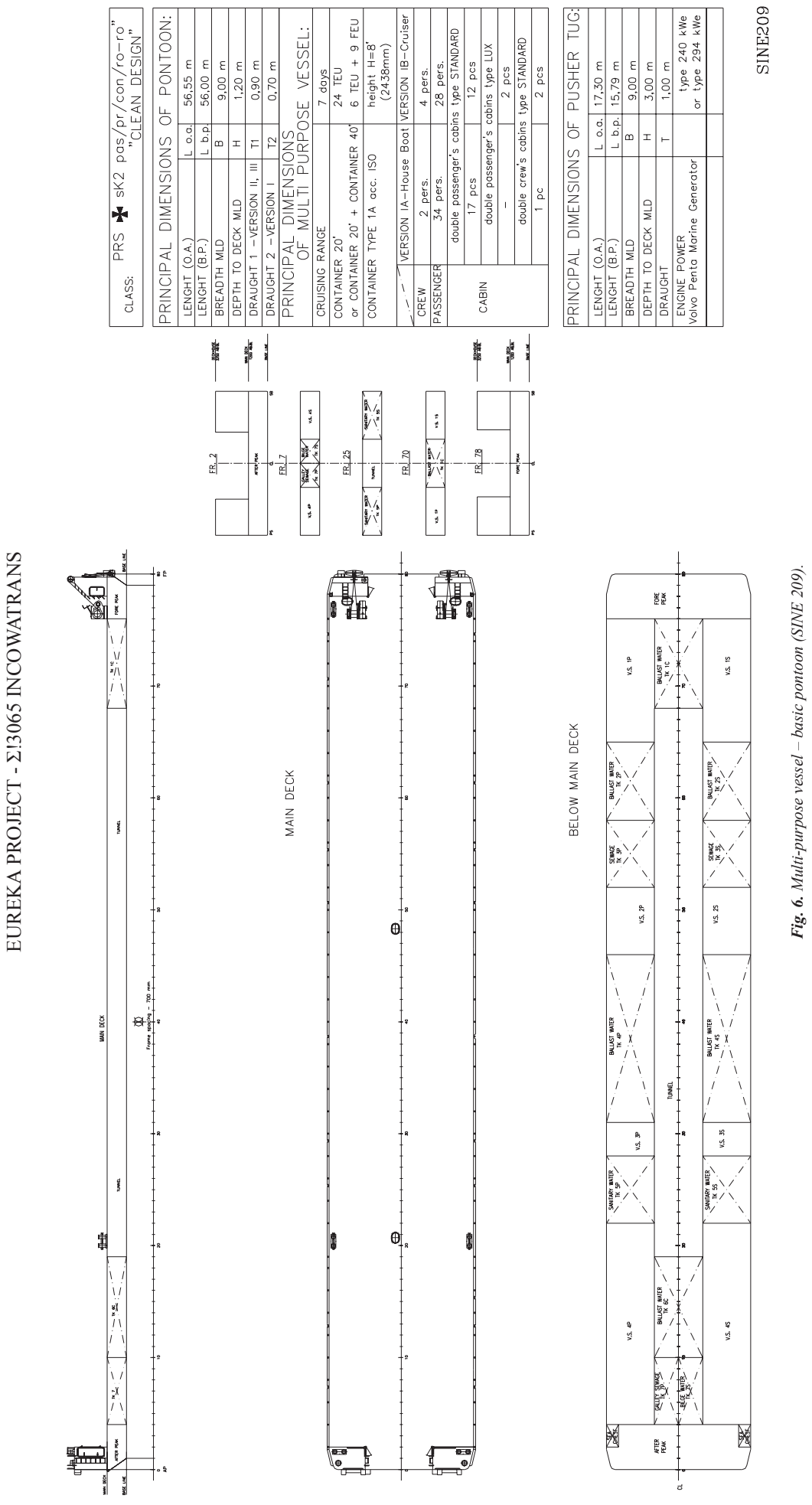

Fig. 6. *Multi-purpose vessel – basic pontoon (SINE 209).*

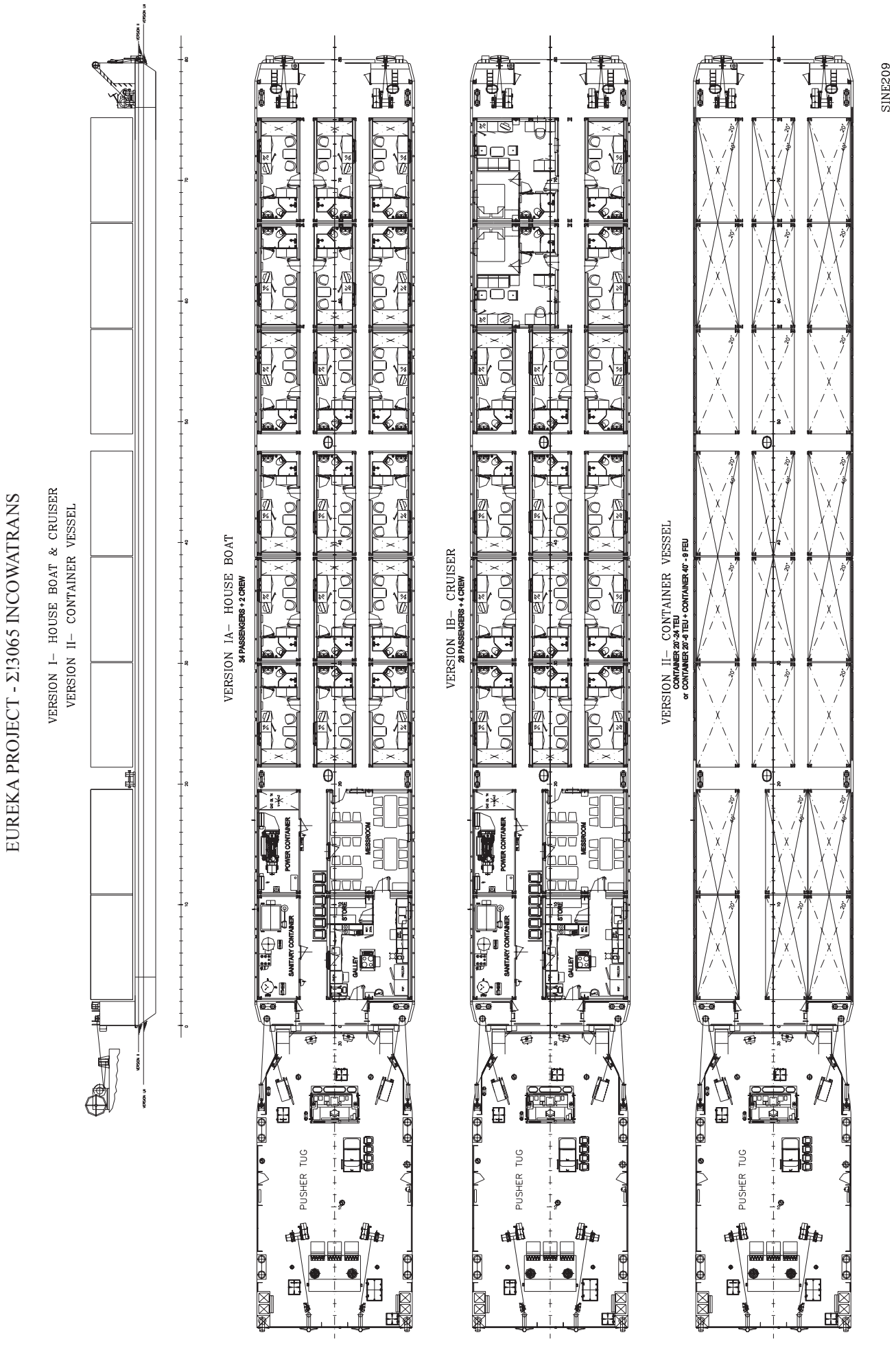

Fig. 7. Multi-purpose vessel – house barge, passenger barge, container vessel (SINE 209).

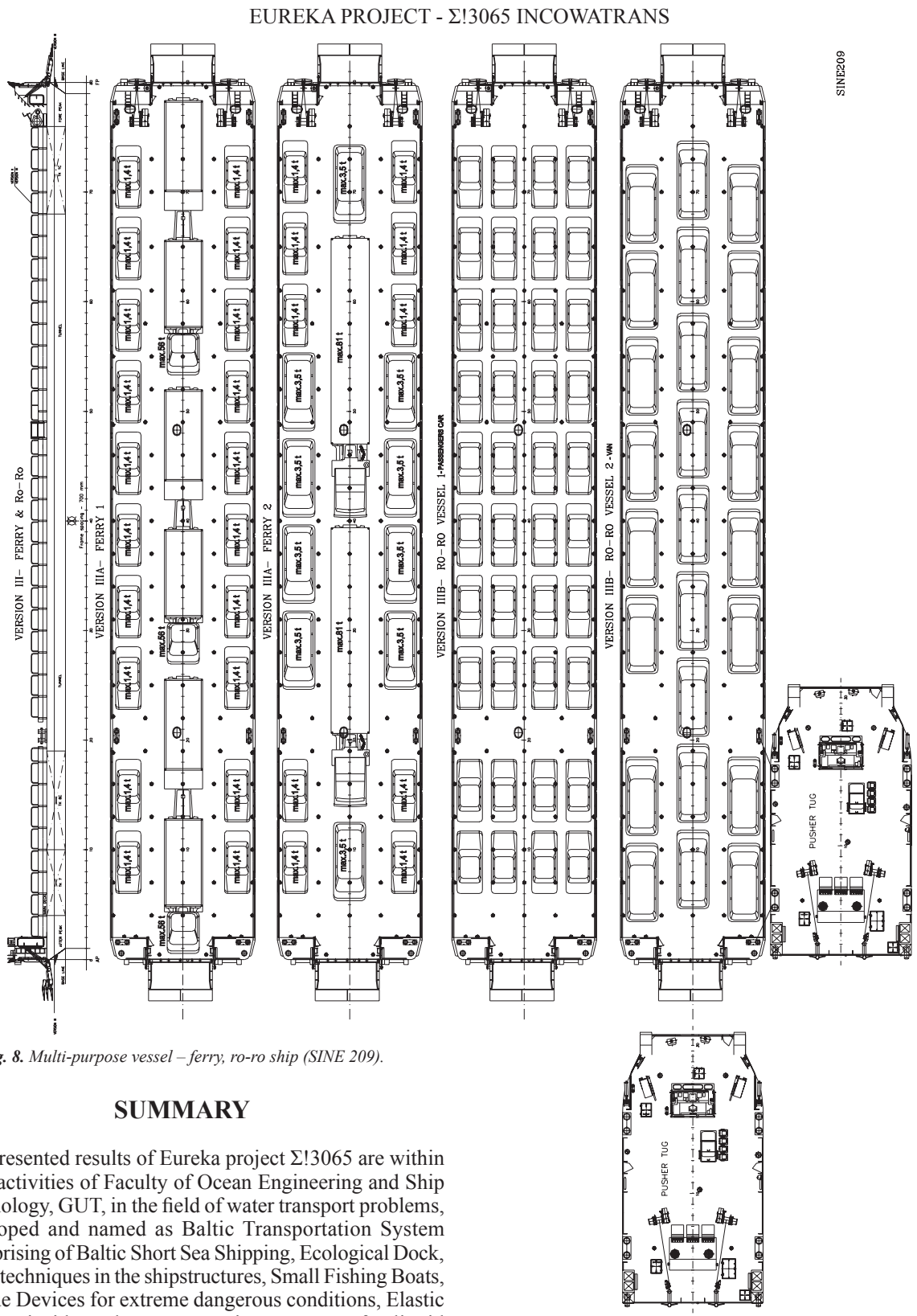

Fig. 8. Multi-purpose vessel – ferry, ro-ro ship (SINE 209).

SUMMARY

- The presented results of Eureka project Σ!3065 are within wide activities of Faculty of Ocean Engineering and Ship Technology, GUT, in the field of water transport problems, developed and named as Baltic Transportation System (comprising of Baltic Short Sea Shipping, Ecological Dock, Laser techniques in the shipstructures, Small Fishing Boats, Rescue Devices for extreme dangerous conditions, Elastic Coating inside tanks as preventive measures for liquid cargos spill and Inland Water Ships).
- The accumulated knowledge in the above described project is published in the 220 reports. Selected results will be presented in the special issue of Polish Maritime Research (December 2006, January 2007).
- The page www.oce.pg.gda.pl/oce2/eureka/inco/inco.htm presents titles of all carried works and reports.
- Realized project of Eureka system sponsored by the Polish Committee Scientific Research concerns facts, problems and solutions important for balanced development of economy, people and technology taking into account environmental protection conditions.
- The designed ships create opportunities for limited revitalization of Polish inland shipping respecting the Nature 2000 limitations and taking into account bad technical conditions of waterways.
- Inland shipping revitalization will create the base for economic and tourist development along the waterways.

BIBLIOGRAPHY

See Appendix