The current and future possibilities to adapt the R-JH3 method to ship power prediction practice

Henryk Jarzyna
Institute of Fluid-Flow Machinery,
Polish Academy of Sciences, Gdańsk

ABSTRACT

In the paper the current and future possibilities of the R-JH3 method are discussed. The R-JH3 method (presented in detail in [27]) was elaborated for the ship power prediction on the basis of a new definition of the open-water propeller fully equivalent to the behind-the-hull propeller. The R-JH3 method can be used to determine the mean effective velocity and the mean effective pitch coefficient of the behind propeller. The R-JH3 method may be very useful for scale-effect investigations and scale-effect designation when results of model self-propulsion test have to be transformed to the ship scale.

Keywords : ship hydromechanics, theory of propellers, ship hull-propeller interaction

PECULIARITY OF THE ITTC-78 POWER PREDICTION METHOD AND NECESSITY OF CHANGE OF THE THIRD GROUP OF PROCEDURES

The ITTC-78 ship power prediction method can be divided into three groups of procedures :

- the 1st group of procedures dealing with the ship resistance R_{TS}
- the 2nd group of procedures concerning the propeller thrust T_{BS} necessary to ensure the ship velocity V_S
- the 3rd group of procedures for prediction of the propeller torque Q_{BS} and the propeller revolution number n_S.

Only the 3rd group of procedures is proposed to be changed.

In the 1st group of procedures the ship model resistance is determined and its experimentally obtained value is transformed to the full scale. The scale effect is the main problem of the transformation.

In the 2nd group of procedures the change of the ship model resistance due to the action of the behind propeller is determined in the form of the suction coefficient. The value of the model suction coefficient is further supposed to be the same as that in the full scale.

In the 3rd group of procedures being the subject of changes, the ITTC-78 method introduces the concept of the equivalent open screw propeller. The concept makes it possible to determine – in model scale – the effective mean velocity and the advance mean coefficient. The possibility can be realized when the model thrust coefficients of the behind propeller and the open propeller are equal to each other. Their identity gives the value of the mean advance coefficient J_{TM} and the effective mean velocity $V_{TM} = J_{TM} \cdot n_M \cdot D_M$.

The torque coefficients of the two propellers for $J = J_{TM}$ are different. The ratio of the two torque coefficients values :

$$\frac{K_{QOM}(J_{TM})}{K_{QBM}} = \eta_{RM}$$

is known as the relative rotative efficiency.

The effective mean velocity V_{TM} and the open propeller (SOM) characteristics $K_{TOM} = f(J)$ and $K_{QOM} = f(J)$ are transformed from model scale to full scale according to the ITTC-78 transformation formulae. This way the mean effective velocity V_{TS} is received. The hydrodynamic characteristics $K_{TOS} = f(J)$ and $K_{QOS} = f(J)$ are to be joined with a new open propeller in full scale. In model scale the identity of the thrust coefficients of the model behind propeller (SBM) and the equivalent model open propeller (SOM) : $K_{TBM} = K_{TOM}(J)$, is the criterion of equivalence of both model propellers. In full scale the identity of the thrust loading coefficients of the behind propeller (SBS) and the open propeller (SOS) is the equivalence criterion of these propellers :

$$\frac{T_{BS}}{\rho_S V_{TS}^2 D_S^2} = \frac{K_{TOS}(J)}{J^2}$$

where :

$\frac{T_{BS}}{\rho_S V_{TS}^2 D_S^2}$ - thrust loading coefficient of the SBS propeller

$\frac{K_{TOS}(J)}{J^2}$ - thrust loading coefficient of the SOS propeller.

From this equivalence criterion the advance coefficient $J = J_{TS}$ can be determined and then the number of revolutions of the propeller, n_S :

$$n_S = \frac{V_{TS}}{J_{TS} D_S}$$

In the ITTC-78 method it is further necessary to assume that the value of the relative rotation efficiency in full scale, η_{RS}, is equal to η_{RM}. From the relationship :

$$\eta_{RM} = \frac{K_{QOM}(J_{TM})}{K_{QBM}} = \frac{K_{QOS}(J_{TS})}{K_{QBS}}$$

the torque coefficient K_{QBS} can be determined :

$$K_{QBS} = \frac{K_{QOS}(J_{TS})}{\eta_{RM}}$$

and hence the torque Q_{BS} and the power P_{DS} :

$$Q_{BS} = K_{QBS} \cdot \rho_S \cdot n_S^2 \cdot D_S^5$$

$$P_{DS} = 2\pi \cdot Q_{BS} \cdot n_S$$

can be calculated.

One can note that the 3rd group of procedures being in use in ship power determination has been designed on the basis of the equivalent open propeller definitions different in model and full scale. The geometry of the SOM propeller and the SBM propeller are identical. The *a priori* defined geometry leads to the hydrodynamic characteristics of such open propeller, $K_{TOM} = f(J)$ and $K_{QOM} = f(J)$, and to the equivalence criterion limited to the thrust coefficients only :

$$K_{TBM} = K_{TOM}(J)$$

From the criterion the advance coefficient $J = J_{TM}$ results. Hence the effective mean velocity $V_{TM} = J_{TM} \cdot n_M \cdot D_M$ can be determined. In full scale the hydrodynamic characteristics $K_{TOS} = f(J)$ and $K_{QOS} = f(J)$ derived form the model relationships : K_{TOM} and K_{QOM} with the help of the ITTC-78 transformation formulae, define the open propeller (SOS).

The equivalence criterion of the SOS propeller and the SBS propeller is different from that in model scale and is given in the form of equality of the thrust loading coefficients of the SBS and SOS propeller.

Some controversial elements of the 3rd group of procedures of the ITTC-78 method can be indicated.

- The open screw propeller is given *a priori* being different in model and full scale :
  - **in model scale** : (SOM) ≡ (SBM)
  - **in full scale** : the SOS propeller is described in the form of the characteristics $K_{QOS}(J)$ and $K_{TOS}(J)$.
- The equivalence criterion of both propellers (the behind propeller and open one) is different in model scale (the equality of thrust coefficients) and in full scale (the equality of thrust loading coefficients).
- The requirement that only the thrust coefficients of both propellers are to be equal to each other in model scale, results in that the torque coefficients of the propellers are different. The ratio of the coefficients, i.e. the relative rotative efficiency, is the same – according to the assumption – in model and full scale. Due to such assumption only it is possible to determine the torque Q_{BS} and the power P_{DS} by means of in the ITTC-78 method.
- The condition of equality of the thrust loading coefficients of both full-scale propellers is based on the following assumptions :
  - the transformation of V_{TM} into V_{TS} is known
  - the transformations of K_{TOM} and K_{QOM} into K_{TOS} and K_{QOS} are known.

The transformations can be verified by using indirect methods only.

The controversial elements in question can be eliminated, in principle, in two ways :

- by introducing the generalization of the equivalent open propeller definition
- or by eliminating the equivalent open propeller definition. In this case the numerical determination of the ship power can be taken into account in the full scale directly.

The first way has been applied in the Jarzyna's papers [20, 21, 22, 27]. The second one is wholly connected with investigations into the computer hydrodynamics problems (numerical basin). It is a very promising direction of scientific activity though its practical application is not yet possible.

Even though this research direction will bring full success, the results of investigations into the equivalent open water propeller will remain of a great value in determining the effective mean values connected with the behind propeller problems.

As an example of such values can serve the effective mean velocity or the effective mean pitch coefficient of the behind propeller. The only way to determine the mean effective values connected with the behind propeller is to make use of the definition of the equivalent open water propeller.

So the generalization of the equivalent open propeller definition can satisfy the following different conditions :

- to make the realization of new concepts of the 3rd group of procedures of the ITTC-78 method possible
- to make it possible to form a compact criterion of determination of mean effective values which are connected with screw propeller's global characteristics
- to serve as a valuable tool in scale effect investigations especially when the propeller thrust full-scale measurements are possible in practice.

THE ESSENCE OF THE R-JH3 METHOD

Definition of the open water propeller equivalent to the behind propeller

For given values (K_{TB} , K_{QB}) of the behind propeller and for the one – parameter family of open – water screw propellers with the pitch coefficient (P/D) being the family parameter (of the same family geometry as that of the behind propeller, except of the propeller pitch) the equation set :

$$(1) \quad \Rightarrow \quad K_{TB} = K_{TOj}\left[J, \left(\frac{P}{D}\right)_j\right]$$

$$(2) \quad \Rightarrow \quad K_{QB} = K_{QOj}\left[J, \left(\frac{P}{D}\right)_j\right]$$

has one and only one solution [$J = J_{TQ}$; $P/D = (P/D)_e$]. The parameter $(P/D)_e$ identifies – out of the propeller family – one propeller $SO[(P/D)_e]$ which is the wanted open propeller (SO) equivalent to the behind propeller (SB). The characteristics of the $SO[(P/D)_e]$ are :

$$K_{TO} = f\left[J, \left(\frac{P}{D}\right)_e\right]$$

$$K_{QO} = f\left[J, \left(\frac{P}{D}\right)_e\right]$$

Identity of other global characteristics of both propellers

The global hydrodynamic parameters of both the propellers: SB and SO[$(P/D)_e$] satisfy the following equations obtained from the identity of thrust loading coefficients and the identity of torque loading coefficients :

$$(3) \quad \Rightarrow \quad \frac{T_B}{\rho V_{TQ}^2 D^2} = \frac{K_{TO}\left[J, \left(\frac{P}{D}\right)_e\right]}{J^2}$$

$$(4) \quad \Rightarrow \quad \frac{Q_B}{\rho V_{TQ}^2 D^3} = \frac{K_{QO}\left[J, \left(\frac{P}{D}\right)_e\right]}{J^2}$$

In order to obtain V_{TQ} from the equation (3) the value $J = J_{TQ}$ resulting from the set of equations (1) , (2) is to be used.

Thereafter the value of the number of propeller revolutions, n :

$$(5) \quad \Rightarrow \quad n = \frac{V_{TQ}}{J_{TQ} D}$$

can be received.

The wanted value of the torque Q_B results from the equation (4) for $J = J_{TQ}$ hence the delivered power P_D can be calculated as : $P_D = 2\pi \cdot Q_B \cdot n$.

Next the thrust and torque coefficients K_{TB} and K_{QB} can be verified.

THE PROBLEMS CONNECTED WITH THE USE OF THE R-JH3 METHOD IN FULL SCALE

The set of equations (1), (2), (3), (4) and (5), in presence of the feedback between the parameters K_{TBS} , K_{QBS} and the roots of the equation set, can be solved by means of the iteration method only. One can suggest two procedures to determine the first approximation values of the K_{TBS} and K_{QBS}.

- ✶ The first procedure is based on the preliminary design of the behind propeller. To this end the following input parameters should be given :

  - T_{BS} - the propeller thrust sufficient to maintain the velocity V_S
  - V_S - ship velocity
  - D_S - screw propeller diameter
  - $V_e/V_S(r/R)$ - the design velocity field.

  The thrust T_{BS} results from the first and second procedure group of the ITTC-78 method. The parameters V_S and D_S are given values. The design velocity field can be produced by using the Koronowicz's procedure (computer program).

- ✶ The second procedure of determination of K_{TBS} and K_{QBS} is the O-JH3 method of ship power prediction.

The O-JH3 method is below presented in detail because it can serve as an independent prognostic method parallel to its function in determining the first approximation values of K_{TBS} and K_{QBS} for the R-JH3 method. The O-JH3 method based on the new definition of the equivalent open water propeller is very strongly connection with the ITTC-78 method and it can serve as a very useful element of correlation of both power prediction methods.

It is worth mentioning that in the case when the paralell measurement results of thrust and torque, number of propeller revolutions and ship velocity are at one's disposal, the R-JH3 method will be a useful tool for verification of and for scale-effect investigations on selected parameters applied in ship hydrodynamics.

GENERAL REMARKS CONCERNING THE REALIZATION OF THE PROGNOSTIC METHODS : R-JH3 AND O-JH3

- ➲ The realization of the methods R-JH3 and O-JH3 does not entail any additional experimental activity in comparison with that related to the ITTC-78 method.
- ➲ In the 3rd group of procedures the results of experimental model tests are processed by means of computer programs quite different from those used in the ITTC-78 method. The proposed methods do not use the open-propeller hydrodynamic characteristics experimentally obtained as in the case of the ITTC-78 method. In the new method the hydrodynamic characteristics of the one – parameter open – propeller family, and thereafter of the equivalent open propeller, are determined by using a computer program. The propeller family's geometry is the same, except of the pitch coefficient equal to that of the behind propeller.
- ➲ The realization of the R-JH3 and O-JH3 methods, in the phase of their introduction to the prognostic practice, is carried out parallel to the calculation procedures of the ITTC-78 method.
- ➲ In the ITTC-78 method the value of the parameter :

$$G_{00} = \frac{\frac{V_{TS}}{V_S}}{\frac{V_{TM}}{V_M}}$$

is forejudged because the mean effective velocity V_{TS} is determined from the model value V_{TM} by using the ITTC-78 transformation.

In the O-JH3 method the variability interval of the parameter G is assumed to be $G_{min} \le G \le G_{max}$, in which the value G_{00} is contained. The results of the O-JH3 method are given in function of the parameter G ($G = G_{00}$ included).

In the R-JH3 method the effective mean velocity V_{TS} results directly from the equation (3) (due to the identity of thrust loading coefficients of the behind propeller and the equivalent open propeller) for $J = J_{TQS}$ and $P/D = (P/D)_{eS}$ being the roots of the set of equations (1) and (2).

In the R-JH3 method the mean effective velocity V_{TQS} is directly dependent upon the input values (K_{TBS},K_{QBS}) to this equation set.

THE REALIZATION OF THE R-JH3 METHOD FOR GIVEN (K_{TB} , K_{QB})VALUES OF THE BEHIND PROPELLER

One can distinguish three cases when the (K_{TB},K_{QB}) values can be determined univocally :

➲ Full-scale measuring results : T_{BS} , Q_{BS} , V_S , n_S .

In the case when the ship measuring results (T_{BS} , Q_{BS} , n_S , V_S) are available, then – for given K_{TBS}, K_{QBS} – the equivalent open propeller, SOS[$(P/D)_{es}$], can be received from the equations (1) , (2) with the roots [J_{TQS},$(P/D)_{es}$]. And, V_{TQS} results from equation (3). Then the number of revolutions

$$n_S = \frac{V_{TQS}}{J_{TQS} D_S}$$

and the torque Q_{BS} can be calculated from (4).

Both the values n_S and Q_{BS} should be comparable with those measured on ship. This way a valuable correctness criterion of the measured values was created. The iteration method can be used to bring the values to identity.

On the other side the full-scale values :

$$V_{TQS} \,,\, K_{TOS} = f\,([J,(P/D)_{es}]$$
$$K_{QOS} = f\,[J,(P/D)_{es}] \,,\, (P/D)_{es}$$

can be compared wih those in model scale :

$$V_{TQM} \,,\, K_{TOM} = f\,([J,(P/D)_{eM}]$$
$$K_{QOM} = f\,[J,(P/D)_{eM}] \,,\, (P/D)_{eM}$$

The method R-JH3, used in parallel for both model and full scale, can be a very efficient tool in studying scale-effect.

➲ Model-scale measuring results : T_{BM} , Q_{BM} , V_M , n_M .

The R-JH3 method can be used in model scale because the values measured in self propulsion tests make it possible to determine K_{TBM} and K_{QBM}. The set of equations (1), (2), (3), (4) and (5) gives, in model scale, the following results :

$$J_{TQM}, (P/D)_{eM} \rightarrow SOM[(P/D)_{eM}] \rightarrow \begin{cases} K_{TOM}\,[J,(P/D)_{eM}] \\ K_{QOM}\,[J,(P/D)_{eM}] \end{cases}$$

$$V_{TM} \rightarrow n_M \quad ; \quad Q_{BM}$$

Two of the values, n_M and Q_{BM} , if related to the measured values, can be a measurement correctness criterion for these values. The iteration method can be used to bring the values to identity.

➲ Calculated values : T_{BS} , Q_{BS} , V_S , n_S for a given final propeller (SBS).

The R-JH3 method makes it possible to find – for a given behind propeller and given parameters (K_{TBS} , K_{QBS}) – the following mean effective values :

- the effective mean velocity V_{TQ}
- the effective mean pitch coefficient $(P/D)_e$.

THE R-JH3 METHOD USED TO POWER PREDICTION DIRECTLY IN FULL SCALE

The difficulties in use of the R-JH3 method directly in full scale have been already mentioned. The difficulties are due to the feedback of the behind propeller and open propeller parameters. Two possible ways of overcoming the difficulties were indicated.

1st – which concerns the preliminary behind propeller design used as a source of the first approximation values of the thrust and torque coefficients : K_{TBS} , K_{QBS}.
One can assume that the designed propeller is the optimum one from the efficiency point of view. For a given propeller diameter an optimum revolution number can be determined. The unknown design velocity field can be described by using different approximate methods, e.g. the results presented by T. Koronowicz [28]. In the referred papers the effective velocity field is numerically generated as the final result of interaction between the ship hull and the screw propeller. Although the investigations are still in progress their partial results can be used when only the first approximation values are needed to start using the R-JH3 method.

2nd – concerning the zero method O-JH3 used to produce the first approximation values of K_{TBS} , K_{QBS}.

Stage 1 : the R-JH3 method is used in model scale. The parameters J_{TQM} , $(P/D)_{eM}$ and the equivalent open propeller, SOM[$(P/D)_{eM}$] , of the hydrodynamic characteristics K_{TOM} and K_{QOM} , are received. The effective mean velocity :
$V_{TQM} = J_{TQM} \cdot n_M \cdot D_M$ can be determined.

Stage 2 : the parameters V_{TQM} , K_{TOM} and K_{QOM} are transformed to full scale by using the ITTC transformation formulae.

Stage 3 : from the equations (3) , (4) and (5) of the R-JH3 method applied to full scale the parameters J_{TQS} , n_S and Q_{BS} can be calculated.

It should be mentioned that V_{TQS} can be determined – according to Griegson and Holtrope [5 , 7] – as a variable parameter given by the relation :

$$V_{TQS} = G \cdot V_{TQM}$$

where G is defined as :

$$G = \frac{\dfrac{V_{TQS}}{V_S}}{\dfrac{V_{TQM}}{V_M}} \quad ; \quad G_{min} \leq G \leq G_{max}$$

In the case when the variable parameter G is introduced all results obtained in stage 3 are functions of this parameter.

Thereafter the thrust and torque coefficients K_{TBS} and K_{QBS} are calculated in order to be used in the R-JH3 method as the first approximation of the input data.
The values $Q_{BS} = f(G)$ and $n_S = f(G)$ can be used to predict the delivered power P_{DS} :

$$P_{DS} = 2\pi \cdot Q_{BS} \cdot n_S$$

NOMENCLATURE

G	-	the ratio of nondimensional effective mean velocity of ship and model
h_R	-	relative rotative "efficiency"
J	-	advance coefficient
K_Q	-	torque coefficient
K_T	-	thrust coefficient
n_M , n_S	-	number of revolutions of model and ship propeller, respectively
P	-	power (in general)
Q	-	propeller torque
SB	-	behind - the - hull (behind) screw propeller
SB_{mod}	-	modified behind screw propeller with constant effective pitch coefficient
SBM	-	behind propeller in model scale
SBS	-	behind propeller in full scale
SO	-	open-water propeller
SO[P/D)e]	-	open-water propeller with the given effectiv pitch coefficient
SOM	-	open-water propeller in model scale
SOS	-	open-water propeller in full scale
T	-	propeller thrust

V_S - ship velocity
V_{TQ} - mean effective velocity from thrust and torque identity

Indices

B - behind quantity
M - model quantity
0 - open water quantity
S - ship quantity

BIBLIOGRAPHY

1. Proccedings of ITTC Reports of the Performance Committee: 15-th ITTC - 1978; 16-th ITTC - 1981; 17-th ITTC - 1984; 18-th ITTC - 1987; 19-th ITTC - 1990; 20-th ITTC - 1993
2. Holtrop J, Mennen G.G.J.: *A Statistical Power Prediction Method.* ISP, Vol.25, No.290, October 1978
3. Lingren Hans, Gilbert Dyne: *Ship Performance Prediction Proccedings*, Vol.1, International Symposium On Advances in Marine Technology. Trondheim, Norway, 1979
4. Horn F.: *Determination of Mean Wake from Propulsion and Open Tests*, ISP, Vol.3 No.21/1956
5. Holtrop J.: *An Approximate Power Prediction Method*, ISP, Vol.29, 1982
6. Grigson M. A.: *On Prediction the Performance of Ships from Models*. RINA. 1983
7. Grigson C.: *Screws Working in Behind and Prediction of the Performance of Full Ships*. JSR, Vol.34, 1990
8. Nakatake K., Kataoka K.: *On Power Prediction and Model Testing Methods*, Trans. of the West-Japan Society Naval Architects, No.85, March 1993
9. Jarzyna H.: *Interaction of Ship Hull and Propeller* (in Polish). Monography. Fluid-Flow Machinery, Vol.14, Ossolineum Publishing House. Wrocław, 1993
10. Jarzyna H.: *Mean Relative Wake Fraction from Power Identity*. Budownictwo Okrętowe, No.5, May 1989
11. Jarzyna H.: *On the Mean Effective Velocity Definition in Model Propulsion Tests*, Marine Technology Transactions, Vol.5, 1994
12. Jarzyna H.: *The Reasons to Introduce a New Definition of the Effective Mean Velocity in Model Propulsion Tests*, Part I, Polish Maritime Research No.1, March 1995; Part II, Polish Maritime Research No 2, June 1995
13. Jarzyna H.: *The Effective Mean Velocity in Model Propulsion Tests. The Essence of the Idea. The Possible Definitions*. Marine Technology Transactions Vol. 6, 1995
14. Jarzyna H.: *A New Method of Effective Mean Velocity Determination in Propulsion Tests*. Proceedings of Marind'96, Varna, 2÷7 June 1996
15. Jarzyna H.: *Some Aspects of the Effective Mean Velocity Determination*. Technical University of Wrocław. Transactions of the XII International Conference on Hydrodynamics in Ship Design, HYDRONAV'97, Szklarska Poręba, 17÷19 Sept. 1997
16. Jarzyna H.: *On the Upper Limit of the Ship Propulsive Efficiency Value*, Proceedings of the 12th International Conference HYDRONAV'97, Wrocław, Szklarska Poręba, 1997
17. Jarzyna H.: *The Present and the Possible Application of the Mean Effective Velocity in Ship Hydrodynamics*, Polish Maritime Research, Vol.5, No.4/1998
18. Jarzyna H.: *Effective Mean Velocity (EMV) and Effective Mean Pitch (EMP) Based on a Common Definition*. Polish Maritime Research, Vol.5, No.3/1998
19. Jarzyna H.: *The New Idea of United Definition of Effective Mean Pitch (EMP) and Effective Mean Velocity (EMV)*. Technical University of Gdańsk. Transactions of 13th Conference HYDRONAV'99, Gdańsk-Ostróda, 1999
20. Jarzyna H., Tuszkowska T.: *A New Method of Ship Propulsive Characteristics Determination*, Transactions of the 14th. Technical University of Szczecin. International Conference HYDRONAV'01, Szczecin-Międzyzdroje, 2001
21. Jarzyna H., Tuszkowska T.: *On the Power Prediction Methods in the Preliminary Ship Design Stage*. Polish Maritime Research, Vol.8, No.3/2001
22. Jarzyna H.: *On Full Scale Power Prediction of Ships Based on a New Idea of Equivalent Open Water Propeller*. IMP PAN. Report No.1539/2001
23. Jarzyna H., Tuszkowska T.: *Propulsion Prognosis for a Ship According to the Zero Version (0-JH) of the New Power Prediction Methods*. Polish Maritime Research, Vol.9, No.3/2002
24. Jarzyna H.: *Some Problems of the Model Self Propulsion Tests* (in Polish). Monography. Ossolineum Publishing House. Wrocław, 2002
25. Jarzyna H., Tuszkowska T., Wilczyński L.: *R-JH Method Using the Preliminary Design of the Behind-the-Hull Propeller in the First Step of Iteration* (in Polish). IMP PAN. Report No.2799/2002
26. Jarzyna H., Tuszkowska T., Wilczyński L.: *The Influence of (K_{TB},K_{QB}) on (J_{TQ},A_{lim}) Parameters Being the Roots of the Set of Equations $K_{TB} = K_{T0j}(J,A_j)$; $K_{QB} = K_{Q0j}(J,A_j)$*. IMP PAN. Report No.2430/2002
27. Jarzyna H., Tuszkowska T.: *Ship Power Prediction Methods Based on a General Definition of the Equivalent Open-Water Screw Propeller,* Monography. Publ. of Institute of Fluid-Flow Machinery, Polish Academy of Sciences. Gdańsk, 2003
28. Koronowicz T., Tuszkowska T., Wacławczyk T.: *A Computer Method for Prediction of the Velocity Field Behind a Full-scale Ship Hull*. Polish Maritime Research, Vol.10, No.1/2003

Acronyms

IMP PAN - Institute of Fluid-Flow Machinery, Polish Academy of Science
ISP - International Shipbuilding Progress
ITTC - International Towing Tank Conference
JSR - Journal of Ship Research
RINA - Royal Institution of Naval Architects

CONTACT WITH THE AUTHOR

Prof. Henryk Jarzyna
Institute of Fluid-Flow Machinery,
Polish Academy of Sciences
Fiszera 14
80-952 Gdańsk, POLAND

Miscellanea

TOP KORAB
awards in the academic year 2003/2004

It is already a tradition that the Society of Polish Naval Archtects and Marine Engineers KORAB has granted awards for the best M.Sc. theses from among those commended by the Faculty of Ocean Engineering and Ship Technology, Gdańsk University of Technology.

In the academic year 2003/2004
the awardwinning was :

- Mr.Krzysztof Potulski, M.Sc. for the project on :

Structural analysis of a corrugated bulkhead/ bottom connection of a medium size tanker

The project was elaborated under supervision of Mr. Janusz Ziółkowski, M.Sc., the Department of Mechanics and Strength of Ship Structures.