RECOMMENDATIONS CONCERNING THE WORK OF THE SYMBOLS AND TERMINOLOGY GROUP AND THE TECHNICAL COMMITTEES ADOPTED BY THE 18TH ITTC

SYMBOLS AND TERMINOLOGY GROUP

Recommendations to the Conference

1. The Conference should adopt the structure of the ITTC Standard Symbols and Terminology List outlined by the Symbols and Terminology Group and used as the basis for the 1987 Draft List distributed at the 18th ITTC in Kobe.

2. The Conference should urge the Technical Committees and individuals to contribute to the completion of the List of Standard Symbols and should encourage the use of the symbols and their further development in cooperation with the Symbols and Terminology Group.

3. The Conference should decide to delay the review and update of the ITTC Dictionary of Ship Hydrodynamics and the official translations of this into principal languages until the final Symbols and Terminology List is published in 1990.

Recommendations for the Future Work of the Group

1. The Symbols and Terminology Group should continue cooperation with other organizations to achieve a common agreement on symbols and terminology.

2. The Symbols and Terminology Group should continue to monitor and coordinate the development of new symbols and terminology by the Technical Committees of the ITTC.

3. The Symbols and Terminology Group should complete the ITTC Standard Symbols and Terminology List based on the 1987 Draft distributed at the 18th ITTC and the following schedule :

   Summer 1988: Edit first draft distributed at the 18th ITTC based on initial inputs invited at the Conference

   Spring 1989: Distribute second draft (updates) to Technical Committees

   October 1989: **Deadline for final inputs from Technical Committees and individuals**

January 1990: Edit final draft

March 1990: Send final master for publication to the host of 19th ITTC

July 1990: Distribution of final ITTC Standard Symbols and Terminology List with Volume 1 of the Proceedings of the 19th ITTC

RESISTANCE AND FLOW COMMITTEE

Recommendations to the Conference

1. Detailed measurements of hull pressure distributions, shear stress, velocity and turbulence are required at nonzero Froude numbers to complement the data gathered through the Cooperative Experimental Program. The use of the established data base in the validation of towing tank test procedures as well as in the development and verification of theoretical methods should be encouraged.

2. Joint experimental and analytical studies on ship stern and wake flows should be pursued to develop accurate prediction capabilities. Development of methods capable of further generalizations to handle appendages and propellers should be encouraged.

3. Fundamental studies in the interaction between wave and viscous phenomena should be pursued to unify the classical inviscid and viscous theories which hithertofore have developed more or less independently. The potential of computational methods as an aid in the study of ship flows is growing. Efforts should be made, therefore, to use these computational methods in combination with conventional experimental and analytical studies to deepen our knowledge of ship resistance and flow. Computer codes should be carefully evaluated. Detailed flow measurements of both model and full scale are encouraged. The effect of surface tension in model testing should be studied, in addition to those of Reynolds and Froude numbers, to determine form factor and wave formation.

4. Collection of full−scale data to verify the various roughness penalty predictors should be encouraged. Statistics of roughness topography and its correlation with friction should be studied to establish reliable roughness functions in computational procedures. Detailed in situ measurements in flow over slime should be made to aid in the development of theoretical models.

5. Experimental work should be continued on detailed observation and measurements of bow flow, with special attention to the structure and topology of flow both on models with and without bulbous bows, to develop suitable physical and mathematical models. Emphasis should be put on comprehensive control of experimental conditions and use of nonintrusive techniques to study the flow.

6. Encourage active communication of results in:
   1) Wave, boundary layer and wake interaction, and its scaling;
   2) Restricted water effects on resistance and flow;
   3) Bow flow, appendage flow, transition and turbulence stimulators;
   4) Roughness problems;

   through special workshops, small meetings or cooperative research.

Recommendations for the Future Work of the Committee

1. Evaluation of computational methods:
   1) Review of computational methods for ship resistance and flow, with special emphasis on the influence of numerical schemes, computational grid, boundary conditions, turbulence modelling, etc.;
   2) Review of new experimental data for the evaluation of computational results;
   3) Review and clarify the problems involved in applying computational methods to tankery problems.
2. Testing of bodies with appendages
   1) Review of experimental and theoretical studies on flow around appendages.
   2) Clarification of hydrodynamic problems in use of turbulence trips, methods of conducting stripping tests, and analysing model wake and drag data.
3. Studies of hydrodynamic problems in restricted water
   1) Review the effects of backflow on hull boundary layer, separation and its relationship with hull forms and water depth.
   2) Conduct cooperative work to establish a comprehensive experimental data base for flow around ships in restricted water.

PROPULSOR COMMITTEE

Recommendations to the Conference

1. Improve theoretical and/or experimental methods to discriminate between propulsor concepts and completed designs on the basis of efficiency.
2. Increase efforts to develop mathematical models for unconventional propulsors in conjunction with flow around the hull.
3. Increase investigations with respect to the role of viscosity in propeller design, performance and maintenance.
4. Determine whether finite element packages, applied for blade stress calculations, meet accuracy requirements. Use by non−specialists may be unreliable; involvement of specialists may be necessary.
5. Support workshops as a means to enhance development of emerging technology, e.g., design techniques for improved propulsor blade sections.
6. Accept and introduce the improved terminology and nomenclature for propeller geometry related to rake and skew.
7. Accept and introduce the additional terminology and nomenclature for propeller flow field related to total and effective velocity.
8. Encourage the preparation and publication of textbooks on established knowledge in the field of ship propulsors.
9. Carry out and/or make available reliable experimental data for three−dimensional flow about propulsors in non−uniform onset flow and on hull pressure fluctuations to serve as a reference basis for propulsor performance trends and mathematical models.
10. Support use of modern means e.g. magnetic tapes and (floppy) disks for easy exchange of literature databases within ITTC.

Recommendations for Future Work of the Committee

1. Prepare literature survey related to propulsors in the period 1987−1989. Review global information and indicate important developments.

2. Find an explanation for the differences in the results for calculation of hull pressure fluctuations. Resolve first the spread in the predictions for non−cavitating conditions.

3. Find an explanation for the differences in comparative propeller design calculations.

4. Survey performance data and design predictions of unconventional propulsors.

5. Survey effects of elastic deformation on steady and unsteady loading.
   Anticipate the use of new materials which may affect hydrodynamic design.

6. Survey the practice of using water tunnels for (compound) propulsor performance.

7. Review blade section geometry developed for marine propulsion application and methods used to incorporate them in propulsor design.

8. Review improvements in analytical/numerical models for propellers (lifting line/surface, boundary layer, shear/turbulent interactions, flow in tip and hub regions, slip stream deformation).

CAVITATION COMMITTEE

Recommendations to the Conference

1. Cavitation susceptibility meters should be further developed for possible future reference procedures to assess the water quality.

2. Theoretical studies and measurements of cavitation nuclei and nuclei distributions in test facilities and the ocean environment should be continued. Nuclei seeding techniques should be further developed.

3. Correlation studies on hull pressures induced by cavitating propellers should continue and the influence of tip vortex breakdown should be further investigated. Cavitation tunnels should also be calibrated for effects of standing pressure waves.

4. For noise measurements in cavitation tunnels, tunnel/free field calibrations should be carried out.
   Model and full scale propeller noise measurements should be further pursued and trials information, in particular good quality data, should be made available for further studies.

5. The use of leading edge roughness on propeller blades is encouraged for further exploration of its effectiveness to reduce cavitation scale effects.

6. Further work is recommended on qualitative and quantitative erosion prediction methods, including general scaling procedures for erosion tests.

7. Further developments in unsteady propeller cavitation theory should be encouraged for improved predictions of hull pressures, noise and erosion.

8. Wall effects on the force characteristics of cavitating propellers and foils should be further investigated. Attention should also be paid to corner−flow cavitation.

9. Total velocity measurements should be considered when simulating wake fields in cavitation tunnels.

Recommendations for Future Work of the Committee

1. Work should continue to evaluate nuclei measuring and seeding techniques in cavitation facilities and progress in identifying cavitation nuclei characteristics should be monitored.

2. Further developments in cavitation susceptibility measurement techniques should be evaluated.

3. Criteria regarding leading edge turbulence stimulation to reduce cavitation scale effects should be further clarified.

4. Studies of tunnel influences, such as standing waves, on propeller−induced pressure measurements should be monitored.

5. Work on noise scaling, including comparisons with full scale data, and on test techniques should continue. Special attention should be given to the influences of facility characteristics. Design features affecting propeller noise should be reviewed.

6. Progress regarding unsteady cavitation on propellers and foils should be reviewed, with emphasis on inception, erosion, noise and vibration excitation.

7. A comparative study on propeller erosion with soft surfaces should be initiated for quantitative evaluation.

8. Progress regarding scale effects on propeller tip and hub vortex cavitation inception should be reviewed.

9. Progress regarding tunnel wall effects due to steady−flow boundary constraints on the characteristics of cavitating propellers and foils should be monitored.

10. Reporting on practical aspects of cavitation testing should be continued and advances in instrumentation pertinent to cavitation testing reviewed.

POWERING PERFORMANCE COMMITTEE

Recommendations to the Conference

1. Form Factor

More fundamental investigations into form factor should be made towards a better physical understanding and application of the form factor concept.

2. Effect of Hull Roughness

Member Organizations should be encouraged to collect full scale performance data which will provide an improved basis for a re-examination of the available proposals for roughness allowance assessment.

3. Propeller Characteristics

Fundamental investigations of the flow regimes on the model propeller blades should be made to develop a more rational method of scaling propeller characteristics. Also the effects of turbulence tripping should be studied. In so doing, attention should be paid to lift characteristics as well as the profile drag of the blade elements.

4. Flow at Model and Full Scale

Member Organizations are encouraged to pay

more attention to the lack of similarity between the stern flows at model and full scale, particularly in connection with complex propulsors.

5. New Model Testing and Analysis Methods

Member Organizations are encouraged to test the new proposals for model testing with a view to their practicality and effectiveness, and to report the results to the Conference.

6. ITTC Performance Prediction Method

Member Organizations are encouraged to use the 1978 ITTC Method and to report the results to the Powering Performance Committee, particularly when problems are encountered.

7. Full−Scale Performance

A more reliable analysis of trial tests and sea margin is needed which incorporates the speed loss in waves (especially when waves are short relative to the ship), added resistance due to steering and yawing. Better methods for measuring wave heights in the open sea are required.

Recommendations for the Future Work of the Committee

1. Form Factor

The Committee should prepare practical guidelines for determination of 1 + k from routine tests. In cooperation with the Resistance and Flow Committee, the effects of flow separation and surface tension on the model measurements should be considered carefully and advice given as to how these effects may be minimized.

2. Appendage Drag

The Committee should work towards a solution to the problem of scaling model hull appendage drag.

3. Effect of Hull Roughness

A revision to the ΔC_F formulation should be considered which can be applied in assessing the effect of hull roughness in both the ship's trial and service conditions.

4. Propeller Characteristics

The Committee should examine the relevant studies made on propeller performance studies with particular reference to the applicability of new findings to routine testing and with respect to the physical bases involved.

5. ITTC Performance Prediction Method

The Committee should continue to monitor the use of the 1978 ITTC Method and to examine any problems raised. Particular attention should be paid to refining the analysis procedure for twin screw ships.

6. Performance of Ships in Restricted Water

The Committee should continue to review the progress made in predicting performance in shallow and restricted waters.

7. High Speed Craft

The Committee should cooperate with High−Speed Marine Vehicle Committee to develop a method of power prediction for high speed craft.

HIGH−SPEED MARINE VEHICLE COMMITTEE

1. Survey model, full−scale, and correlation data on all aspects of the performance of HSMVs and report these results to the ITTC on a regular basis.

2. Review full−scale test techniques used by Member organizations and recommend standard test procedures for all HSMVs.

3. Review model test techniques used by Member Organizations and recommend standard test procedures.

4. Consider the technology of catamaran hulls; identify their unique hydrodynamic problems and define methods for model testing.

5. Continue to solve outstanding problems, such as those listed in section III of this report, in cooperation with other technical committees.

6. Survey numerical methods applicable to HSMVs and compare with model and/or prototype test data to establish range of validity of these methods wherever possible.

MANOEUVRABILITY COMMITTEE

Recommendations to the Conference

1. The ESSO OSAKA manoeuvring trial results represent a unique collection of data which are, however, unfortunately contaminated by ambient current. It is suggested that the trial data be corrected for current by means of hydraulic modelling and/or system identification.

2. Member Organizations are recommended to continue to make either captive or free−sailing model tests with the ESSO OSAKA, but emphasis should be placed on shallow water conditions.

3. A plea is made for the execution of accurate, well documented manoeuvring trials for ship−model correlation purposes, particularly for fine forms. Measurements should be made both for service speed and low speed conditions in deep and shallow waters. The introduction of the NAVSTAR Global Positioning System may greatly facilitate such trials.

4. Further investigations of hull−propeller−rudder interactions, including rudder stock torque, particularly in shallow water, are recommended.

Recommendations for the Future Work of the Committee

1. The Committee should continue to monitor the activities of regulatory bodies as well as proposals for new manoeuvring criteria, indices and definitive manoeuvres.

2. The developmment of theoretical and empirical methods for the determination of hydrodynamic and aerodynamic forces acting on ships should be continued. The interaction between hull, propeller and rudder, particularly in shallow water, should be taken into account. Attention should also be given to ship interactions and the influence of environmental conditions.

3. The results of captive model tests, with special regard to the hydrodynamics of hull, propeller and rudder under various ambient conditions should be reviewed and collected. Results of free−sailing model tests should also be considered.

4. Experimental model and full−scale test techniques, instrumentation and facilities, as applied to manoeuvrability studies, should be kept under review. Developments in the field of system identification and parameter estimation should receive attention.

5. The subject of model and full−scale correlation should continue to receive carefull consideration.

6. The Committee should continue to monitor developments in the field of simulation and prediction. Particular attention should be paid to general techniques of mathematical modelling, such as four quadrant representations as well as transient and non−uniform conditions.

7. New developments within the field of automatic control should be followed. Special emphasis should be given to control devices such as lateral thrusters, high performance rudders and CP propellers.

SEAKEEPING COMMITTEE

Recommendations to the Conference

1. Standards for Experiments on Rarely Occurring Events

The following interim standard for experiments on rarely occurring events is proposed:
Experiments to determine the statistics of rarely occurring events such as slamming and deck wetness in irregular waves should last for a minimum of one hour (full scale equivalent). In comparative tests (eg to establish the relative merits of different designs) the wave conditions should be chosen so that a substantial number of events occur.

2. Criteria

Criteria for acceptable motions and other rough weather phenomena are all too often not related to specific activities of the ship. The Committee recommends that ship model basins should play a more active role in determining criteria and that:

a. Criteria should relate to responses which are of specific importance to the mission considered.
b. Acceptable response levels should be determined by long term monitoring of data, trials, questionnaires or discussions with the operators.

Recommendations for the Future Work of the Committee

1. The Conference should continue to be informed of any significant new developments in seakeeping which help to solve the technical problems facing its members.

2. The Committee should monitor the ability of tanks to generate spatially uniform directional wave systems applicable to tests at forward speed.

3. A study aimed at establishing a more soundly based standard for experiments on rarely occurring events should be initiated.

4. The Committee should encourage the development of better standards of reporting conditions and procedures for seakeeping experiments and theoretical predictions.

5. The Committee should continue to monitor developments in the theoretical prediction of ship responses. Particular emphasis should be given to slamming, deck wetness, rolling, capsizing and added resistance.

6. Efforts should be made to explain the discrepancies between the results obtained from the S−175 model experiments.

7. The Committee should encourage further experiments to determine the effect of above water form on deck wetness and capsizing.

OCEAN ENGINEERING COMMITTEE

Recommendations to the Conference

1. All members of the ITTC involved in the analysis and interpretation of wave data are encouraged to check their techniques by analysing the data tape developed by the Ocean Engineering Committee.

2. All members using harmonic analysis techniques for the amplitude frequency and phase of regular waves and responses are encouraged, as a standard check, to verify the consistency of their result with peak to peak values.

3. Members performing tests on moored systems are recommended to take special note of the lack of model/full scale correlation of the low frequency motions of these systems, the importance of the system damping, and the potentially important scale effects on damping that may influence the results of such tests.

Recommendations for the Future Work of the Committee

1. The Committee should monitor work that will lead to the identification of cases and circumstances where it is necessary to model multi−directional waves.

2. The Committee should encourage the collection and dissemination of more ocean measurements of multi−directional wave fields.

3. Attention should be given to the definition of typical joint probabilities of extreme wave, wind and current conditions.

4. The Committee should investigate the physics of interaction between currents and waves and the implications for the hydrodynamic loading on structures and vessels. Similarly the Committee should investigate the influence of wave profile on wind structure and the consequent modification of aerodynamic loading.

5. The Committee should define a detailed implementation of a harmonic analysis technique for the determination of frequency, amplitude and phase of regular waves and responses. This technique should be recommended to the next ITTC for adoption by all members.

6. There are many unsolved problems in the field of low frequency damping of moored systems, and the next Committee should continue to work in this area with the ultimate objective of establishing standards for model tests.

7. The Committee should continue to monitor research work on flow around cylindrical members. Particular attention should be given to new theoretical developments based on vortex modelling and the correlation of these methods with model test and full scale.

8. Committee investigations of advances in theoretical methods should concentrate on techniques for the description of non−linear phenomena, and on the identification of cases where it is necessary to use such non−linear techniques.

9. Work should continue that will assist the extrapolation of model test and numerical

simulation data to provide reliable estimates of extreme response probabilities, and thus a quantitative measure of safety.

10. The Committee should continue to pursue the reasons for the discrepancies in the semi-submersible first-order motion predictions, and in particular should encourage the performance of forced oscillation tests and theoretical predictions, to provide data on the value of the added mass at low frequencies.

PERFORMANCE IN ICE-COVERED WATERS COMMITTEE

Recommendations for the Future Work of the Committee

1. Further improve model ice to enable the simulation of level ice and other ice features with respect to the different failure modes as they occur in interactions with ships and structures.

2. Obtain mutual agreement on testing techniques for the establishment of the relevant mechanical properties of model ice.

3. Continue the development of propulsion test techniques and compare model test results from different Member Organizations with available full scale propulsion data.

4. Continue studies on friction phenomena in model and full scale icebreaking.

5. Carry out a comparative test series with a standard offshore structure model. Incorporate recommendations of the ITTC Panel on Validation Procedures, when available, in experiment, design and data analysis.

6. Review current information on manoeuvrability model tests in ice.