

## Powering Performance Committee

Committee Chair: Mr. R.J. Stenson

Session Chair: Mr. B. Bowden

### I DISCUSSIONS

#### On an Updated Guide for Speed/Powering Trials

by M. Abe and M. Hirano, Akishima Laboratories, Mitsui, Japan

We highly appreciate that the Committee has surveyed current practices of full scale trials together with correlation of trials results by a detailed questionnaire distributed to member organizations and shipyards, and has shown an example of updated guides for the speed/powering trials.

The Committee has distinguished the scientific type of research trials from the builder's type trials to contractually demonstrate the speed/power, and has recommended the use of a guide for the scientific type of research trials as an ITTC updated guide for full scale trials.

However it is generally accepted as easily seen in the responses to the questionnaire that the builder's type trials may currently be conducted by leading shipyards with an acceptable accuracy on the scientific basis for the model-ship correlation.

Our point is that the 21st ITTC Recommendation on full scale trials and its analyses must be aimed at conventional trials practically accepted on the scientific basis so as to update the 12th ITTC guide in 1969.

From the point of view mentioned above, we would like to request that the trial guide presented in Appendix I of the Committee Report be partially revised as described in the attached draft which has been sent to the Committee Chairman in advance. In addition,

we would like to suggest that further efforts on the updating of full scale trial guide be made by the succeeding Committee of the 22nd ITTC, and the specialist committee of Trial and Monitoring may be recommendable.

The major points for which revisions are requested are as follows:

(1) Preliminary Controls.  
Displacement and Loading (on page 432)

The top two lines of "Trials should be conducted with the ship loaded out to its design displacement and trim." should be replaced by "Trials should be conducted at the design load (fully loaded) condition, and/or at the ballasted (trial) condition where model tests are conducted at the corresponding load condition in addition to the design load."

The above is due to the facts that it is generally impossible for such dry cargo ships as container ships and bulk carriers to conduct full scale trials at the design load condition.

For such type of ships as the above, the full scale speed/power at the design load condition can practically be estimated with the use of full scale predictions based on model tests together with analyzed results for trial condition (ballasted condition) taking the model-ship correlation into account.

(2) Operation of Ship During Trial (on page 434)

The lines from 12th thru 15th of "Three runs at each condition should be conducted in alternate directions xxx." should be replaced by "Consecutive two runs at each speed should be conducted in alternate directions xxx."

Although the mean of means method would be recommendable, the consecutive two runs are enough to obtain the mean values with a sufficient accuracy in a practical sense by applying the Taniguchi-Tamura's method for the correction of effects due to wind and current.

Moreover three runs may be impractical for such a case as the VLCC trial. This is because it usually takes almost one day for a VLCC to run at four speeds with three runs each, and half a day may be allowable limit from a view point of practical trial operation considering such points at the night operation with unexpected difficulties and the change of sea and weather conditions during the trial.

(3) Figure A-1 (on page 434)  
"Approx. 4 min." in the Figure should be deleted, because the time for approach run largely depends upon the size of ships, for example it usually takes about half an hour for a VLCC case.

#### Verbal contribution by

D. Clarke  
University of Newcastle, UK

My name is David Clarke from the University of Newcastle, UK. I have listened with interest and some amazement to the presentation and discussion regarding the speed trials. Previously, I worked for BSRA and was at one time conducting speed trials and eventually became responsible for the group carrying out the speed trials.

The BSRA Code of Practice for Speed Trials encompassed most of the items raised and discussed in the Committee Report. Trials were carried out on about 6 - 12 ships per year in those days, and the results were used for ship model correlation purposes.

The points which were already considered 25 years ago were as follows:

- The run up distance for a VLCC should be greater than about 6 miles.
- Two consecutive runs at each power setting, with wind and tide corrections applied in the analysis.
- Day and night trials, usually the middle of the night.
- Ship position fixing by means of Decca Hifix, or transponder methods gave comparable accuracy with GPS systems.

The BSRA Code of Practice for Speed Trials and the theory behind the analysis were published in two Volumes and will be available through BMT, who still retain the copyright and "Intellectual Property Rights". Could I ask that the new Committee, or Group which will be looking after this topic, please read them and take them into account in your future work.

#### Contribution to the Discussion on Powering Performance

J. Holtrop  
MARIN, Wageningen, The Netherlands

I express my congratulations to the last Powering Performance Committee for compiling a fine and comprehensive report. When digesting all that has been written I conclude that after all these years of experimental and theoretical research the objective of making more reliable predictions has come only a little closer, if any.

At first sight, it seems to be a far from satisfying situation to see that the very old problems of scale effects on appendages, flow separation, complex propulsors, form effects and sea trial procedures are still dominating the recommendations and contents of the report. This situation does not imply that no significant progress has been made. On the contrary, despite the growing complexity of propulsors with lower and lower rotative speeds, and more hull forms being designed with a critical flow behaviour, in all the mentioned areas substantial advances have led to more understanding, and more rational and reliable procedures.

The Powering Performance Committee has often evaluated various alternative prediction methods by statistical analysis of correlation data. Such studies have always helped the community of towing tank institutions to assess the merits of various procedures proposed and to identify areas for further improvement. In this respect I missed any reference to the work of Grigson, who, in some papers presented to the RINA in 1993, 1994 and 1995, made some quite interesting studies on the basic principles of model-to-ship extrapolation as the flat plate friction formulation, the Reynolds number scale effect, if any, the use of results of geosims and the treatment of various scale effect components.

These and other remaining problems, of which many are of a classical nature, suggest

that the work of the Performance Committee is not finished and I hope, as a former servant of this committee, that in some way or another, the work will go on.

### **Powering Performance Committee Discussion**

M. Ikehata  
Yokohama National University  
Yokohama, Japan

1. In ship trials there are necessarily, to some extent, the effects of not only waves and winds in a seaway but also ship motions, pitching, heaving, rolling and so on, induced by the waves and winds. In the analysis of the sea trial data such effects should be made corrections. I think that the Committee should make and propose the standard method to correct the effects of waves, winds and ship motions. How does the Committee consider?

2. In the 1978 ITTC Performance Prediction Method, Prohaska's method is proposed and recommended to determine the form factor,  $k$ , from the results of the resistance test of a ship model. However, as you know Prohaska's method is not applicable to the ballast condition of must bulbous bow ships. What method does the Committee recommend for that condition instead of Prohaska's method?

### **Discussion on the Report of the Powering Performance Committee**

Tetsuo Nagamatsu  
Mitsubishi Heavy Industries, Ltd., Japan

This discussion is concerned with the Appendix I of the committee report, in which the Committee presents an updated guide for the conduct of powering trial.

The main points of this discussion are as follows:

(1) The present report should describe more distinctively that the guidance given in Appendix I is for the rigorous scientific trials, and that the usual shipbuilders' trial can be conducted following the guide given by 12th ITTC.

(2) The title of Appendix I should be revised to, for example, "A Guide of speed/Powering Trials for Obtaining Scientific Data". And the description in "Recommendations to the Conference" should

be restricted to the special powering trials for rigorous scientific purpose.

The powering trial is usually conducted for two purposes: One is to confirm the attainment of the contract speed at a given power, and the other is to accumulate the scientific data of model-ship correlation. The former is mainly pursued by shipbuilders, and the latter by researchers for more precise power prediction of full scale ship from model test results.

For the research on model-ship correlation, it is desired that the data should be obtained under as tightly controlled circumstances as possible. However, it is not practical to claim that the powering trial by shipbuilders should also be conducted under such ideal circumstances, although the accumulation of model-ship correlation data is very important for shipbuilders, because the results must be fed back to the powering prediction of newly designed ships in the future.

The report of 12th ITTC Performance Committee have suggested the guide for measured mile trial, which was accepted as a compromise between the requirements of trial for obtaining scientific data and shipbuilders' needs. In principle, most of Japanese shipbuilders conduct the powering trial based on the guide of the 12th ITTC, reflecting current practice. There seems to be no problem to accomplish the two purposes of powering trial.

In addition, even if the present Guide is restricted to the rigorous scientific trial, there still remains some inadequate items which should be further discussed and revised such as the distance of approach run shown in Fig. A-1. Therefore, the discussor would like to recommend the Specialist Technical Committee on Trial & monitoring to continue further study on individual items of the present Guide.

### **Discussion on the Report of the Powering Performance Committee**

by K. Nakatake  
(Kyushu University, Fukuoka, Japan)

I would like to congratulate the Powering Performance Committee (PPC) on their last PPC report and wish to make a comment.

In chapter 5, the report showed a standard uncertainty analysis method for powering predictions. In obtaining the precision error,

they used the mean values of the subdivided sections of time history of the one-run record. Apparently these values are not independent mutually and then the exact precision error can not be obtained. This method is the same as Validation Panel method referred in the PPC report of 20th ITTC.

Because it is impractical to repeat many multiple runs for one speed, the discussor is reluctantly obliged to accept the method. But we must notice that "the precision error" obtained is only an index to indicate stable measurement. In calculation, choice of number of subdivisions or time interval seems to affect the results.

Therefore, the proper number (or time interval) should be chosen at each model basin.

#### **A comment on: Standardize Uncertainty Analysis for representative testing methods for powering predictions**

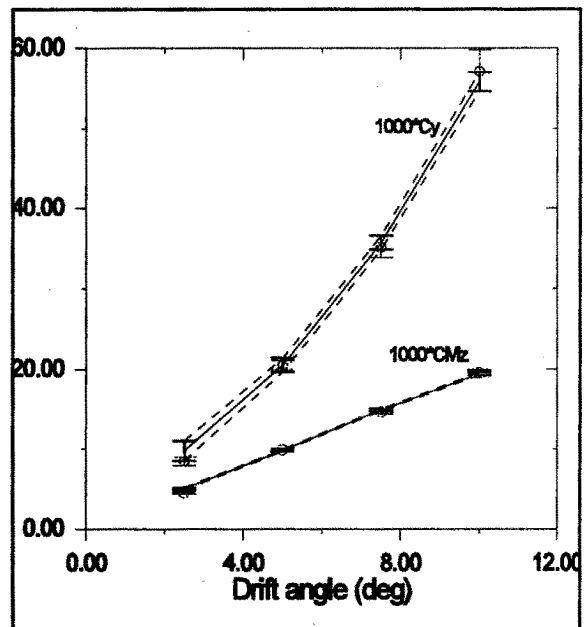
R. Penna  
INSEAN - Istituto Nazionale per Studi ed Esperienze di Architettura Navale  
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I agree with the methodology position reported at page 412 about the defined Precision errors as "variable errors that can be reduced by use of multiple readings...", but in my opinion these readings must be independent. It is not clear why multiple readings of temperature taken at various depth and position allow to obtain the precision error, whereas resistance measures taken in different runs are not useful to achieve the same result. Why resistance measures taken in different run at the same hydrodynamic conditions are different results and not the water temperature taken in different positions?

In my opinion towing tanks should give hydrodynamic results with uncertainty limits that represent the probability range, where results obtained in same hydrodynamic conditions should be found, according to adopted confidence limit. It is clear that rigorous validation activity is expensive, but we do not confuse the experimental cost with the validation cost.

For example, here the validation results about the hydrodynamic forces measured on a ship model in drift motion are reported. In this case multiple readings (not less than 20) have

carried out at two velocity (low and high Fr) and four drift angle values. The experiment was organised to repeat the readings every four runs, changing drift angle and measuring two steady velocity each run. In this way the complete experiment has been performed by 80 runs during a period seven days long. In the figure the uncertainty region (dot line) for the sideforce and z-moment coefficients is reported. It is also reported (red error bar) the uncertainty obtained according to the Committee's suggested method to divide the time history into a number of sections. The results are obviously in disagreement.



#### **Discussion on the Report of the Powering Performance Committee**

by Noriyuki Sasaki  
Sumitomo Heavy Industries Ltd., Japan

The purpose of this discussion is to point out the necessity of modification for Appendix I of the committee report by announcing the actual sea trial data of commercial vessels which are the most frequently built by many shipbuilding companies.

The points to be modified or to be added are as follows :

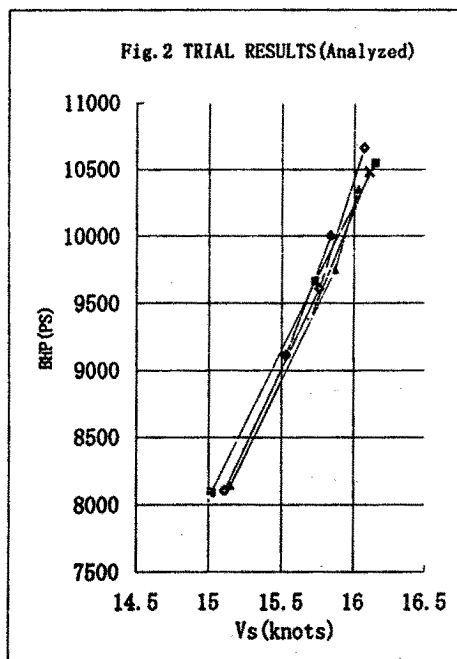
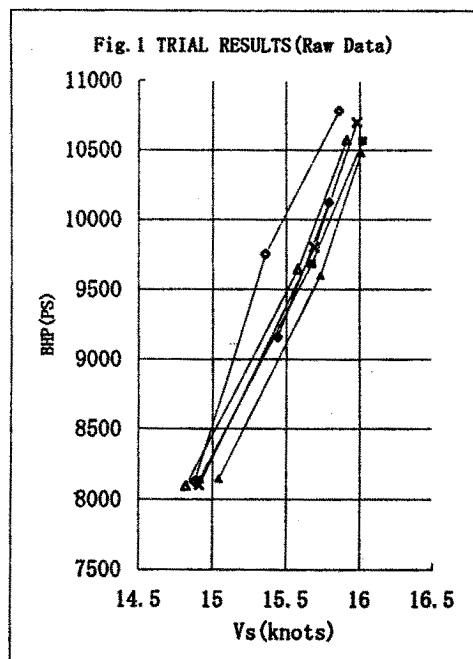
- (1) The report should declare that this trial code is a guidance for the ship which has special purpose such as research work.
- (2) As for the commercial sea trial, the

guide of the 12th ITTC for speed / powering is very useful and reasonable.

It is generally recognized that a sea trial conducted by a shipbuilding company is very labourious and costly work. In the case of VLCC, almost 100 people are onboard to confirm the ship is built in accordance with the contract. The speed trial is one of them of the sea trial measurements and only 2 or 3 engineers are engaged in it while it occupies long time. Therefore it is very important to reduce the time for speed trial to save the cost of sea trial without spoiling the accuracy of

speed measurement. The report of 12th ITTC Performance Committee have suggested the very reasonable guide for speed trial procedure from not only the scientific but also economical aspect.

Fig. 1 shows the raw data of speed trial of same Panamax B/C series which were built by Sumitomo in these 2 years. The all speed trials were conducted according to the guide of 12th ITTC Powering Committee. If we apply a standard method for analysis to these speed data, we can get very accurate powering information as shown in Fig.2.



### Comments on the Report of the Powering Performance Committee

Kinya Tamura  
Nagasaki Institute of Applied Science, Japan

First of all, I would like to express my sincere appreciation to the members of the Powering Performance Committee for their effort and achievement. Since I served as a member of former Performance Committee, I know very well the importance of their work.

I would like to express my comments on the two subjects of the report.

#### (1) An Updated Guide for Speed Powering Trials.

"ITTC Guide for Measured-Mile Trials", which the Committee intended to update, was adopted at the 12th ITTC (1969). This was the

revision of "Propulsion Trial Code" prepared by Dr. K.Taniguchi at the 10th ITTC (1963). (Taniguchi, 1963). At that time, I cooperated with him in making draft of this Code. For this reason, I have much interested with the philosophy of the Guide newly prepared by the Committee.

In the former one, the philosophy was to present a guidance with enough scientific meaning and, at the same time, with wide application even to a commercial acceptance trial with a little loss of time and money in order to obtain trial data of many kinds and size of ships. This was very important view point to analyze reliable ship-model correlation data and to establish power prediction method to be applicable to many kinds and size of ships.

To the contrary, the present Committee

stressed the importance to distinguish between commercial acceptance trial and scientific type of research trial whereby model correlation work can be performed.

My question is whether the Committee can expect to obtain enough data for model ship correlation work for many kinds and size of ships under this Guide or not. If not, what is the objective to prepare this Updated Guide?

Secondly, I would like to point out that one of the most important items for trial code is to give guidance on the distance of approach run. In the former Code, the distance was given for both high speed liner and tanker of 60,000 ~ 100,000 DWT in rough estimation. Where this size of tanker was thought the largest at that time.

At present, in the case of VLCCs which are characterized by large mass and comparatively small engine power, the time needed for approach run is usually beyond 30 or 40 minutes. I regret that the Committee might not treat this important item with much caution.

I would like to recommend the Committee to adopt some calculation formula which give necessary distance of approach run for each ship under given tolerance and boundary conditions. In this connection, the report presented by Dr. K. Taniguchi which treated a calculation method and the comparison with the measured results to the 11th ITTC (1966) is very much informative (Taniguchi, 1966).

Thirdly, the criteria of water depth was decided from the view point of the shallow water effect on wave resistance and the extent of blockage effect in the former guide. The physical meaning was quite clear. The adequacy of this concept was supported even by my paper which treats shallow water effect and virtual blockage in shallow water. (Tamura, 1989).

I am afraid that the criteria introduced by the Committee may have less physical meaning than the former one. I would like to know from what view point and evaluation the Committee replaced the criteria.

## (2) Self-Propulsion Test Method for Separation Prone Hull Forms

On this subject, I would like to point out that important contribution was made by SR159 Committee of the Shipbuilding Research Association of Japan, which was composed of

the potential members of universities, laboratories and model basins in Japan, chaired by late Prof. H. Sasajima and lasted four years (1975~1978). The present discussor served also as one of its sub-committee chairman.

As a result of this joint study, the occurrence of unstable thrust and torque measurements in the self-propulsion tests was characterized by the occurrence of an unsymmetrical flow around stern near the water surface by the action of propeller. A side force was developed at the stern in accordance with the flow separation. It must be pointed out that the method of self-propulsion whether model was captured or not could not give significant difference.

The occurrence of unsymmetrical flow could be distinguished by the behaviour of wake when the propeller loading was changed widely from zero thrust to the model point of self-propulsion, by measuring the side force at the stern and, if possible, flow visualization around stern. The excerpt of this joint study was referred in the report of the Performance Committee of 15th and 16th ITTC by myself in charge.

Later, I made a review on the studies of this phenomenon in Japan which included studies from its very beginning, the joint study of SR 159, the relation with the unusual phenomenon in manoeuvrability and also my views on scale effect and ship-model correlation. (Tamura, 1990 & 1991). I regret that the present Committee might not give any attention to these important works before to conclude its views.

My proposal on this subject is:

(a) It must be needed to conduct measurements including observation of flow pattern carefully, to distinguish the analyzed results due to flow patterns and to apply them to full scale prediction by the use of proper correlation data which was obtained under the same boundary conditions.

(b) If it is probable that this kind of unsymmetrical flow occurs only in model, it is important to find such a procedure to prevent the flow separation in model tests, as the application of stern fin or so.

At last, I know this is the final session of the Performance Committee. I appreciate very much the activities of the Committee during these 33 years since its inauguration at the 10th

ITTC (1963).

I want to see where the ITTC is going to without the activities of Performance Committee hereafter.

#### References:

Tamura, K., Resistance Tests in Shallow Water on a Variety of Ship Models, Transactions of the West Japan Society of N.A. No. 78 (1989).

Tamura, K., Study on Unsymmetrical Flow around Stern of High Block Coefficient Ship Models at Self-Propulsion Tests, (in Japanese), Transactions of the West Japan Society of N.A. No. 80 (1990).

Tamura, K., Study on Unsymmetrical Flow around Stern of high Block Coefficient Ship Models at Self-Propulsion Tests, Proceedings of Int. Symposium on HADMAR'91 (1991) Varna, Bulgaria.

Taniguchi, K., Propulsion Trial Code, the Report of the Propulsion Committee, 10th ITTC (1963).

Taniguchi, K., The data of the Change of Water Speed during the Approach Run and the Tidal Current Speed in Trial Course, the Report of the Performance Committee, 11th ITTC (1966).

Taniguchi, K., On the Distance of Approach Runs, the Report of the Performance Committee, 11th ITTC (1966).

## II REPLIES

### Response to Discussion by Dr. M. Abe and Dr. Hirano

The Powering Performance Committee thanks Dr. Abe and Dr. Hirano for their discussion of our report and especially for taking the time to provide an annex of recommended changes to our Updated Guide for Speed/Powering Trials. We agree with their suggestion that further updating of the guide should be accomplished by the new specialist committee on Trials. We will endeavour to review their recommendations and forward our comments and the appropriate changes to the New Trials committee for their consideration.

We would like to respond to the two major points of requested revision: Preliminary

### Controls

(Displacement and Loading) and Operation of Ship During Trial.

They recommend that the statement, "Trials should be conducted with the ship loaded out to its design displacement and trim", be modified to add, "and/or at the ballasted (trial) condition where model tests are conducted at the corresponding load condition in addition to the design load". We would suggest a slightly different modification to add, "wherever possible", and then his statement. We would also emphasize that relying on the model tests to determine the effects of significant displacement/trim changes on speed/power performance full scale is somewhat risky. A more precise method although time consuming and probably impractical would be to conduct limited repeat conditions at a second displacement full scale.

Dr. Abe and Dr. Hirano further recommend that the method of conducting "three runs at each condition in alternate directions" be replaced by "two runs at each speed in alternate directions". They state that although the mean of means method of three runs is recommended, that two runs would suffice applying the Taniguchi-Tamura method for correction of effects due to wind and current. They further state that three runs may be impractical for the VLCC type of trial because of the time it takes to conduct a run. This is precisely the reason that three runs and a mean of means method is recommended, to account for the effects of time varying current, tides and winds between reciprocal runs. We would agree with them that two runs would be acceptable if some minimum criteria of repeatability of speed, power, rpm, and torque between runs is specified. The advent of new technologies such as radar track and GPS allow for trials to be conducted 24 hours a day and new instrumentation and data collection allow for rapid comparison of run data. The extra few hours spent on trial may very possibly be well worth the investment to accurately determine the powering performance of these ships.

Finally, we agree with Dr. Abe and Dr. Hirano that the approximately 4-minute approach indicated in the figure should be removed and we recommend it be replaced by "steady approach conditions". Again, we would like to thank Dr. Abe and Dr. Hirano for their comments and suggestions.

### Powering Performance Committee reply to Dr. Clarke

The Committee thanks Dr. Clarke for his comments from the floor regarding his experience conducting speed trials with BSRA. His points regarding run approach distance for VLCCs and number of consecutive runs have already been discussed in our previous responses. Regarding accuracy of radar track and GPS, we would agree they are comparable, but point out the advantage of the flexibility provided by GPS by not being constrained to a particular range site. Regarding the BSRA Code of Practice for Speed Trials, we did read it and take it into account in our Committee work, as indicated on page 411 of our report. We Concur with Dr. Clarke's recommendation that the new Specialist Committee on Trials also consider the Code in their future work.

### Powering Performance Committee Reply to Mr. J. Holtrop

The PPC thanks Mr. Holtrop for his contribution to our report and highly appreciates his analysis of the work carried out in the long run by the Committee, so well chaired by him in the past.

The Committee fully agrees that the major items which have occupied the previous Performance Committees have not been solved now in a way which can be considered as the best forever.

On the other hand, one of the building stones in correlation of ship performance predictions and full scale data, is the accuracy and reliability of the sea trials itself. We hope the emphasis in this item in our present committee will result in some improved quality of the full scale data in next samples of correlation data. With respect to the accuracy of the other elements in the correlation, viz. model measurements and prediction methods, we trust that the former will benefit to some extent from ISO certification efforts in the towing tanks.

Focusing the question about the work carried out by Mr. Grigson, on the model ship correlation, published by the RINA, the Committee agrees with Mr. Holtrop in considering Mr. Grigson's proposals very interesting. With respect to the progress

claimed by Mr. Grigson, we share the skepticism expressed in your comment to Mr. Grigson's 1994 paper: That the major reduction shown in the standard deviations, compared with those of the other statistical results, can as well be caused by the selected data sample used as by the prediction method. The reliability of an extrapolation procedure can be only established by means of the recalculation of a great number of tests and the comparison of these results with the corresponding sea trials.

We agree however that Mr. Grigson's treatment of some basic matters in the model-to-ship correlation, is quite interesting and deserves further consideration within the ITTC, as was expressed in reply by the former committee.

### Response to Discussion by Prof. Ikehata

The Committee thanks Prof. Ikehata for his comments on trials analysis and on Prohaska's method. As regards the trials analysis comment, the revised trials guide points out the importance of conducting trials within minimal acceptable criteria of sea state and wind. It further discusses the importance of obtaining measurements of wind speed and direction, wave height, and ships motions including heave, pitch, and roll whenever possible. We agree with Prof. Ikehata that the influence of the effects on the speed/powering relationship of the ship should be accounted for. We would hope that the results of the survey and the revised trial guide could be used as the foundation for establishing such corrections. Perhaps the newly formed specialist committee on trials can address this issue further.

The spread of the resistance measurements at low Froude numbers, in the case of a bulbous bow ship tested at very light ballast condition, is not applicable to the Prohaska's method to determine the form factor. In this case one possibility should be the use of the method of the minimum to obtain the form factor, if a minimum can be detected. Another possibility could be to approach the form factor value by statistical formulae from those of the literature: normally depending on the main dimensions, block coefficient, etc. of the ship. In this last option the experimental value of the form factor determined by the Prohaska's method from tests carried out at other conditions can be used to check the most appropriate empirical formula.

## **Response to Discussion by Dr. Tetsuo Nagamatsu**

The Powering Performance Committee would like to thank Dr. Nagamatsu for his discussion of Appendix I of our report, "An Updated Guide for Speed/Powering Trials".

Although we agree with Dr. Nagamatsu that the guidance given in the Appendix is more appropriate for rigorous scientific type trials, we do not feel that there should be two different guides for powering trials recommended by ITTC. We would hope that this guide could be used for both types of trials and, if precisely followed, would be considered as the ideal for the conduct of speed/powering trials where model correlation is planned. Although we feel that it would be prudent to follow as many of the procedures within the guide as possible when conducting the builder's type trial, we are aware of the time and cost constraints ship builders must operate under.

We further agree with Dr. Nagamatsu that the accumulation of model-ship correlation data is very important for shipbuilding in order to improve powering predictions of future ships. We feel that this updated guide, if precisely followed, will enable the accumulation of very useful correlation data for the shipbuilding community, as well as the research community.

We agree with the comment on revising the distance of the approach run shown in Fig. A-1, and also agree that the new specialist committee on Trials should continue further studies on individual items in the guide as proposed by other discussions.

## **Reply to discussor-K. Nakatake-21st ITTC by Neil Bose**

The Committee agrees with Professor Nakatake that the method of arriving at a precision error of a test signal, by taking the mean values of subdivided sections of the time history of the signal, is not rigorously correct as these do not represent independent experiments. However, as the discussor points out, it is normally impractical to repeat many multiple runs for one speed. In addition there are other problems:

1. At some (manually controlled) tanks, it is actually impossible to repeat a run at exactly the same speed and this led to a concern that the repeated run was really a run at a different

actual speed and hence a different test. By calculating a precision error based on runs of this type, the error measured would partly represent the ability of the operator and the machinery to achieve identical speeds on multiple runs.

2. In tanks where a carriage control system maintains speed at a given value, the precision error calculated from multiple runs would represent a function of the carriage speed control system. This may or may not be a quantity of interest to the experimenter depending on the stability of the measured carriage speed itself. If the carriage speed is very stable, then each run might be thought of as a different test. If there is a surge oscillation, then stability of speed is important and the precision error estimated using subdivided sections may be the quantity of greater interest.

The number of segments chosen to subdivide the record, their relative size (or time) and whether they are equal or otherwise, may affect the value of the precision error. Each individual data point in the time history has been taken independently from the population. Taking a number of these data points within a time segment and then averaging them is legitimate. However, the problem arises in selecting the time segment. The question that needs to be addressed is: Does the time segment capture all random and other influences on the precision error? It is likely that random precision errors in the data acquisition unit (precision variations inherent in the measuring system) were captured, because of the relation between the data collection rate and the length of the time segments, but influences that vary with time, like friction in the water lubricated bearings of the propeller boat and random experimental uncertainties, were probably not captured because the time segments were too small. No calculations were done to see if variation in the sections did affect results and the Committee agrees with the discussor that this might be worthwhile as an additional analysis component at each model basin.

## **Powering Performance Committee Reply to Dr. R. Penna by Neil Bose**

Many of the points already made in reply to the discussion by Prof. Nakatake are also relevant in our reply to Dr. Penna. In

addition, in Dr. Penna's results for side force and z-moment coefficients it is not clear why the Committee's approach to precision uncertainty values (using mean values of subdivided sections of the time history) gives a larger uncertainty limit than repeated experiments. Were bias error included in the error bars shown? The concern of using subdivided sections of the time history to estimate the precision error is that this error may be underestimated by this approach.

#### **Response to Discussion by Dr. Noriyuke Sasaki**

We thank Dr. Sasaki for his thoughtful comments and the data provided from a series of trials conducted by Sumitomo Heavy Industries.

Dr. Sasaki proposes to modify Appendix I in the Powering Performance Committee report to specify that the trial code is guidance for special purpose such as research work. He further suggests that for commercial sea trials the Guide for the 12th ITTC be used. We do not agree that there should be two guides. We feel that adherence to the recommended procedures in the guide is appropriate for scientific work involving model correlation. We also feel that commercial type trials should utilize the guide to the maximum extent possible within time and cost constraints. We specifically did not refer to Appendix I as a Code, but as a Guide, with recommended procedures to be followed wherever practical.

As presented in Figs. 1 and 2 of Dr. Sasaki's discussion, raw trial data can be analyzed to provide accurate powering information. We agree with this assessment, however in Fig. 1, it is interesting to note that at a constant velocity of 15.45 kt there is an approximate 1,000 hp spread between the raw trial data obtained from a number of ships in the same series. This equates to 38% of the entire range of data presented 2,650 hp. For a constant horsepower of 9,750 hp, there is a 0.5 kt difference in the various trial's data whereas the entire speed range presented is 1 kt. It would appear that a greater range of speed power conditions would be appropriate to adequately define the ships' powering performance.

We are curious to know what standard analysis and corrections were made to the raw data to generate the curves presented in Fig. 2.

With the corrections made, it appears that there are still significant differences between ships throughout the speed power range. Again, we want to thank Dr. Sasaki for providing his discussion,

#### **Response to Discussion by Dr. Kinya Tamura**

The Powering Performance Committee wishes to thank Dr. Tamura for his insightful comments on our report. His comments address two specific areas of the report, the Updated Guide for Speed/Powering Trials, and Self-Propulsion Test Method for Separation-Prone Hull Forms. We will address our response to each area separately.

#### "Updated Guide for Speed/Powering Trials"

As regards the Updated Guide for Speed/Powering Trials; Dr. Tamura discusses the philosophy used in the preparation of the 1969 Code which was to present guidance with enough scientific meaning and with wide application even to commercial acceptance trials in order to obtain trial data of many kinds and sizes of ships. While we would agree that this was a worthwhile goal, we would question how successful it has been. The results of our survey of some 75 member organizations resulted in only six positive responses to our questions regarding the application of full scale trial data for correlation purposes. Perhaps this is indicative of the lack of quality and scientific value of the data being collected. We felt it was important to be somewhat more rigorous in the recommended approach to the conduct of trials whereby the data is to be used for correlation purposes. This is not to say that trial data collected in a less rigorous manner is not useful, but we would question its value for correlation purposes. Dr. Tamura also questions the objective to prepare the updated Guide. The overall objective in the preparation of the updated Guide was to incorporate the new technologies, and resulting methods of conducting trials which have evolved over the past 27 years since the 1969 Guide was introduced. As determined by the survey, the measured mile method is seldom used nowadays.

Dr. Tamura rightfully points out the importance of giving guidance on the distance of the approach to the run. It is interesting to note that although the 1969 Guide gave guidance on two types of ships, cargo liners

and tankers of 65,000-100,000 tons, it also stated that there was no definitive criterion to determine minimum acceptable length of run in general. Dr. Tamura recommends that the Committee adopt some form of calculation formula to give necessary distance of approach run. Perhaps this can be attempted by the newly-formed Trials Committee during the 22nd ITTC. We would caution the new committee, however, regarding the difficulties in attempting to determine a definitive criterion which accounts for the many different sizes and types of ships with varied types of propulsion. This is an area, however, where the new technologies can be used to assure steady conditions prior to starting a run, which is the main purpose of having an adequate approach run distance. Computer-based onboard data monitoring systems allow continuous monitoring of parameters such as rudder angle, heading, torque, rpm, propeller pitch, and thrust, to ascertain steady conditions, and also to balance conditions between propeller shafts on multiple-shaft ships. The new GPS systems allow for the continuous monitoring and display of ship's position and speed, typically the last parameter to reach a steady condition, while also allowing for greater flexibility in the conduct and start and stop of a run. We would recommend that these new technologies be used to determine steady conditions for the conduct of a run rather than a calculated minimum distance criterion. In this regard, the figure shown in the Updated Guide should be modified by removing the times associated with the approach to the run and replacing them with "steady approach conditions".

Finally the criteria of water depth  $d \geq \frac{10TV}{\sqrt{L}}$ , was chosen as it includes in a single formula the important effects of speed, draft, and length of the ship. This criterion is recommended by the SNAME Code for Sea Trials 1973. This formula does have a different physical meaning than the use of a combination of the two formulae presented in the 1969 Guide, as the length of the ship rather than the beam of the ship is accounted for. We would argue, however, that this formula does not have less of

a physical meaning than either formula in the 1969 Guide.

### Reply to Dr. Tamura on his comments "Self-Propulsion Test Method for Separation-Prone Hull Forms"

The Committee thanks Dr. Tamura for his contribution in which he pointed out the important results of SR159 Committee on unsymmetrical flow around stern.

The studies on unsymmetrical flow around stern have been reviewed repeatedly in the reports of the past ITTC Performance Committee. So, the committee report here focused attention on the self-propulsion test methods for separation prone hull forms and indicated the fact that the fluctuating thrust accelerates the model in the continental method and the residual acceleration results in the instability of the thrust deduction fraction results even if it is not so significant.

The Committee appreciates Dr. Tamura's information on his work where he made a fine review on the studies of this unusual phenomenon in Japan and expressed his views on scale effect and ship-model correlation. Dr. Tamura's proposals on the measurements including observation of flow pattern and the procedure to prevent the flow separation in model tests will be helpful for future studies on unsymmetrical flow around stern.

Again, we thank Dr. Tamura for his comments and for his continued interest in the work of the Powering Performance Committee of which he is a past member. We also share his concern regarding the future work of the ITTC without the activities of the Powering Performance Committee. We fervently hope that these activities will continue to be addressed by some of the new-organized committees.