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Ship Speed Trials Re-evaluated

Rough Draft

The traditional way of conducting and evaluating ship speed trials is very costly and involved and at the same time **not very trustworthy**. The reason for this situation is that **the logic behind** the various **traditional and accepted procedures is in parts obscure** to say the least. Consequently the author is promoting the **necessary clarification and rationalization, not only in view of the requirements of ISO 900x, but primarily in view of the legal aspects and implications.**

Although the ideas, originally developed as a by-product of the METEOR project some ten years ago, are surprisingly simple and the results of the re-evaluation of data are in complete agreement with the traditional results, the procedure is not readily accepted by colleagues worldwide, but the results are already forming the nucleus of a discussion.

The stimulus for the recent activities of the author has been the Japanese **ISO Committee Draft (CD) 15016**. His first reaction was an alternative draft proposal framed in terms of the theory of rational conflict resolution. His reservations were and are, even stronger now, that an ISO **standard should not just continue to refine past practice**, but should meet the highest 'standards' and take advantage of the latest state of the art and technology in every respect.

In the interest of the profession, science and technology, and the costumers, yards and owners, a serious **discussion not only of the details, but of the fundamentals in the first place, is strongly suggested.** Naval architects need to **take the discomfort of the industry they are serving very serious** and come up themselves with adequate solutions before outsiders or industry tell them what they better should do or should do better. A problem is that the topic is not very fashionable with chairs of ship theory, practitioners being left pretty much alone.

The new ISO/CD 15016 example provided the latest test case for the rational evaluation of trials proposed by the author and developed in the course of the discussion of the new activities to standardize the evaluation of ship speed trials. There remain differences in the evaluations still to be analyzed. Independent of this analysis **the differences in magnitude and, particularly, in trend of the normalized results** between the proposed rational and the proposed ISO evaluations **can be ascribed to inconsistencies in the ISO procedure. These may reflect laminarity effects at low speed model tests.**

Of course the rational method proposed does not yet cope with all the problems and details being still in its infancy and needing the joint effort and agreement of all experts before it can be established as a reference and as a standard. **The advantages of the rational procedure are a minimum number of transparent conventions and the consistent application of simple systems identification methods requiring no reference to model test results and other prior data, as it should be.**

The propeller performance in the behind condition, i. e. in the full scale wake, and the current velocity can be identified simultaneously by solving one set of linear equations. After 'calibration' the propeller power characteristic in the behind condition can be used for monitoring purposes, e. g. to determine the value of current velocity from measured values of the rate of revolution and the torque, or to determine the value of resistance after additional calibrations or even crude assumptions.

Further the power required due to the resistance in water, in wind and in waves can be identified simultaneously by solving another set of linear equations. Identifying parameters of models from observed data, even visually observed wave data, has the advantage that systematic errors in the observations are to a great extent automatically accounted for. In case of the proposed, very involved ISO method this does not apply, although it is based on the same wind measurements and the same crude

wave observations available. This fact is one major reason for the concerns about the ISO method expressed nearly unisonously by experts in shipyards and institutions.

A problem arises in analyzing the required power. At extreme weather conditions the residua are not small as in case of the supplied power. The reason is doubtless the poor resolution of the wave observation. If the crude model is kept the residua have to be accounted for. From the data at hand the values of the added power due to waves being identified according to the rational method are more than twice as large as the 'nominal' values computed according to the proposed ISO method. And the latter has been particularly conceived to deal with this problem, just with reference to the very crude data of wave observation, but without any reference to the observed data of brake power!

In order to avoid any discussion on purposely selecting data the data of all ten runs have been included in the evaluation. This has the advantage to increase the size of the sample for statistical evaluations. In addition to the overall evaluation ten evaluations have been added of the ten possible sets of data for nine runs. The stability of the results is very good, showing the nearly perfect consistency of the data with only very few exceptions.

In view of the ill-conditioned problems arising there is no chance to solve the equations with do-it-yourself algorithms, **singular value decomposition is an absolute requirement.** In a great number of examples, based on actual data from industry, it has been shown that this procedure is superior to the traditional procedures of solving eight or ten simultaneous equations iteratively. The author has no idea how this can be done reliably!

There is no question that the **results depend on the few models chosen and on the data available**. This sensitivity is not a problem of the rational method, but an inherent property of the problem to be solved. And **this sensitivity is exactly what urgently requires adequate standardization** in order to arrive at comparable, 'objective' results. The author does not share the opinion expressed by English colleagues in the discussion of ISO/CD 15016 that the procedure cannot be standardized.

In his contribution to the discussion of the Report of the Specialist Committee on Trials and Monitoring to the 22nd ITTC in Seoul and Shanghai September 05/11, 1999, the author has fully endorsed Recommendation 5 to the Conference concerning the recording of 'time histories'. Even if runs are considered stationary **sound performance and confidence analyses have to be based on 'instantaneous' values of the data**. The present samples of at best eight or ten 'doubtful' averages are just too small in size for serious applications of statistical methods.

Many problems in the evaluation of trials are due to waiting for steady conditions, i. e. ignoring all interesting information, and using ill-defined average values. In the METEOR and CORSAIR trials **quasisteady test manoeuvres** have been shown to be much superior to steady testing, **providing not only much more information, but at the same time the necessary references for the systematic suppression of the omni-present noise**, even at service conditions in heavy weather, without picking up systematic errors.

As has been shown further in the METEOR and CORSAIR trials **the additional measurement of thrust permits a complete analysis of the hull-propeller interaction**. But it may take another generation before the potential of this transparent technology is taken advantage of. It can be envisaged that in future the method will be applied for the evaluation of model tests and trials and for monitoring of ship performance in service, and thus eventually increasing and improving the data base on scale effects. Validation of CFD codes introduced into ship design can only be successfully achieved along this route.

As **a new paradigm on ship speed trials evaluation** the method proposed may take quite some time to make its way into practice, although the technology is available. But in view of modern optimum ship design it is more than timely that the present, unsatisfactory practice is supplemented and, maybe some day, replaced by the more transparent, more rational and 'more physical', **still conventional procedure**. The models used are the **crudest possible constitutive conventions**, but they may serve the purpose until somebody comes up with a more adequate proposals.

At the time of presentation more results of evaluations, even such based on 'time histories', may be available. **All related studies,** including the details of all examples investigated so far, are to be found on the website of the author under the Recent Papers in the sections On the Evaluation of Ship Speed Trials, On the Propulsion Tests with METEOR and On the Propulsion Tests with CORSAIR.

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