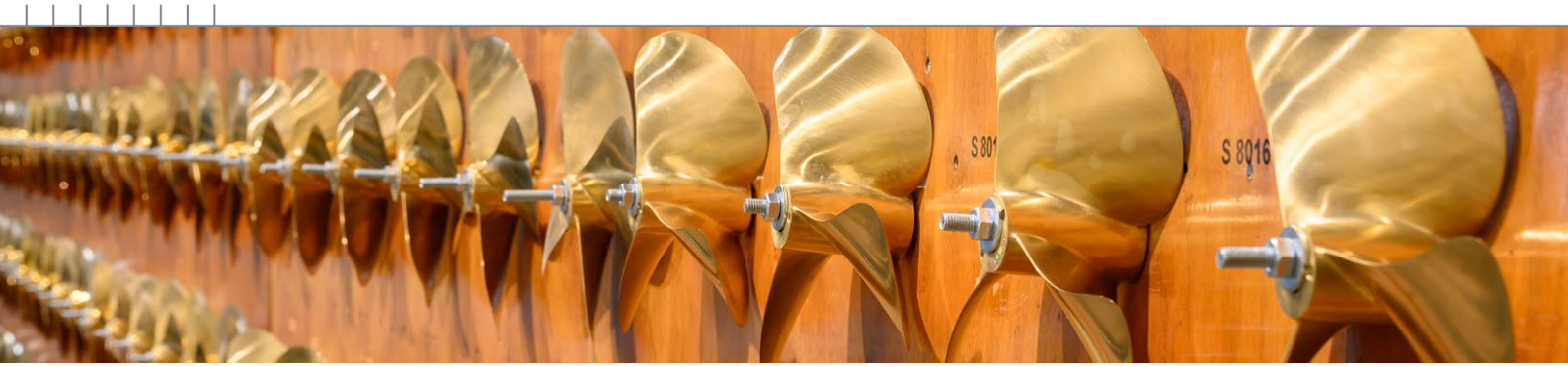

Tripping JIP

Develop new scale corrections for propellers using boundary layer tripping

MARIN proposes the Tripping JIP (Joint Industry Project) aiming at reliable full-scale predictions for both open water performance and propulsive performance. The goal of this JIP is to develop new propeller scale-corrections to be able to predict more accurately full scale open water performance and propulsive performance.

Motivation:

- For propeller designers and manufacturers: less surprises during model tests or full scale trials and better control of the propeller design on both model scale and full scale.
- For yards, ship owners and operators: more reliable full scale predictions and improved propeller designs.
- For R&D: benchmark data for RANS computations on propellers for reference and quality checks.
- For other research institutes, class societies and participants with their own model test facilities improvement of the extrapolation methodology and more reliable predictions.

Full scale performance of propellers is still an area of large uncertainty during the propeller design phase, during the extrapolation of model tests for powering predictions and during full scale monitoring. On full scale, propellers usually operate with turbulent flow. On model scale, however, laminar flow, flow transition and more pronounced flow separation are encountered. Model tests and powering predictions suffer from these effects.

It is proposed to perform new open-water model tests using turbulators such that the boundary layer would be tripped towards a turbulent flow. Turbulators on the leading edge of the model scale propellers are very efficient in tripping the boundary layer. The turbulent flow on the propellers at model scale reduces the scale effect uncertainties. New scale corrections need to be applied, thereby replacing ITTC corrections that did not capture the scale effects correctly. The corresponding uncertainty of the final prediction and the standard deviation to full scale trials would greatly improve.

The Reynolds scale effects for a fully turbulent flow can be computed with CFD. MARIN is confident that using RANS computations, reliable scale corrections can be obtained for tripped propellers. These computations have become mature, reliable and robust, and are suited to this task.

www.marin.nl/jips/tripping

Related products:

- Wageningen CD-series propellers (2015) of open and ducted controllable pitch propellers
- Wageningen F-series propellers (2023) of open fixed pitch propellers

Expertise and experience:
MARIN's propeller design and research team has well-founded expertise in performing model tests, and developing and applying propeller design and analysis software. MARIN has vast experience in developing systematic propeller series. This ranges from series with standard geometries to modern series as the CD-series and F-series, for which the propeller geometry varies in accordance with the typical operational requirements of the envisaged propeller. MARIN continually aims at improving the reliability of powering predictions, both experimentally and computationally.

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Scope

The scope of the Tripping JIP project is defined in four work packages:

1. Propeller open water model tests with turbulators – the F-series, FC-series, C-series and B-series will be revisited amongst other (public) propellers. About 100 model tests at 4 different Reynolds numbers are planned and 23 new propeller models will be manufactured.
2. Open water RANS computations – study the performance at a large range of Reynolds number, up to full scale, with varying surface roughness. About 130 propellers will be extensively computed. A RANS workshop will be organized to set the CFD approach.
3. Develop a generic scale correction method based on the model tests and RANS computations – to be used with tripped propellers to replace the currently used scale corrections. This will be at least a function of blade number, pitch, blade area ratio, J-value, Reynolds number (both at model scale and full scale) and full scale surface roughness. Correlation allowances for RANS computations will also be created based on this dataset.
4. Develop a full scale B-series polynomial – combine the open water model tests, the RANS-computations and the generic scale correction method to make a new polynomial. A software package will be provided.

State-of-the-art tools

The propellers will tested in open water conditions using the quasi-steady measurement technique, which was successfully deployed for the previous Wageningen series propellers. The new propeller models will be manufactured on a new 5-axis milling machine. Turbulators are custom plotted for each propeller to trip the boundary layer. RANS computations will be performed with ReFresco (www.refresco.org).

Time schedule

The pre-kickoff meeting is scheduled for 30 November 2023. The project will take three years to complete. **Registration is recommended before 1 March, 2024.**

Organisation

The work is conducted as a Joint Industry Project (JIP), executed by MARIN. Results and costs are shared with participating organisations that have signed the JIP participation agreement. Twice a year JIP progress meetings are organized during the Vessel Operator Forum (www.vesseloperatorforum.com). All participants will have full and exclusive access to the project results, software and other information through the confidential project website.