Agreement Tripping JIP

Issue No.	Originator	Date	Remarks
V1.0	John Huisman	27-09-2023	JIP leaflet on PPA
V1.1	John Huisman	29-09-2023	Typo in the finance table
V1.2	John Huisman	03-10-2023	Final logo
V1.3	John Huisman	15-01-2024	Addition 11.2 and 12.6
V1.4	John Huisman	28-03-2024	Further specification of deliverables in Annex A.3, page 36
V2.0	John Huisman	16-04-2024	Update of Annex A and B after first Participant Meeting in April 2024
V2.1	John Huisman	06-06-2024	Fine tuning of Annex A after feedback from the Participants in May 2024

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THIS AGREEMENT IS ENTERED INTO THIS **[DATE OF SIGNING]** (“THE EFFECTIVE DATE”) BY AND BETWEEN

MARITIME RESEARCH INSTITUTE NETHERLANDS, (hereinafter called "Contractor") a Dutch foundation having its principal place of business and mailing address at 2 Haagsteeg, 6708 PM Wageningen, The Netherlands

and

[name Participant]

(hereinafter called "Participant"): a corporation with Participant place of business at:

[full address Participant]

(Participant and Contractor together hereinafter referred to as “Party” or “Parties” as the context requires)

This agreement consists of the following documents:

1	Agreement	
2	Annex A	Proposal
3	Annex B	Participation fee and terms of payment
4	Annex C	Amendments (if applicable)

WHEREAS

A) Contractor is an internationally recognised maritime research institute and has extensive skill, experience and knowledge in undertaking and providing studies on maritime subjects and is willing and able to coordinate and perform the Project as described in Annex A (as hereunder defined).

B) Participant wishes to cooperate with Contractor and the other Participants in the Project and receive the benefits thereof including the Project Deliverables as described below and use the same in its business.

C) The scope of this Agreement is the cooperation between the Participants aimed at the completion of the Project as further described in this Agreement.

NOW, THEREFORE, IT IS AGREED AS FOLLOWS:

1 DEFINITIONS

In this agreement the following words shall have the meanings specified.

1.1 **Affiliate**, with respect to any of the Participants, (i) any company directly or indirectly owned or controlled by or owning or controlling such Participant, or under common ownership or control with such Participant, for so long as such ownership or control exists, including any subsidiaries.

1.2 **Agreement**, this agreement and the Annexes thereto.

1.3 **Annex**, an annex to this Agreement, signed by the Participants and Contractor.

1.4 **Confidential Information,** Participants Information and/or Project Deliverables Information as the context so requires.

1.5 **Disclosing Party,** the Participant (including any Affiliate of the Participant) that discloses the Confidential Information to the Receiving Party pursuant to this Agreement.

1.6 **IP Rights,** all patents, copyright, database rights, design rights, know-how, trademarks and service marks (all whether registered or not and including all applications for any of them and all equivalent rights in all parts of the world) and all rights of confidence, whenever and however arising for their full term and including all renewals and extensions.

1.7 **Late Participants**, those Participants who enter into this Agreement after 1 March 2024.

1.8 **Original Participants**, those Participants who sign this Agreement before 1 March 2024, as well as Contractor.

1.9 **Participants**, are both the Original and Late Participants.

1.10 **Participants Information,** all confidential data or information relating to the Project including any general knowledge of the business plans and/or activities of Participants and/or their Affiliates disclosed by the Participants, their Affiliates and/or employees of either Participants or their Affiliates to the Contractor.

1.11 **Participant IP Rights** means any IP Rights to the extent that:

(i) they relate to the Participants Information and were vested or applied for, as the case may be, at the time of disclosure of the relevant Participants Information to the Contractor, and

(ii) Participants are entitled to grant licences there under, subject to any condition which Participants is required to impose.

1.12 **Participant Steering Group** or **PSG**, the Participants representative committee formed under the provisions of this Agreement.

1.13 **Project ,** the project, as described in attached Project Proposal (Annex A).

1.14 **Project Deliverables** means the Deliverables listed in the Project Proposal.

1.15 **Project Deliverables Information,** any or all confidential data or information relating to the Project Deliverables but excluding the Participants Information, that is received or obtained by Participants either directly or indirectly from Contractor in writing and marked “Confidential” or, if it is disclosed orally or visually, reduced to writing and marked “Confidential” within thirty (30) days of such disclosure.

1.16 **Project Proposal,** the proposal No. 35082, in which the Contractor sets out how it intends to perform the Project (Annex A).

1.17 **Receiving Party**, the Participant (including Affiliates of the Participants and Contractor), which receives Confidential Information from the Disclosing Party, pursuant to this Agreement.

1.18 **Services**, the research services to undertake the Project and produce the Project Deliverables.

1.19 **Software,** computer code in the form of an executable as part of the Project Deliverables. The source code is not part of the Project Deliverables.

2 PURPOSE OF THE AGREEMENT

2.1 The purpose of the Agreement is to regulate the execution of the Project in accordance with the Project description (Annex A), to regulate the financial relations between the Participants, to define the organisation of the Project, and to define the rights and duties that the Participants have towards each other with regard to the progress of the Project and its results.

2.2 Similar agreements are entered into between MARIN and each Participant. If the bilateral agreements between MARIN and each of the Participants are not identical the deviations shall be explained in Annex C.

2.3 By signing this Agreement, the Parties irrevocably agree to cooperate with the other Participants and to allow all Participants to demand performance of the obligations accepted by them herein. This clause is a third party clause as meant in article 6:253 of the Dutch Civil Code. Also, by signing this Agreement, the Parties accept the third party clauses in the other agreements between MARIN and any Participant.

3 COORDINATOR

3.1 MARIN shall act as coordinator. The coordinator shall assume overall responsibility for liaison between the Participants concerning the Project. The coordinator shall also assume overall responsibility for liaison between sub-contractors concerning the Project. To this effect, the coordinator shall discharge on behalf of the Participants such functions as are defined by this Agreement and the Participant Steering Group (see Article 9).

3.2 The functions of the coordinator shall be limited to:

a) relationship and correspondence with the Participants and third parties;
b) administration, provision of the chairman of the Participant Steering Group, and follow-up of its decisions;
c) as appropriate sub-contract work to sub-contractors;
d) coordinate work contributions of parties and any work sub-contracted to sub-contractors in line with the general conditions of this Agreement and Annex A;
e) supervision of progress relative to the time schedules in Annex A or otherwise set up by common agreement of the parties;
f) reporting of the financial progress of the Project to the Participant Steering Group;
g) distribution of the funds between the parties in accordance with agreed routines, ref. Annexes A, B and C;
h) transmission of any documents connected with the Project between the parties;
i) propose changes and modifications to work and budget plans in Annex A and B as appropriate and within the terms of the Agreement;
j) storage of all trade reports and publications prepared under this Agreement for at least five years after the Project termination.

4 RESPONSIBILITIES

4.1 Each Party undertakes to use all reasonable endeavours to make available the appropriate and agreed rights and information on time to the other Participants and to participate and assist in the execution of the Project as stated in this Agreement.

4.2 In supplying any information or materials to any of the other Participants hereunder, the terms of Article 10 apply.

5 ASSIGNMENT

5.1 No Party shall, without the prior written consent of the other Participants, assign or otherwise transfer partially or totally its rights under this Agreement.

5.2 This provision shall not apply when such assignments or transfer will be in favour of an Affiliate of a Party. In such cases, the relevant Party shall inform the other contracting Party of the intention to assign or transfer prior the transfer or assignment.

6 RELATIONSHIP BETWEEN PARTIES

6.1 Nothing contained in this Agreement is intended nor shall it be construed as creating a partnership with legal entity on its own or joint venture among the Parties nor as creating or requiring any ongoing or continuing relationship or commitment among the Parties, beyond that relationship specifically created by this Agreement. Each Party hereto retains the right to conduct its own business as it sees fit.

6.2 Further, nothing contained herein shall be interpreted or construed as precluding any Party from carrying out its own independent research directed towards the objectives of the Project, and no other Party shall have any rights whatsoever with respect to the results thereof.

6.3 By signing this Agreement, Participant enters into a contractual relationship between Contractor as well as with all other Participants who have signed an identical JIP Participation Agreement (PPA). This enables each Participant to enforce its rights and obligations directly against another Participant.

7 THE PROJECT

7.1 This Agreement shall come into of force on the day of signing and shall continue to be of force until (i) the Project has been completed, (ii) the Participants decide to terminate this Agreement unanimously, (iii) this Agreement is being terminated in accordance with Article 13, or (iv) it is has become definite that the Project will not commence due to insufficient budget as described in Article 7.2.
With respect to Late Participants this Agreement shall come in force as far as they are concerned on the day such Late Participant signs the Agreement.

7.2 The Project shall commence and become effective when at least 80% (eighty percent) of the costs estimated and detailed in Annex A is available from participation fees of the Participants and/or government subsidies or at such time when the Participants and Contractor agree on a modified scope, related costs and commencing date. In the event that the aforementioned parties cannot agree such scope and costs, the participation fees already paid shall be refunded and the Participant shall have no further payment obligation to the Contractor. In all cases the scope of work and related costs shall be limited to the available budget from the participation fees.

7.3 Contractor shall act in the capacity of an independent contractor with respect to the Participant, and shall perform the Project in good faith using its own reasonable methods, within the time frame specified in Annex A. Contractor shall not subcontract any portion of the Project without prior written consent of the Participant. However, purchasing stock or off-the shelf materials or securing routine services which do not involve special skills or expertise are not to be considered subcontracting of Contractor's Services.

7.4 Contractor undertakes that the Services will be provided with reasonable care and skill and in accordance with all legal and regulatory requirements.

8 PAYMENT AND INVOICING

8.1 The fee for the participation of each Original Participant is the amount mentioned in Annex B. The fee for the participation of each Late Participant shall be 125% of the fee for Original Participants.

8.2 If the contributions of the Participants exceed the Project costs in the Proposal (Annex A), Contractor shall propose to the Participant Steering Group several options for expanding the scope of work. The Participant Steering Group shall be entitled to vote and agree on the expansion of the scope of work.

8.3 Payment of the Project costs will be effected in accordance with the payment scheme as mentioned in Annex B.

8.4 Contractor shall keep accurate books, records and other documentation in strict accordance with generally accepted accounting principles IAS (International Accounting Standards) to support all charges made hereunder and to verify that any fees received pursuant to Article 8.1 above have been properly handled.

8.5 For two (2) years following expiration of the confidentiality period set forth below in Article 10, Contractor shall preserve such books, records and other documentation and will permit representatives of Participant to inspect them, during usual business hours and to make excerpts there from for the purpose of auditing and verifying such charges and fee handling.

8.6 Except as otherwise expressly provided herein, neither Contractor nor any director, employee or agent of Contractor, its subcontractors or vendors, shall – directly or indirectly – give to or receive from any director, employee or agent of Participant or its Affiliates any gift or entertainment of significant value or any commission, fee or rebate in connection with this Agreement.

9 PARTICIPANT'S REPRESENTATION

9.1 Each Participant shall appoint a representative and alternative representative.

The representative, or alternate appointed by each Participant, will serve as a member of the Participant Steering Group (PSG). The PSG will appoint a chairman of the PSG who shall not be the Contractor's representative.

Participant's representative is: **[name and contact details of representative]**

Participant's alternate is: **[name and contact details of alternate]**

9.2 The PSG shall advise Contractor on the performance of the Project-activities and make decisions on joint Participant issues in the Project, all within the frame work of the attached Proposal (Annex A) and this Agreement. These decisions will be taken with a majority of the votes.

9.3 The PSG shall have meetings whenever required by one of the Participants but at least twice every year. In the PSG meetings progress, results and planning of the Project will be reported by Contractor together with the relevant work package leaders and sub-contractors.

9.4 If during the project, the project costs are not balanced by the project income, Contractor will propose to the Steering Group several options to reduce the scope of work or agree otherwise. The PSG will vote on such reductions of the scope of work.

9.5 If PSG agrees, the Contractor may allow new Participants to participate in the Project as Late Participants.

9.6 Each member of the PSG shall have one vote for one person and all decisions shall be made with a majority of the total votes in the PSG.

9.7 Each member of the PSG may exercise a veto right with respect to a PSG decision if this decision is related to a project-task in which this member is involved in and the legitimate interests of that member would be severely affected by the PSG decision. A member of the PSG may not veto decisions related to its own breach of obligations.

10 CONFIDENTIALITY

10.1 Contractor undertakes that it shall, during execution of the Project and for a period of two (2) years after Project Deliverables have been received (the "Confidentiality Period"):

(i) not disclose or pass any Participant Information to any third party including without limitation any Participant;

(ii) not use any Participant Information for any purpose other than the Project;

(iii) and keep all Participant Information secure, making it available only to those employees of Contractor who require access to it for the Project and who have agreed to be bound by confidentiality obligations no less onerous than those set out herein.

10.2 Each Participant undertakes that it shall, during the Confidentiality Period:

(i) not disclose or pass any Project Deliverables Information to any third party other than any other Participant or Contractor or otherwise as set out in this Agreement;

(ii) not use any Project Deliverables Information for any purpose other than as set out in this Agreement.

For the purpose of this confidentiality clause, Project Deliverables Information shall not only refer to the said definition in Article 1.15 but also include Project Deliverables (separately defined in Article 1.14). Each Participant and its Affiliates may disclose the Project Deliverables Information to:

(i) its Affiliates;

(ii) those employees of that Participant or its Affiliates who have a reasonable need to know such information;

(iii) operators and members of joint ventures in which that Participant or its Affiliates have an ownership or equity interest, or a production sharing agreement;

(iv) any third party engaged by the Participant for the sole "have made or used" benefit of Participant pursuant to the licence granted in Article 12.

Each Participant is aware of the fact that the Project Deliverables Information contains confidential information and business secrets of Contractor. Participant is obliged to keep the Project Deliverables Information and all other associated data and information confidential. Therefore each Participant guarantees that all Affiliates, employees, operators, members of joint ventures or third parties will hold the Project Deliverables Information in confidence to the same extent as required in this Article. Each Participant will take all necessary precautionary measures in this respect both (i) within its own organization as well as (ii) in providing any Project Deliverables Information to the abovementioned parties.

Moreover, each Participant guarantees that the Project Deliverables Information will only be used for the purposes set out in the licence granted to that Participant and its Affiliates under Article 12 below. With regard to the Project Deliverables Information provided to third parties, each Participant guarantees that the Project Deliverables Information will solely be used for the benefit of Participant.

Each Participant will be liable for any damage or loss resulting from the disclosure or use of Project Deliverables Information in breach with this agreement either by itself or by any of the other parties it disclosed the Project Deliverables Information to. The Receiving Party agrees that any liability occurring from a breach of confidentiality by the Receiving Party are not considered as indirect or consequential losses or damages and shall not be excluded by Article 11.

10.3 Project Deliverables Information provided to Participant hereunder shall be treated by Contractor and Participant and all Affiliates of Participant to whom the Project Deliverables Information is provided under Article 10.2 with the same reasonable precautions with which Contractor or Participant or Affiliates of Participant treats their own confidential information of like kind to prevent access thereto by others than those to whom the Project Deliverables Information may be provided under Article 10.2.

10.4 The provisions of Articles 10.1, 10.2 and 10.3 shall not apply to Confidential Information which the Receiving Party can show by reasonable proof to the Disclosing Party:

(a) is now or hereafter becomes publicly available through no fault of the Receiving Party;

(b) was in the possession of the Receiving Party prior to the receipt of the Confidential information under this Agreement and was not acquired by such Receiving Party from a third party under an obligation of confidence to the Disclosing Party; or

(c) has been developed by the Receiving Party as a result of activities carried out independently of the Project and without access to or knowledge of Confidential Information made available hereunder; or

(d) was obtained without restriction on disclosure from a third party who is lawfully in possession of such information and free to disclose it and not subject to a contractual or a fiduciary relationship with the Receiving Party with respect to such Confidential information;

(e) is required by applicable law or regulation to disclose such information; provided, however, that the occurrence of the above (a) through (d) shall not be construed as granting any rights, express or implied, under any IP Rights

10.5 Contractor may disclose the Project Deliverables Information to any court of law or governmental authorities or agencies for permitting procedures or if required to do so by law. In the event that a Party is obliged to make a disclosure of any of the Project Deliverables Information to a court of law or governmental authority or agency, such Party shall, to the extent permissible by law, inform the other Party of the government authority or agency's request and the details of the information required to be disclosed prior to the actual disclosure.

10.6 Participant and Contractor are allowed to make use of the Project Deliverables, Project Deliverables Information and Software as part of their normal business. The Project Deliverables and Project Deliverables Information may not be sold, or used in computer codes that are sold, to other parties within the Confidentiality Period save as otherwise agreed by the Parties.

10.7 At Participant's request, Contractor shall return to Participant or at Participant's option destroy, all records of all or part of the Participant Information then in Contractor's possession or control.

11 WARRANTY AND LIABILITY

11.1 Contractor warrants that the Project Deliverables shall conform to the description set forth in Annex A. Contractor also warrants that it has the right to perform the Project and to grant the rights provided hereunder. Contractor further warrants that the Project Deliverables and the Projects Deliverables Information and the rights granted hereunder have not and will not infringe any IP Right or other proprietary interest of any third party. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, USAGE OF TRADE, AND FITNESS FOR A PARTICULAR PURPOSE, ARE DISCLAIMED TO THE EXTENT PERMISSABLE BY LAW. EXCEPT AS WARRANTED HEREUNDER, CONTRACTOR WILL NOT BE LIABLE TO PARTICIPANT OR ITS AFFILIATES FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION INDIRECT AND CONSEQUENTIAL DAMAGES, ARISING FROM ANY USE OF THE PROJECT DELIVERABLES BY OR ON BEHALF OF PARTICIPANT OR ITS AFFILIATES.

Contractor shall indemnify Participant and its Affiliates and hold Participant and its Affiliates harmless from all claims, liabilities, losses and damages, asserted by any person, together with all costs (including legal costs), expenses or liabilities relating thereto based upon or resulting from any claim or action for infringement of any IP Rights made against Participant and/or its Affiliates resulting from Participant's and/or its Affiliates' possession or use of the Project Deliverables and/or Project Deliverables Information.

11.2 Notwithstanding anything in this Agreement to the contrary neither Party shall be liable to another Participant or to Contractor for any incidental, special, indirect or consequential damages or losses, including – without limitation – loss of profits, contracts, revenue or of anticipated savings, loss of use of any equipment, business interruption, increased costs, down-time, reservoir loss or the cost of capital, however arising. Such limitation on liability shall apply with regard to any claim or action, whether it is based in whole or in part on contract, tort, or otherwise, including the negligence, strict liability, or wilful act of either part.

11.3 Notwithstanding any provision to the contrary herein the liabilities and indemnification obligations of Participant and Contractor shall in no event exceed 100% of the applicable fee due by Participant to the Contractor pursuant to Annex B.

11.4 The Parties agree that the indemnities contained in this Agreement will be supported by adequate liability insurance provided by each indemnitor.

11.5 Each Party acknowledges that the Project Deliverables may be subject to export control, and that compliance with appropriate government regulations may be necessary to obtain required approvals before disclosing such Project Deliverables to foreign persons, businesses or governments. Parties agree to comply with all applicable governmental export control laws and regulations, including the requirement for obtaining any export license, if applicable.

12 IP RIGHTS AND LICENCES

12.1 Any IP Rights arising from the Project Deliverables and Project Deliverables Information ("the Rights") shall be vested in the Contractor, and the Participant and its Affiliates shall receive free of charge an irrevocable, perpetual, world-wide, non-exclusive, unlimited, non-transferable licence under the Rights to use and have used the Project Deliverables and the Project Deliverables Information for any purpose and to make, use (and have made for such use), have used on its behalf and sell any product, apparatus or other embodiment and to use any process or methods or carry out any other act covered by the Rights. The Contractor shall, by way of further assurance of its obligations in this Article, execute any document or do any such act required by the Participant or its Affiliates, to confirm the licence of the Rights granted to the Participant and its Affiliates pursuant to this Article.

12.2 The participation fee listed in Annex B shall in principle be considered to include a fair and reasonable form of remuneration at market level for the granted licence described under Article 12.1. Contractor however reserves the right to renegotiate the remuneration at a later stage where it has become evident that the granted licence represents a higher value than anticipated.

12.3 Decisions with respect to obtaining patent rights on inventions made in the course of the Project shall be at the discretion of the Contractor, however, in the event that the Contractor declines to apply for patents rights with respect to such an invention, Participant shall have the option (but no obligation) to apply in any country at its sole cost for such patent rights.

12.4 Subject to Article 12.5, Participant hereby grants Contractor a royalty free, non-exclusive, non-transferable right to use the Participant Information together with a royalty free, non-exclusive, non-transferable licence under the Participant IP Rights solely for the purpose of carrying out the Project. Said right and licence shall only be valid for the duration of the Project.

12.5 Contractor shall not incorporate the Participant IP Rights in the Project Deliverables or license the Participant IP Rights to any Project Participants unless otherwise agreed in writing between the Parties, and Contractor shall not commercially exploit or in any way license the Participant IP Rights to any third party (other than Project Participants if agreed in writing between the Parties). Contractor hereby acknowledges that the Participant IP Rights are vested in the Participant or its Affiliates as the case may be.

12.6 Participant is not obligated to disclose any other information or Confidential Information than those specifically stated in this Contract.

13 TERMINATION AND WITHDRAWAL

13.1 A Participant (the "Terminating Participant") may terminate this Agreement at any time prior to completion of the Project by giving Contractor 30 (thirty) days written notice to that effect. In such event Participant has the obligation to make payments which are due at that time and is not entitled to any refund of payment and will not receive any subsequent Project Deliverables or Project Deliverables Information due to be delivered to Participant after the date of termination of the Agreement by the Participant. Payments due are to be construed as outstanding invoices as well as a pro rata fee which shall be determined and invoiced on the basis of the time elapsed between the date of the last invoiced fee and the date of termination by the Terminating Participant. In terminating the Agreement, the Terminating Participant remains bound by the confidentiality obligations of this Agreement and waives all rights against the other Participants ("Remaining Participants") and any rights to obtain a licence or other intellectual property right and the Contractor remains bound by Article 10, whilst Contractor shall in respect of the Terminating Participant remain bound by Article 11.1 (indemnity).

13.2 The Project may be terminated without cause at any time prior to completion thereof by unanimous vote of the Participants with written notice to Contractor. Termination will be effective three days after receipt by Contractor of such written notice. Participant will pay Contractor a percentage of the applicable lump sum set forth above in Annex A. Such percentage will be equal to the percentage of the Project completed through the effective date of termination. This percentage will be mutually determined by Contractor and the Participants. If Participant has already paid Contractor an amount which exceeds this percentage of the applicable lump sum, Contractor will promptly remit the excess to Participant. In the event of termination, Contractor will provide Participant with one copy of the Project Deliverables and Project Deliverables Information in whatever state of completion they are in. Termination will not affect the confidentiality obligations of this Agreement.

13.3 Notwithstanding Article 13.1, Participant may withdraw from the Project by written notice in the event that Contractor is in default of any of its obligations with respect to the performance of the Project or any term of this Agreement. In such event Participant has the obligation to make payments which are due at that time and which are not affected by the Default and is not entitled to any refund of payment and will not receive any subsequent Project Deliverables, but is entitled to possess and utilize the Project Deliverables furnished prior to such notice.

13.4 Contractor may terminate this Agreement by written notice in the event that a Participant is in default ("Defaulting Participant") and continues to be so for more than 30 days after a written notice by Contractor. The Defaulting Participant shall be deemed to have agreed that:

13.4.1 the Defaulting Participant shall remain liable for his financial obligations as set out in Article 8;

13.4.2 the licences – if any - granted to the Defaulting Participant by the other Participants under this Agreement shall cease immediately but the licences so granted by the Defaulting Participant to the other Participants, Contractor and its Affiliates shall remain in full force and effect;

13.4.3 the Defaulting Participant will not receive any subsequent Project Deliverables and is not entitled to possess and utilize the Project Deliverables furnished prior to such notice; the agreement which is deemed to have been given by the Defaulting Participant as aforesaid shall be without prejudice to the rights of the Defaulting Participant to appeal against the termination.

14 CONDITIONS OF USE OF THE SOFTWARE

14.1 Contractor grants free of charge a non-exclusive, non-transferable, irrevocable, perpetual world-wide license for the use of Software to Participants and their Affiliates.

14.2 Software may be used in combination with or merged into other computer codes for use by Participants and their Affiliates.

14.3 Any other act than mentioned under Articles 14.1 or 14.2, or allowed under mandatory Netherlands Law, involving reproduction or use of, by Participants and their Affiliates or other dealing in Software is prohibited.

14.4 The Participant shall ensure that Software, each copy thereof and any portion merged into another program at all times includes Contractor's copyright notice together with any features, which disclose the name of the software or the Participant.

14.5 Contractor is entitled to cancel the right of use of the Software immediately by written notice, if licensee is in breach of any of its obligations under these conditions of use.

14.6 Any errors in Software encountered by Participant should be brought to Contractor's attention. Participant will send a clear description of the error encountered to Contractor, including input and output files.

14.7 Contractor shall, at no additional charges to the Participant, use its best efforts to correct any malfunctions that arise in the delivered computer package Software within the period of one (1) year after delivery of the program. Malfunctions shall mean inconsistencies between program code and specifications and any errors deemed by Contractor to be in the delivered program package.

14.8 Support specifically required by Participant for extensions and modifications will be charged to Participant on the basis of man-hour rates, computer costs and other costs. (e.g. logistic/travel costs).

14.9 The Participant’s fee includes a maintenance and support fee for the first year after the delivery of the final release of the Software. Support of Software such as diagnosis of errors, providing of updates and assistance in the understanding of the software and documentation will be available from Contractor with a maximum of 24 hours per participant during this period. After the first year, the Participant can subscribe to a support contract, at his option. Without such contract no support can be given or updates provided after the first year after delivery.

14.10 Installation and maintenance are agreed for one or more specific operating systems. If the Software is used on a platform using a different operating system as the operating systems listed in the contract then the Contractor will not be in a position to support the Software and no support will be given.

14.11 Contractor will not sell Software within the confidentiality period of two years as defined in Article 10, without permission of all Participants.

14.12 By acceptation of Software the Participant accepts and places himself under the obligations to observe the above Conditions of Use.

15 MISCELLANEOUS PROVISIONS

15.1 This Agreement including Annexes is executed in the English language and constitutes the entire Agreement between the Parties and supersedes and replaces all prior and contemporaneous Agreements, written or oral, between the Parties relating to the Services.

15.2 Notices, reports and other communications with respect to this Agreement will be referred to the Participant's Representative set out in Article 9.1 and ir. T.J. Huisman on behalf of Contractor.

15.3 Any notice related to this Agreement, including a notice of change of address, must be sent to the addresses stated at the beginning of this Agreement, either by registered mail, which is deemed to be effective notice five days after mailing, or by courier or facsimile, which are effective notices only when acknowledged by a courier's delivery receipt or by a specific non-automatic return facsimile transmission.

15.4 The termination or expiration of this Agreement shall not release either Party from any liability, obligations, or agreement which, pursuant to any provision of this Agreement, is to survive or be performed after such expiration or termination. Specifically in this regard, but without limitation, Articles 10, 11, 15, and 16 shall survive termination of this Agreement.

15.5 The subject headings on this Agreement have been placed thereon for the convenience of the Parties and shall not be considered in any question or interpretation or construction of this Agreement.

15.6 The failure of either Party to enforce at any time or for any period of time any provision of this Agreement shall not be construed as a waiver of such provision or of the right of such Party thereafter to enforce such provision.

15.7 Any costs arising from the production of the Project Deliverables or/and the Project Deliverables Information shall be paid out of the available budget from the participation fees. Any costs arising from the use of the Project Deliverables or/and the Project Deliverables Information shall be borne by Participant. The provisions of this Article shall survive any termination or expiration of this Agreement.

15.8 It is agreed that in the event of either Party being rendered unable, wholly or in part, by force majeure to carry out its obligations under this Agreement, other than its obligation to make payments of money due hereunder, then on such Party(ies) giving notice and full particulars of such force majeure in writing to the other Party as soon as possible after the occurrence of this cause relied on, then the obligations of the Party(ies) giving such notice, to the extent that they are affected by such force majeure, shall be suspended during the continuance of any inability so caused, but for no longer period. In the event that an event of force majeure continues for a period greater than thirty cumulative (30) days from the date such event was first reported by the Party prevented from performing under this Agreement to the other Party, the other Party shall have the right to terminate this Agreement by submitting a written notice to the other Party. After such notification of termination of this Agreement, the Parties shall renegotiate in order to assess the possibilities of continuing the contractual relationship taking into account the new conditions. If no agreement is reached within a period of 1 (one) month after receipt of the notice of Agreement termination, the termination shall become effective and the provisions of Article 13 shall apply with respect to such termination. The term "force majeure", as employed herein, shall mean acts of God, strikes, lockouts, or other industrial disturbances, acts of the public enemies, wars, blockades, insurrections, riots, epidemics, landslides, lightning, earthquakes, fires, storms, floods, washouts, arrests, and restraints of rulers and people, civil disturbances, explosions, and any other causes not within the control of the Party claiming a suspension, which by the exercise of due diligence such Party shall not have been able to avoid or overcome.

15.9 If a provision of this Agreement is declared invalid or is unenforceable in any other way, the other provisions shall remain in full force and effect. In such event the Parties shall replace the invalid provision with a valid provision in accordance with the object and the purport of this Agreement, in such a manner that the new provision shall deviate as little as possible from the invalid provision.

16 GOVERNING LAW AND JURISDICTION

16.1 This Agreement will be governed by the law of The Netherlands.

16.2 Any disputes arising out of or in connection with this Agreement which cannot be amicably resolved between the Parties shall be exclusively referred to the Netherlands Arbitration Institute ("NAI") under the Regulations of the NAI, by three arbitrators appointed in accordance with the aforementioned regulations. The arbitration proceedings shall be in the English language. The Parties agree that the judgment of the NAI shall be final and binding upon the Parties.

Total participants fee applicable to Participant: 45,000.- EURO (Excluding VAT)

This Agreement is made in 2 originals, one for the Participant and one for Contractor. Agreements identical to this Agreement are to be signed by all of the Participants.

All signature sheets will be compiled, enclosed to this Agreement, and sent to the parties within two weeks after the closing date for Original Participants. Late Participants will receive the compiled signature sheets of Original Participants within two weeks after Contractor and Late Participants have signed their Agreement.

Contractor:	Participant:
MARITIME RESEARCH INSTITUTE NETHERLANDS (MARIN)	**[name Participant]**
Signature:	Signature:
Name:	Name:
Title:	Title:
Place & Date:	Place & Date:

ANNEX A: PROJECT PROPOSAL

Tripping JIP proposal

Proposal to develop new propeller scale-corrections using boundary layer tripping

Version 2.1

CONTENTS

Website: Tripping | MARIN

1 INTRODUCTION

In this document MARIN proposes a new JIP (Joint Industry Project) aimed at reliable full-scale predictions for both open water performance and propulsive performance.

This document is version 2.1, written after the first participant meeting of 10 April, 2024 and finetuned after the second participant meeting of 16 May, 2024. The scope is reduced to align with the signed number of participants. The new scope as presented in the current version is in accordance with the discussions from these meetings.

This document is structured as follows. Chapter 2 elaborates on the four work packages within the JIP. Chapter 3 lists the intended deliverables. Chapter 4 specifies the finance and Chapter 5 proposes the planning.

The introduction is structured as follows: Section 1.1 states the goal for the new JIP after which the JIP is motivated in Section 1.2, including a summary of the background information and a brief review of literature. Section 1.3 provides the plan of approach and the scope of work. Finally, section 1.4 motivates the goal of the project in more detail for different parties that may participate in this JIP.

1.1 Goal

The goal of this JIP is to develop new propeller scale-corrections to predict the full-scale open water performance and propulsive performance more accurately by creating a synergy between model scale experiments and CFD computations.

The aim of the JIP is to narrow the gap between model tests and simulations to improve the final full scale performance prediction. In the JIP the CFD will not be adapted towards model scale results using transition modelling, but model tests will be adapted towards the CFD predictions by tripping of the boundary layer using turbulators. This would significantly decrease the uncertainty of both the CFD and the model tests.

This JIP will make recommendations towards the ITTC such that the developed scale corrections and corresponding extrapolation methodology would become widely used, replacing the current ITTC scale corrections.

1.2 Background

1.2.1 Propeller series

The F-series JIP was finished recently. The F-series is a series of 150 fixed pitch propellers (FPP) which were manufactured and tested on model scale for the open water performance. Figure 1-1 is a photo of the series on the wall of the towing tank in Wageningen.

Traditionally, the B-series were used. The performance data is used in the early design stages of ships and propellers. The efficiency of B-series propellers is good, but their design does not particularly consider other aspects of propeller performance -like hull pressures, noise and cavitation erosion- that have become more and more important over the years. It is important that in the early stages of design, ship and propeller designers have reliable performance data available that provide realistic and competitive efficiency levels balanced against certain cavitation, noise, and vibration requirements. The Wageningen F-series was developed for that purpose for fixed pitch propellers (FPP). Prior to that, the Wageningen CD-series were developed for controllable pitch propellers (CPP).

Figure 1-1: Wageningen F-series propellers on the wall above the Deep-water Towing Tank (DT)

1.2.2 Scale effects

For both the F-series and the CD-series a set of high-quality model scale data was obtained. Nonetheless, propellers are not operated at model scale, but at full scale. 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. This is a well-known model scale artefact which influences model test results.

The current model scale tests suffer from these scale effects as paint tests have shown the large amount of laminar flow, flow transition and flow separation on model scale. This makes model tests prone to inconsistency and feeds uncertainty to the full-scale prediction, since the currently applied scale corrections from the ITTC do not take this into account.

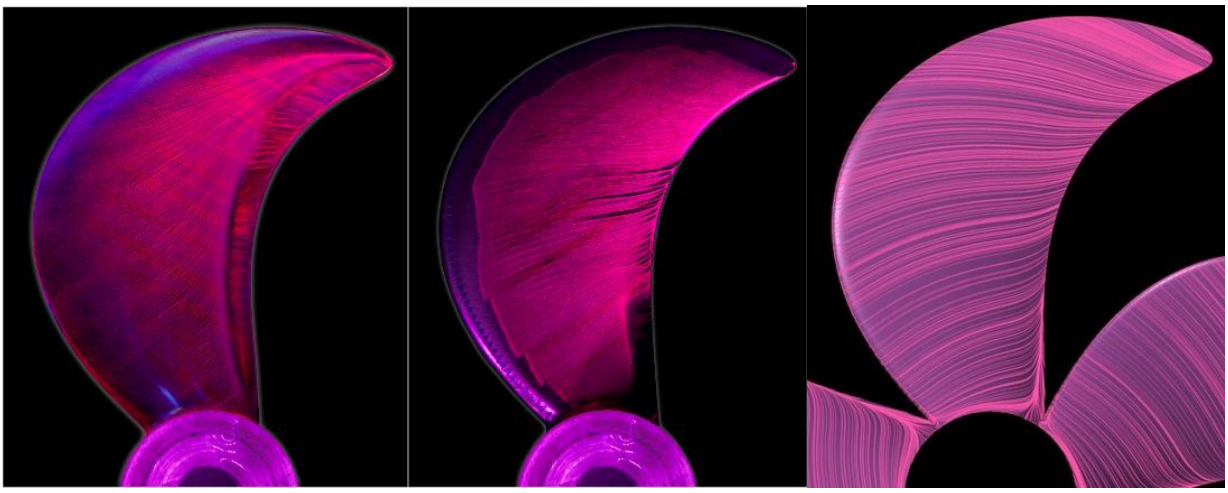

Figure 1-2: Paint test showing laminar flow on a smooth blade (left), paint test showing turbulent flow using turbulators (middle) and RANS computation with turbulent flow.

Furthermore, literature and investigations on the CD-series show that the traditional ITTC corrections often do not even reflect the real model scale effects such that the predicted full-scale performance would also not reflect reality. In addition, due to tight design margins and harsh competition, it is often not possible anymore in modern propeller to make designs that would perform well both in model scale and full scale. Especially the lower blade area ratio (BAR) propellers deviate from the ITTC corrections.

Hasuike et al. from Nakashima (2017) stressed that a full-scale propeller has less flow separation in comparison with model scale. Some of propeller designs may show high efficiency in full scale although the efficiency in model scale is deteriorated by flow separation. This raises the importance of improved methods for the prediction of high efficiency propeller designs in full scale.

Also, Bulten and Stoltenkamp from Wartsila (2017) emphasize that with the tight design margins of modern propulsion units, it is often not possible anymore to make designs which can perform well in both model scale experiments and actual full-scale operation. They say that it should be obvious that the design focus should be on the full-scale operation.

Lücke and Streckwall from HSVA (2017) concluded that paints tests showed an unexpected high amount of laminar flow. They propose to separate the scalable and non-scalable parts of the propulsion characteristics with more care. They also studied the flow regime on the propeller in behind ship situation versus open water. They observed a small difference, which seems to be related mainly to variation of angle of attack rather than to the turbulence intensity of the inflow. This was also observed by Hasuike et al. from Nakashima (2017), who stressed that flow characteristics in model scale, both during open water tests and propulsion tests, were still mainly laminar, including laminar flow separation.

Hasuike et al. from Nakashima (2017) also conclude that full scale extrapolation from model scale by model test should be improved. A combination of full-scale RANS simulations and a ‘2POT method’ for extrapolation showed good capability to estimate the propulsive efficiency with higher accuracy.

1.2.3 Boundary layer tripping

If the flow on model scale would be turbulent, the characteristics of the flow would be alike full scale, which would potentially improve the accuracy of the powering predictions. To achieve this, model tests were done at MARIN such that the boundary layer would be tripped towards a turbulent flow.

Research at MARIN showed that turbulators on the leading edge of the model scale propellers are very efficient in tripping the boundary layer, see Figure 1-2 and Figure 1-3.

Figure 1-3: Two propellers with wishbone turbulators on the leading edge

The geometry of the turbulators is wish-bone alike, like the zigzag strips which are widely used in the model tests for the aviation industry. The traditional sand roughness was found to be less consistent and less effective. Inspired by the zigzag turbulator, MARIN developed the wishbone turbulator. Geometry, size, height, density, orientation and position were varied upon satisfaction. Finally, an effective, efficient, repeatable and controllable method was found to trip the laminar boundary layer as close as possible to the leading edge, without disturbing the shape of the propeller. The wishbone turbulator geometry is the basis of the logo of this new JIP.

The turbulent flow on the propellers at model scale reduces the scale effect uncertainties and captures the full-scale situation accurately. The corresponding uncertainty of the final prediction and the standard deviation to full scale trials would greatly improve. More details are provided by Schuiling et al. (2024) and Kerkvliet et al. (2024).

For an internal R&D project, MARIN revisited 13 propellers from the 4-bladed F-series by applying turbulators to each of them. The data was analysed with respect to the series-polynomial that was developed during the F-series JIP. As shown in Figure 1-4 the efficiency clearly changes, especially for the low blade area ratio propellers. The effect on KT and KQ can also be considerable, especially for the low blade area ratio propellers with high pitch. Paint tests showed that laminar flow effects play a very dominant role.

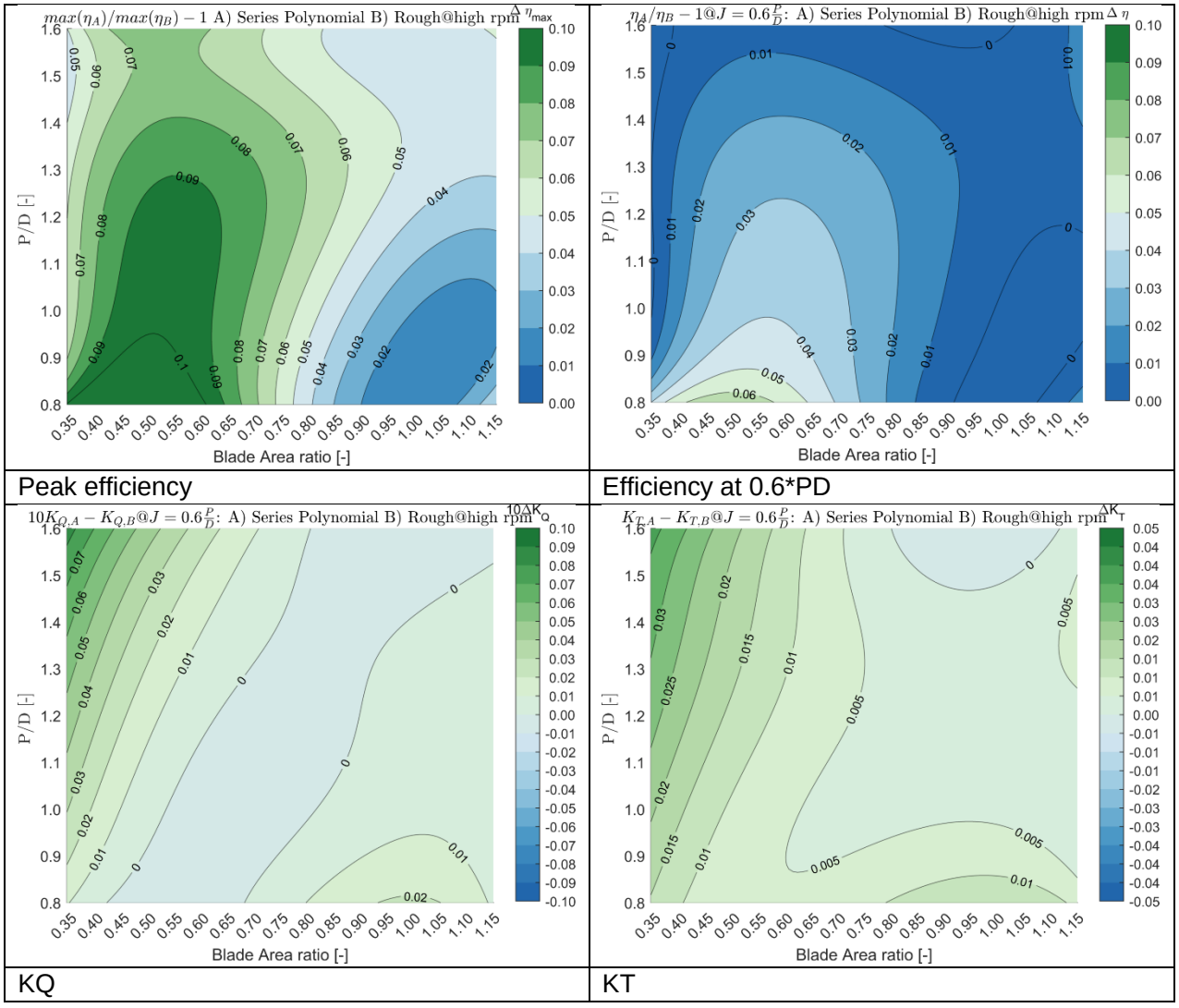

Figure 1-4: Comparison of performance of the F4-series with clean blades (series polynomial) and rough (using turbulators to trip the flow) blades

1.2.4 RANS computations

However, the efficiency of the model scale propeller with turbulent flow is much less compared to the same propeller with laminar flow. A turbulent boundary layer dissipates more energy. Nonetheless, the effect on performance as function of RPM (Re) becomes consistent because the boundary layer regime stays turbulent, without transition effects. Extrapolation towards full scale would then only involve a Reynolds scaling effect on friction and lift, while the flow characteristics remain similar.

Investigations have shown that the results of standard RANS computations and turbulated model tests are very close together, as shown in Figure 1-5. Already in 2015, Rijpkema et al. showed that RANS computed with turbulent flow and model tests with a tripped boundary layer (using sand-roughness in that time) provide a good match.

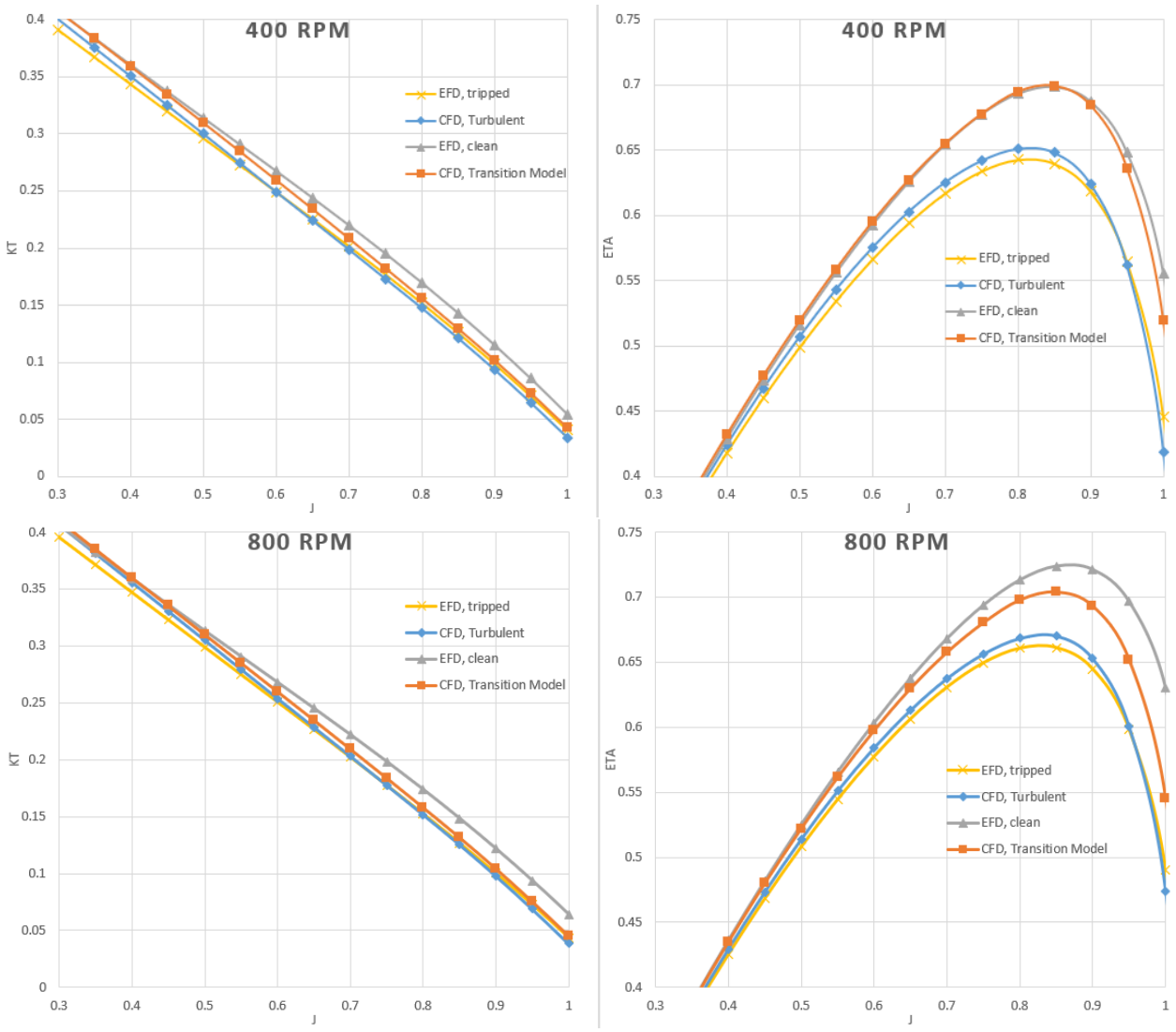

Figure 1-5: Comparison of RANS computations and model scale experiments

The Reynolds scale effects for a fully turbulent flow can be computed with standard RANS computations, see Figure 1-6. The efficiency and KT increase with increasing Reynolds number. KQ stays nearly constant; the increasing lift component in KQ compensates the decreasing friction component with increasing Reynolds number.

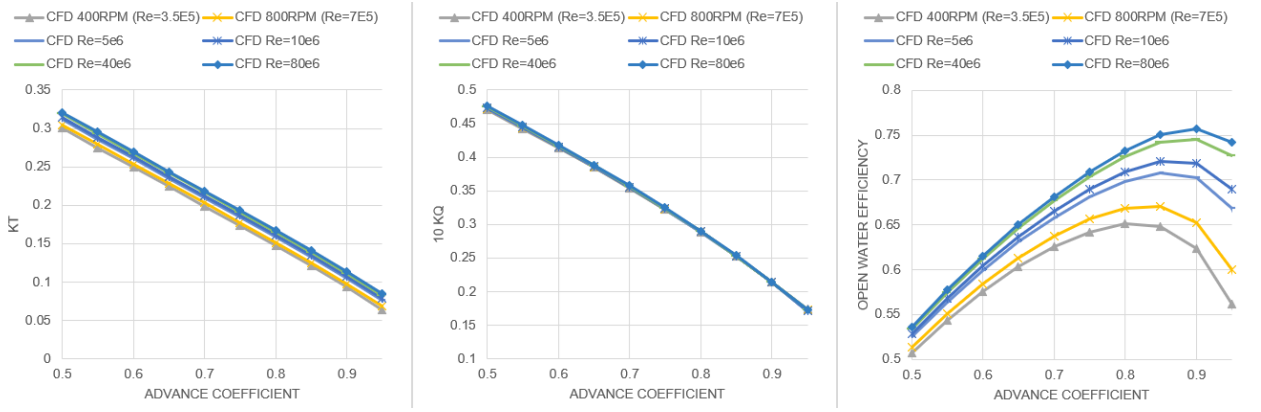

Figure 1-6: Reynolds variation using CFD with turbulent flow

Slot (2017) also investigated the scale effect using RANS. He explained that the computed scale effect can be split into a pressure (lift) and frictional part, as shown in Figure 1-7.

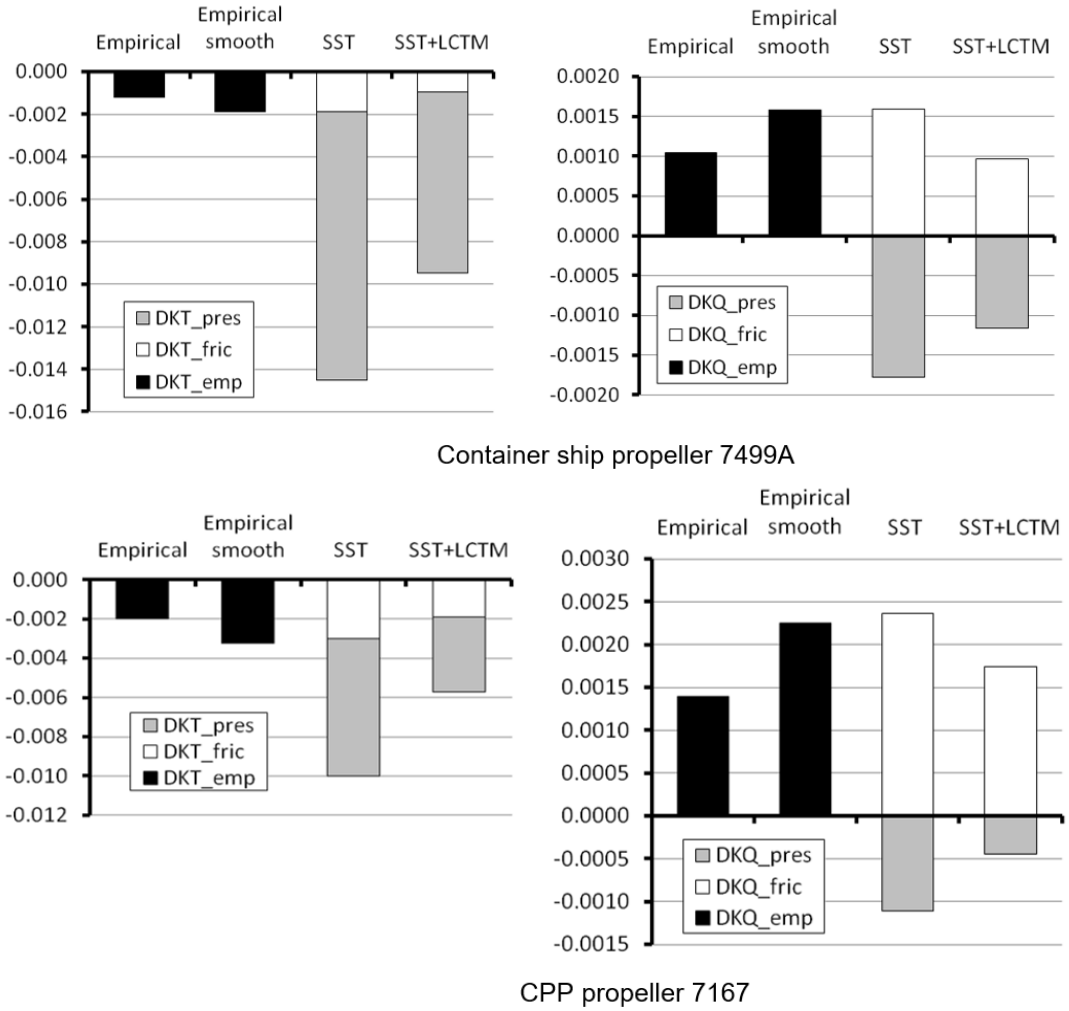

Figure 1-7: Scale effect corrections as reported by Slot (2017)

The frictional component is similar in magnitude to the scale corrections. However, a significant part of the computed scale effects is due to the changes in the pressure forces, which clearly indicates that the lift forces on the blades change. This phenomenon is not incorporated in the current scale corrections. This leads to relatively large differences in full scale prediction compared to the RANS results. RANS based scale corrections would substantially increase the correction on KT, while it decreases the correction on KQ, compared to the empirical corrections.

1.2.5 Scale effect corrections

There have been numerous publications on improved scale effect corrections. Some use a strip method. However, this method has still primarily effect on KQ, while the main scale effect is visible in KT, see Figure 1-5. Strip methods neglect 3D effects as well.

Whereas Slot (2017) focussed on transition modelling to predict the scale effects with RANS, this JIP would focus on turbulent flow only. Although RANS computations involving laminar flow and flow transition are possible as well, they require a lot of tuning and experience and come with large uncertainty. RANS computations for turbulent flow are standard, do not require tuning and are consistent and reliable.

In addition, Slot (2017) also stressed that surface roughness of the full-scale propeller is currently not considered in the extrapolation methods. This would likely to lead to a sizable over-prediction of the friction contribution to the scale effects. This over-prediction may have a considerable effect on scale effects for KQ. Using the standard RANS methods, it is possible to incorporate the full-scale roughness effects in the flow solution.

MARIN is confident that reliable scale corrections can be appropriately computed: standard RANS computations have become mature, reliable and robust, suited to this task.

1.2.6 Literature

The background of the Tripping JIP can be found in the following two papers which are available on the Tripping JIP website: Tripping | MARIN.

Schuiling, B., Kerkvliet, M. & Rijpkema, D. 2024. **An Experimental Study on Flow Visualisation and Passive Control of Model Propeller Boundary Layers**. Eighth International Symposium on Marine Propulsors SMP'24, Berlin, Germany, March 2024.

Kerkvliet, M., Baltazar, J., Schuiling, B. & Ec¸a, L. 2024. **A Numerical Study on Model Propeller Performance Prediction Including Transitional and Passively Controlled Boundary Layer Considerations.** Eighth International Symposium on Marine Propulsors SMP'24, Berlin, Germany, March 2024.

Further, the following references are mentioned in this document:

Douwe Rijpkema, Joao Baltazar, Jose Falcao de Campos. 2015. Maritime Research Institute Netherlands (MARIN) & Instituto Superior Tecnico (IST). **Viscous flow simulations of propellers in different Reynolds number regimes**. Fourth International Symposium on Marine Propulsors, SMP'15, Austin, Texas, USA, 31 May - 4 June 2015

Thomas Lücke, Heinrich Streckwall. 2017. Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA). **Experience with Small Blade Area Propeller Performance**. Fifth International Symposium on Marine Propulsors SMP'17, Espoo, Finland, June 2017

Nobuhiro Hasuike, Masafumi Okazaki, Akinori Okazaki and Keita Fujiyama. 2017. Nakashima Propeller Co., Ltd. & Software Cradle Co., Ltd.. **Scale effects of marine propellers in POT and self propulsion test conditions**. Fifth International Symposium on Marine Propulsors SMP'17, Espoo, Finland, June 2017

Norbert Bulten, Petra Stoltenkamp. 2017. Wärtsilä Netherlands. **Full scale CFD: the end of the Froude-Reynolds battle**. Fifth International Symposium on Marine Propulsion SMP'17, Espoo, Finland, June 2017

Jesse Slot. 2017. Maritime Research Institute Netherlands (MARIN). **REVIEW OF EMPIRICAL SCALE CORRECTIONS FOR PROPELLERS**. ARD report 70033-9-RD.

1.3 Scope of work

The scope of the project is divided into four work packages, which are elaborated in Chapter 2 and summarized below:

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 65 model tests at 4 different Reynolds numbers and 23 additional propeller models are planned.
2. Open water RANS computations – study the performance at a large range of Reynolds number, up to full scale with varying surface roughness. About 65 propellers will be extensively computed. A RANS workshop will be organized first to set the CFD capabilities.
3. Develop a proposal for 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. The new scaling corrections 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 new full scale polynomials – 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.

1.4 JIP Participation

The project is of interest to many organisations in the maritime industry worldwide, like other research institutes, propeller manufacturers, shipyards, ship owners, ship operators, classification societies, design offices and universities. The results are expected to be widely used for many years to come.

The project is too large to be financed by one, or a small group of organisations. Hence, this proposal is set-up as a Joint Industry Project (JIP) with many participants.

- For propeller designers and manufacturers, the results of this project would lead to less surprises during model tests and better control of the propeller design on both model scale and full scale. The proposed approach would allow to direct the design focus primarily to full scale, being less limited by model scale limitations.

- For yards and operators this project would result in more reliable full-scale predictions and improved propeller designs. Due to the higher uncertainty of model tests without tripping, the contractual risks will be mitigated when applying tripping.

- For R&D, this project would provide benchmark data for RANS computations on propellers for reference and quality checks.

- For other research institutes and participants with their own model test facilities this project would improve the extrapolation methodology and would give more reliable predictions.

Overall, it is envisaged that this JIP will made a significant step towards a new and widely accepted extrapolation method, which makes the differences between model institutes less prominent. A broad support on this would also serve as incentive for the ITTC to adapt their guidelines in due course.

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 in the Vessel Operator Forum (www.vesseloperatorforum.com).

The participants will have access to the project results, software and other information through the confidential project website. The results will be confidential for three years after completion. Publication of any results will be communicated to all participants. Upon publication of any results, all participants will be mentioned.

A JIP enables a large-scale research project, while sharing experiences and expertise in co-operation for common understanding and industry standards. Typically, a JIP project bridges the gap between basic R&D activities and full application in commercial projects. The activities are typical pre-competitive co-operation. Therefore, part of the costs is supported by subsidies from the Dutch government.

The advantages for all participants are to participate in large scale R&D with leverage on costs. All participants could be actively involved in the definition of the final scope of work and learn from the experiences of other participants. During the meetings, networking is encouraged to strengthen relations, connect with others and profile the companies.

2 WORK PACKAGES

This JIP will be divided into four work packages, which are discussed in the following sections.

2.1 WP1: Open-water model-tests with turbulators

New open-water model-tests will be performed with turbulators to trip the flow towards a turbulent boundary layer on model scale to have the flow characteristics representative to the full-scale flow regime.

2.1.1 Propeller selection

To build up knowledge over a range of blade number, blade area ratio and pitch, selected F-series, FC-series and the C-series (design pitch only) will be retested with turbulators. The focus is on the open water performance of the propellers in the first quadrant until KQ = 0.

The F-series consists of 150 propeller models. However, within the scope of this project subset of 13 propellers per blade number is offered for model tests. During the FC-series it was found that 8 propellers per blade number would capture part of the design space already quite accurate. It is expected that 13 propellers per blade number would be required to cover the complete range of blade area ratio and pitch accurately. As an example for the 5-bladed F-series propellers, the table below shows the selection of propellers. The shaded cells are the produced FC-series propellers, while the FC denotes the 3 selected FC-series for the Tripping JIP. The x-markers represent the selection of propellers for the Tripping JIP in the area in which high accuracy is required, while the o-markers represent propellers as selected for the Tripping JIP in the area for which less accuracy is required. The exact selection of the o-marked propellers will be done after more careful investigation.

Selection of the 13 Fseries propeller Z = 5		Pitch					
		0.6	0.8	1.0	1.2	1.4	1.6
BAR	0.40	x		x		x	o
	0.53		x FC		x		
	0.69	x		x FC		x FC	
	0.91				o		
	1.20	o		o			o

The table below provides the selection of propellers for the C-series. Spindle torque measurements will be done on the C-series propellers. The current scope will only consider the C-series in design pitch.

Selection of the 8 C-series propeller (design pitch only) Z = 4		Design pitch			
		0.8	1	1.2	1.4
BAR	0.40	x	x		x
	0.55		x	x	
	0.70	x		x	x

The C-series geometry can be openly used for the Tripping JIP. Data from the C-series JIP will not be shared in the Tripping JIP. New results generated within the Tripping JIP become available to all participants of the Tripping JIP.

Two B-series propeller are revisited. Due to the constant and simple design they are interesting in the study into scale corrections. Moreover, the B-series are still very relevant for the industry. The existing propeller models are not suited anymore for the current quality requirements. Therefore, an existing new B4-70 (PD = 1.0) propeller will be used, and a new B4-40 (PD = 0.8) propeller will be manufactured. Initially, only two B-series propellers are considered within the Tripping JIP to suppress the costs. These B-series propellers are intended as check and support for the data from the F-series.

One F-series alike propeller will be considered: S7800 is similar to the F4-40 PD = 0.8. A geo-sim study will be performed on S7800 to study the influence of propeller diameter on model scale. The choice and the corresponding smaller diameter will be agreed upon in the early stage of the project.

Four public propellers are proposed to be considered as well, among which at least the Potsdam propeller P1790 as used within the ITTC benchmark. The final choice for the other three propellers will be made in an early stage of the project.

In addition, participants are encouraged to bring in their own propeller design to be used in this study. In the budget there is room for 5 propellers. Preferably, the geometry is to be made openly available within the Tripping JIP.

In conclusion: the table below shows the intended scope of model tests:

Geometry restricted and results dimensionless[A]	Geometry and results open	Geometry and results open
Existing series propellers	*Existing series propellers*	*Other propellers*
F4: 13 propellers F5: 13 propellers F6: 13 propellers	C4-40 (design pitch): 3 propellers C4-55 (design pitch): 2 propellers C4-70 (design pitch): 3 propellers	5 propellers from participants, to be selected from existing stock propellers[B]
FC5: 3 propellers	B4-70, PD = 1.0 (already available) B4-40, PD = 0.8 (new to be made)	3 existing MARIN propellers
		4 public propellers, to be delivered by other institutes
		1 geo-sim propeller
42 tests	***10 tests, 1 propeller models***	***13 tests, 1 propeller model***
Total of 65 tests at 4 different rotation rates and 2 propeller models to be manufactured.		

A: only for participants of the Tripping JIP that were not part of the F-series and/or FC-series.
B: geometry preferably to be made openly available, but not necessarily.

2.1.2 Rotation rates

For a good understanding of the scale effects, the propeller performance over a range of rotation rates is required for more reliable performance predictions, ranging from very low rotation rates during low speed in behind testing towards the higher rotation rates as used during a propeller open water test. Hence 4 rotation rates are to be tested for each propeller model. The automated quasi steady open water (QSO) method will be used, requiring only one run for each rotation rate, as was used for the F-series and CD-series as well.

2.1.3 Ducted propellers

Ducted propellers are not part of the basis scope of work. These are more challenging in both model tests with turbulators and RANS computations. Therefore, the KA-series and D-series are left outside the basis scope of work. Nonetheless, it is expected that tripping will be a good solution to mitigate the even stronger scale effects on ducted propellers. Ducted propellers may be considered in additional work, as shown in Section 2.5.

2.1.4 MARIN facility

The open water tests will be conducted at MARIN in the Deep Water Towing Tank (DT) which measures 250 m by 10.5 m by 5.5 m in length, width and depth respectively. The new open water setup as developed for the F-series project will be used.

Figure 2-1: Deep Water Towing Tank and F-series-developed open water setup

2.1.5 Turbulators

The turbulators are automatically designed and oriented for each propeller and plotted in a sticker for easy and consistent application. Turbulators are applied on both sides of the propeller, near the leading edge. Appropriate corrections for the resistance of the turbulators itself will be applied on the results from the model tests.

2.2 WP2: RANS computations

To study the performance of each propeller at a large range of Reynolds number, up to full scale, RANS computations will be performed. The propellers that will be model tested, will also be subjected to extensive RANS computations at different Reynolds number and different full-scale roughness.

The geometry will be modelled exactly like the model test situation, including the hub and stream pieces. This would also allow to extract the correct corrections for the drag of the hub and stream pieces to be applied on the results of the model tests, instead of using the empirical formulations. The open geometries will be shared in suitable format to the JIP participants to be used in their own RANS computations.

The RANS computations will be done at a range of Reynolds number, varying from low rotation rate as used during propulsion tests towards large diameter propellers on full scale. Not only the Reynolds number will be a variable in the computations, but also the roughness will be varied for the full-scale Reynolds numbers.

It is estimated that 6 Reynolds numbers and 4 different roughnesses will be computed for each propeller, totalling 10 computations per propeller.

MARIN will use Cadence fidelity grid generation to create high quality grids –a surface to volume method with structured-like resolution around the blade edges– with a consistent and scripted approach for all propellers. This approach combines the best from Numeca's Hexpress, Pointwise and GridPro. The ReFRESCO solver (www.refresco.org) will be used. Standardized automated pre- and postprocessing will be used for consistency.

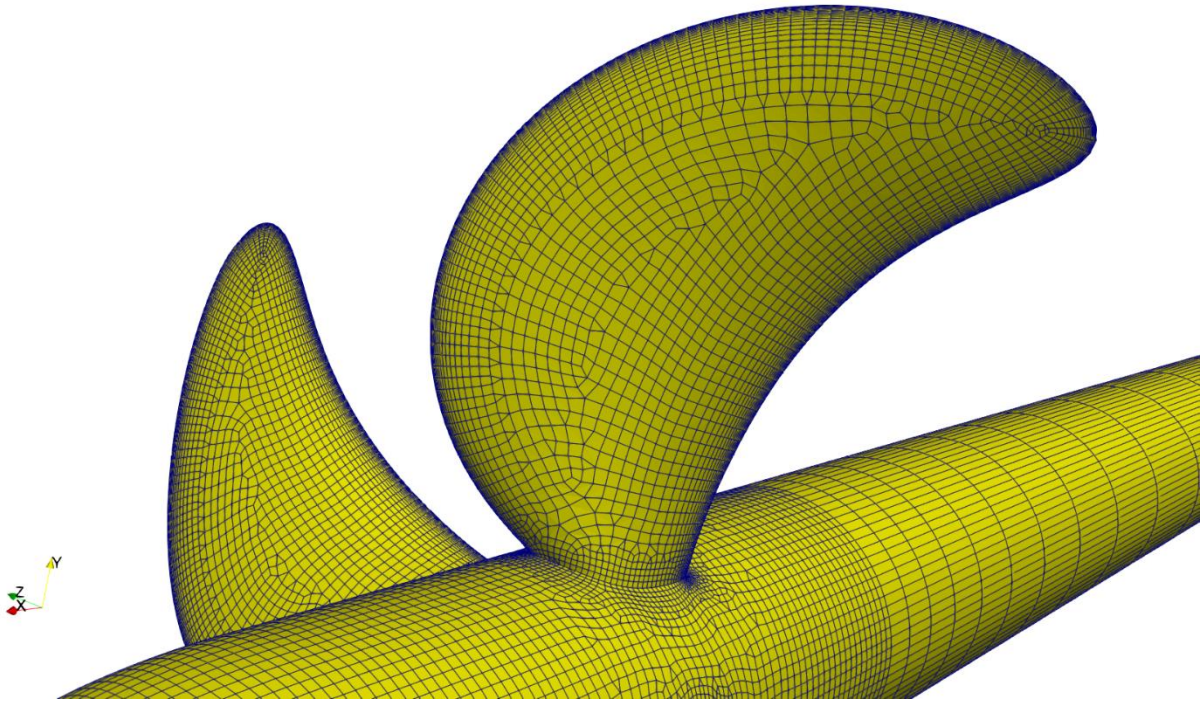

Figure 2-2: Example of Cadence fidelity surface grid

2.2.1 RANS workshop for original participants

Before starting all computations, a workshop will be organized to discuss the procedure and approach for RANS on propellers. One of the propellers will be selected as reference. MARIN will share the CFD-ready geometry in suitable format.

The original participants will be encouraged to perform their own computations with their grid generation and solver on the selected propeller. MARIN will extensively compute this propeller for a larger range of Reynolds and surface roughness.

In the workshop the results will be discussed, and were necessary, adjustments will be made to set the approach for all propellers.

In addition, before starting up the bulk of RANS computations, a selected set of propellers will be subjected to an extensive mesh dependency study, after which it will be decided what mesh will be used for all propellers. The process will be automated as much as possible for consistency.

2.3 WP3: Development of new propeller scale corrections and correlation allowance

2.3.1 Scale corrections

The results of the RANS computations and model tests will not only serve to provide a benchmark, but are also primarily intended for the development of:

1. New propeller scale corrections to be used in model tests. The new propeller scale corrections would serve to replace the current scale corrections from the ITTC.

2. Propeller correlation allowances for RANS computations to be used with numerical powering predictions.

Both the scale corrections and correlation allowances combine the results of the model tests and the RANS computations. For the model tests the focus is primarily on scale effects, while on the correlation allowance the focus is also on the offset between RANS and model tests results. Both the scale corrections and correlation allowances would probably be a polynomial as function of at least blade number, pitch, blade area, J-value, Reynolds at model scale, Reynolds at full scale and full-scale surface roughness. Depending on the results, corrections may be made for chord length distribution and pitch unloading.

The scale correction methodology will serve as a benchmark for future projects. It is envisioned that it will be used as a new standard for propeller scale effects, but it would also serve as quality check on custom computed scale corrections.

The scale corrections that will be developed are intended for use together with model tests with tripped boundary layer using turbulators. A new correction method for non-tripped boundary layer using clean and polished propellers is not the intended approach for it will not serve the goal of reducing the uncertainties of both RANS computations (using transition modelling) and model tests (with transition effects).

2.3.2 A proposal for a new extrapolation method

To use the new scale corrections, a new extrapolation method is envisioned as well. The open water diagram of a propeller (with turbulators to trip the flow) needs to be measured for at least three rotation rates to make a small polynomial as function of J-value and rotation rate. Doing so, it is possible to analyse the propulsive coefficients at the correct rotation rate. Each ship speed of the propulsion test will get a unique and representative scale correction. Effectively, this extrapolation method would be an improvement to the so-called 2-POT method. The hydrodynamic coefficients are determined with open water data at the correct Reynolds number, while the efficiency of the propeller is based on open water measurements at higher Reynolds number. Despite the turbulence tripping with turbulators, there still may be some additional flow separation due to the lower Reynolds number, which is then corrected for using the measured open water data at higher rotation rate. A proposal for these updated model test procedures and extrapolation methodology will be worked out in this work package.

2.3.3 Behind test

To support the developments, also a propulsion test will be performed at MARIN on an openly available ship model. Resistance tests and propulsion tests (with and without tripping) will be done and analysed. The extrapolation of the results will be done using the standard MARIN method and the envisioned tripping extrapolation method.

2.3.4 Reference tests by other institutes

Other governmental supported model test institutes are invited to collaborate to the Tripping JIP by performing additional tests or reference tests, for which they may supply a quotation to the Participant Steering Group, with total costs up to the amount of the participation fee. As such, institutes will join participating to the Tripping JIP ‘in-kind’. For those joining after May 2024, management costs of 5 kE should be accounted for.

2.4 WP4: Development of full-scale Wageningen series

Based on the results from the model tests and the RANS computations, the polynomials of the F-series and C-series will be created from the new model tests based on tripping. The polynomial will become not only a function of blade number, pitch, blade area and J-value, but also of Reynolds at model scale, Reynolds at full scale and full-scale surface roughness.

The full-scale numerical F-series (4 to 6 blades) and C-series (design pitch) polynomial will be implemented in a software package for propeller design. The polynomial will remain for exclusive use by the JIP participants for three years after the finishing of this project.

The new full scale polynomial for the F-series (4 to 6 blades) will only be delivered to all Participants who were also a member of the F-series JIP. The new full scale polynomial for the C-series (design pitch) will become available to all Tripping JIP participants.

2.5 Future possibilities for additional work

The Tripping JIP provides opportunities for additional work. However, the current budget does not allow for this. Ideally, additional work is to be funded by the budget from new participants to the Tripping JIP. Possibilities for additional work could be, but would not be limited to:

- Consideration of additional propellers for the F-series, FC-series, C-series or the B-series. For instance, the three and seven bladed F-series may be considered, or the five bladed C-series.
- Model tests and computations for off-design pitch settings for the C-series.
- Consideration of ducted propellers from the Ka-series and D-series. From CFD comparisons, ducted propellers are known to face additional scale effects compared to open propellers. Consideration of the D-series would highly add value to the Tripping JIP. In the absence of any experience concerning this, basic investigations to get the tripping on the duct correct should be included.
- Additional paint tests of specific propellers to visualize the flow phenomena as function of J-value and Reynolds number, on either or both clean blades and blades with turbulators.
- Investigation on the effect of the thickness over chord ratio on scale effects. Ice-class propellers in particular seem to face strong scale effects.
- Consideration of the power regeneration area in the first and third quadrant.
- Additional propulsion tests using turbulators on (public) reference ships to study the behaviour of the new scale corrections and extrapolation method.

A choice for additional work will always be made in mutual agreement by the Participant Steering Group during a JIP meeting. Note that contingency and the double MARIN contribution will be reconsidered first upon the participation of new participants.

3 DELIVERABLES

The following will be the deliverables of the JIP:

1. Full results of the tripped model tests and RANS computations on the C-series and the other public propellers.
2. Dimensionless results in terms of Reynolds scaling of the tripped model tests and RANS computations for the F-series and FC-series.
3. Generic propeller scale correction polynomial.
4. Generic RANS correlation allowance polynomial.
5. A proposal for updated model test procedure and extrapolation method.
6. Results of reference tests and behind tests (including extrapolation towards full scale predictions), performed at different model test institutes.
7. Full scale numerical C4-series polynomial (design pitch only).
8. Software package for propeller design using the full-scale numerical C4-series (design pitch only) polynomial.

In addition, the full scale polynomial for the F-series (4 to 6 blades) will be delivered to all Participants who were also a member of the F-series JIP.

4 FINANCE

4.1 Budget

The estimated costs of the described scope of work are specified in the table below, also considering the inflation over the years:

	Description	**Costs (k€)**
WP1	Manufacturing of 2 propeller models	20
WP1	65 propeller model tests with turbulators	205
WP2	RANS workshop [A]	110
WP2	65 propellers computed by RANS	160
WP3	A proposal for a new extrapolation method	45
WP3	Behind tests and reference tests by other institutes	255
WP4	Development of full-scale series, including software package	60
	Project management, meetings and start-up costs	85
	Contingency	40
Total		**980**

[A] Participation to the RANS workshop by doing computations will be awarded for 6 k€ for original participants. This budget is included in the costs of the workshop. New participants cannot participate like this anymore.

The above budget includes the in-kind contributions of five other model test institutes.

Contingency was significantly reduced with respect to the previous versions of the project plan. This risk is considered acceptable in view of the expectation for new participants. Nonetheless, before continuing with additional work (see section 2.5), contingency will be reconsidered.

4.2 Funding

The funding of the described scope of work is specified based on the current number of participants:

	Description	**Funding (k€)**
	MARIN contribution [B]	90
	Subsidy Dutch government (TKI)	170
	Participant contribution (16 participants x 3 years x 15 k€)	720
Total		**980**

[B] *To initialize the proposed scope, MARIN will contribute double until new participants will join*

The participant fee is set as 45 k€ (15 k€ per year, for three years).

In case the total funding becomes higher than budgeted due to the participation of more than 17[B] participants, additional work will be agreed with the participants in an expansion of the scope of work.

The project will be carried out by MARIN, unless specified otherwise. Attendance to the meetings, computational checks or testing of the software, are to be carried by the participants at their own costs.

5 PLANNING

The project will be carried out by MARIN. Participants are expected to actively contribute to the project meetings. Two meetings will be arranged each year.

The project is defined as a 3-year project, although it is intended to execute the basis scope of the project earlier. Due to potential additional work, the project would probably exceed the timeline of 3 years.

On 30 November 2023 at the VOF in Busan, South Korea, the first version of the proposal was pitched. The VOF is the Vessel Operator Forum under which the Tripping JIP is hosted: https://www.vesseloperatorforum.com/.

The first work group meeting was organized during The Blue Forum, April 2024 in Venezia, Italy, with 11 participants. The scope of work was adapted, based on which Annex A changed from version 1.4 to version 2.0.

The second work group meeting was held online in May 2024, with 16 participants, including 5 model test institutes. The scope of work was adapted, based on which Annex A changed from version 2.0 to version 2.1.

The following table provides the intended timeline for each work package. The RANS workshop will probably be organized at MARIN in Wageningen in a separate meeting.

		2024				2025				2026			
WP	Description	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Start up and definitions												
WP1	Model tests with turbulators												
WP2	RANS workshop												
WP2	RANS computations												
WP3	Propulsion tests, including analysis												
WP3	Reference testing												
WP3	Development of scale correction polynomials												
WP3	A proposal for a new extrapolation method												
WP4	Development of full-scale series and software tool												

ANNEX B

Participation fees (excluding VAT)

The participation fee for all participating organizations is 45,000.-.

Terms of payment

- First payment: 1/3 of the participation fee, to be invoiced upon signing of the agreement.
- Second payment: 1/3 of the participation fee, to be invoiced in November 2025
- Final payment: 1/3 of the participation fee, to be in invoiced upon delivery of the results and acceptance by the PSG.

Payments shall be due and payable sixty (60) days after receipt of invoice by Participant.

ANNEX C

Deviations to the Agreement