

## TERMS OF REFERENCE (ToR) FOR AN ANALYSIS OF THE IMPACT OF BIOFOULING ON THE HYDRODYNAMIC RESISTANCE AND ENERGY EFFICIENCY OF SHIPS

### 1 SCOPE OF WORK

1.1 The required work for this Assignment is to carry out an analysis of:

- (a) the effect of biofouling (on hull, internal sea water system, propeller and niche areas) on energy efficiency of ships;
- (b) the effect of biofouling mitigating measures (proactive and reactive) on resistance and energy efficiency of ships;
- (c) the additional greenhouse gas (GHG) emissions related to (a) and their potential abatement resulting from (b); and
- (d) any information gap(s) related to (a), (b), or (c).

1.2 The proactive and reactive mitigating measures referred to in (b) means current industry biofouling management practices, including (but not limited to) the use of antifouling coatings; use of marine growth preventive systems (MGPS) and technologies; propeller polishing; ship hull cleaning and grooming practices; and other cleaning practices for appendages and niche areas.

1.3 The main outcome of this exercise will be a technical report (the Report) containing the findings of the analysis.

### 2 BACKGROUND

2.1 This work is commissioned by the members of the [Global Industry Alliance \(GIA\)](#) for Marine Biosafety. The GIA for Marine Biosafety has been established under the GEF-UNDP-IMO [GloFouling Partnerships](#) as an alliance of leaders from the private sector representing maritime industries, who will work together and with the GloFouling Partnerships to support improved biofouling management and marine biosafety initiatives.

2.2 The GloFouling Partnerships Project Coordination Unit (PCU), based at the International Maritime Organization (IMO) Headquarters in London, United Kingdom, manages this Assignment.

### 3 PURPOSE

3.1 A great deal of research has been carried out in the past years, whether in the academic, scientific or industrial world, to assess the effect of biofouling on ship resistance, fuel efficiency and GHG emissions. It is important for the industry to fully understand this effect, but information on this research and its results is scattered, which makes it difficult to have an

accurate and updated understanding of the issue. In addition, different parameters and methods are used for quantification, which results in various values.

3.2 With this in mind, the GIA has agreed to commission work to collate and review existing information publicly available with a view to get higher clarity on:

- .1 the impact of biofouling in vessel hulls, apparatus and niche areas on fuel consumption and associated GHG emissions; and
- .2 the impact of biofouling proactive and reactive management measures (listed in paragraph 1.2) on fuel consumption and associated reduction of GHG emissions.

3.2 Higher clarity is particularly important given that biofouling management practices and technological solutions are key resources readily available for achieving part of the IMO GHG reduction targets that have been set out for the shipping industry by 2050. The IMO GHG strategy envisages, in particular, a reduction in carbon intensity of international shipping (to reduce CO<sub>2</sub> emissions per transport work, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008); and that total annual GHG emissions from international shipping should be reduced by at least 50% by 2050 compared to 2008.

#### **4 REPORT KEY ELEMENTS**

4.1 The expert will identify, and the report will describe the following:

Part I - Impact of biofouling on fuel consumption (fuel penalty):

- .1 various ship's hull and niche areas fouling conditions (type, location, variation in height and extent over a surface); their correlation with roughness levels and ship hydrodynamics, using standard fouling ratings/scale;
- .2 how ship design can reduce hull and niche areas fouling and influence fuel consumption;
- .3 synopsis and review of the different calculation methods currently used for estimating consequent increase in fuel consumption and GHG emissions due to biofouling; and
- .4 most accurate values or range of values (estimated or based on real data cases) for increase in fuel consumption and GHG emissions as a result of ship's hull and niche areas fouling.

Part II - Benefits of implementing biofouling management practices (gaining /maintaining energy efficiency to an optimum level):

- .1 synopsis and review of the different calculation methods currently used for estimating consequent decrease in fuel consumption and GHG emissions as a result of biofouling management measures listed in paragraph 1.2; and
- .2 most accurate values or range of values (estimated or based on real data cases) for decrease in fuel consumption and GHG emissions as a result of biofouling management measures.

Part III - Information gaps and areas where additional research is needed.

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## **5 REPORT CONTENT**

5.1 The report will contain the findings of the analysis carried out by the expert based on the literature survey and information collated and will document the key elements described in paragraph 4.1 above.

5.2 The report will also contain, as a minimum:

- .1 a brief review of current industry biofouling management practices listed in paragraph 1.2;
- .2 an economic cost-benefit analysis of biofouling management measures;
- .3 an environmental cost-benefit analysis of biofouling management measures;
- .4 recommendations on areas where additional research is needed;
- .5 a summary for industry and government decision-makers; and
- .6 list of references and sources of information.

5.3 The Table of Contents of the Report will be discussed and agreed between the expert and the PCU as work progresses. The expert is encouraged and expected to provide any additional suggestion(s) on the content and/or format of the Report that is deemed relevant in fulfilling the objectives of this Assignment.

## **6 MODUS OPERANDI**

6.1 The Consultant will be expected to take full responsibility for drafting of report. However, it is recommended that the Consultant shall seek expert advice on the different technical aspects included in the report.

6.2 While the Consultant should make his/her own arrangements to this effect, the GloFouling PCU will share the contact details of experts with relevant knowledge and/or experience that have confirmed their willingness to provide guidance during the development of the report.

## **7 DESIGN, FORMAT AND LANGUAGE**

7.1 The Report shall be drafted in English. To the extent possible, clear and plain language, tables and visuals (with obtained copyrights) must be used so it is easy to understand by a non-specialised audience. Where relevant, the use of summary tables is encouraged for providing reference information.

## **8 QUALITY CONTROL**

8.1 The Consultant shall define, as part of his proposal, what quality control process will be undertaken by the Consultant early in the development process of the Report to ensure that the final version is adequately designed and formatted to achieve its end purpose.

## **9 MILESTONES AND FINAL DELIVERABLE**

9.1 The Consultant shall achieve all seven Milestones and deliver the Final Draft of the Report (Final Deliverable) for the completion of this Assignment. Milestones and Final Deliverable are described hereunder:

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**Milestone 1 – Initial Meeting with PCU:** a meeting will be organised between the PCU and the Consultant to discuss the present ToR and best approaches for the completion of this Assignment, as well as any other relevant issues.

**Milestone 2 – Detailed Methodology and Work Plan:** Based on discussions with the GloFouling PCU for this Assignment during the **initial meeting**, the Consultant must provide a final methodology and work plan. This document must describe, in detail, the methodology (how the Consultant intends to approach the development of the Report) and work plan (based on actual calendar) to achieve the Requirements outlined above. This document must also reflect interactions with external contributors and with the PCU during the initial meeting and any further discussion after the meeting.

The PCU will review this document and provide comments to the Consultant within eight (8) working days after receiving the document.

**Milestone 3 – Presentation of Roadmap for Completion:** The Roadmap for completion will be presented by the Consultant to the PCU during a **2nd meeting**, no later than five (5) weeks after the Assignment award date. The meeting with the PCU will provide an opportunity to confirm direction, timelines and to discuss any issues the Consultant or the PCU may foresee. The Consultant will draft and submit to the PCU a short summary of discussions and decision points agreed during the meeting.

**Milestone 4 – Draft Zero with Preliminary Table of Contents/Outline:** The Consultant will provide a Draft Zero describing the general approach that will be taken to develop the Report, as well as its preliminary structure (preliminary Table of Contents with titles of sections and subsections indicated, a brief description of their contents, and how they link to requirements). To this effect, the Consultant shall coordinate **input from external experts** that have agreed to give advice to the development of the Report.

The PCU will coordinate the review and provide comments to the Consultant within ten (10) working days after receiving the document.

**Milestone 5 – Draft 1:** The Consultant must provide one electronic copy of the Draft 1 in Microsoft Word format. Draft 1 shall contain all sections of the Report including identification of illustrations, figures, case studies, diagrams and photos as needed and reflect work described in the Requirements of these ToR.

The Draft 1 must also consider and address any comments from the PCU and discussion outcomes received during and after meetings and communications between the PCU and the Consultant.

The PCU will coordinate the review and provide comments to the Consultant within ten (10) working days after receiving the Draft 1.

**Milestone 6 – 3rd (mid-project) Meeting:** A third meeting will be required following the PCU review of the Draft 1 to confirm direction, timelines and provide the opportunity to discuss any issues the Consultant or the PCU may foresee.

**Milestone 7 – Draft 2:** The Consultant must provide one electronic copy of the Report in Microsoft Word format. Draft 2 shall be a new version that incorporates/addresses all comments provided by the PCU on Draft 1; during the 3rd Meeting and during communications exchanges thereafter between the PCU and the Consultant.

The PCU will coordinate the review of Draft 2 and provide comments to the Consultant within fifteen (15) working days after receiving it.

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**Milestone 8 – Draft 3:** The Consultant will provide an almost finalised Draft, which shall incorporate and address all comments provided by the PCU during the completion of this Assignment. Draft 3 document will be circulated for an external peer review, with a view to secure comments from key external stakeholders.

The PCU will coordinate the peer review of Draft 3 and provide comments to the Consultant within fifteen (15) working days after receiving it.

**Deliverable – Final Draft:** The Final Draft must incorporate/address all comments provided by the PCU during the completion of this Assignment. The Final draft document will be considered as final and meeting all requirements of the present Assignment only at the satisfaction of the PCU.

9.2 The Consultant must provide the Final Draft electronically in Microsoft Word and Adobe Acrobat (PDF) formats.

## **10 REQUIREMENTS REGARDING MATERIAL PRODUCED**

10.1 Background material, information or other items used to develop the Report (such as notes, text, graphics, surveys, raw data, spreadsheets and records of discussions) shall be made available to the PCU.

10.2 All rights, including title, copyright and patent rights, in any work produced by the Consultant for this Assignment, shall be vested in IMO, which alone shall hold all rights of use. Where necessary, adequate authorisation shall be secured for any third-party materials included in the Report. For IMO's records the Consultant must provide separate supporting document (in any suitable format) outlining all the obtained copyrights (for non-commercial use), required credit and contact details of the source for each externally obtained visual (infographic, photo, graphic and similar).

## **11 COMMUNICATION**

11.1 In addition to the meetings mentioned in Section 8, regular feedback (every two weeks as feasible) through email, and/or video or phone calls must be maintained between the Consultant and the PCU during the completion of this Assignment.

## **12 WORK LOCATION**

12.1 All work will be performed from the Consultant's (or team of Consultants) place of business. All eventual meetings with the PCU (and any other relevant person or other IMO staff) and presentations will be conducted by conference call.

## **13 CONSULTANT (OR TEAM OF CONSULTANTS) PROFILE**

13.1 The Consultant should have direct experience with the development of information reports geared at the industry.

13.2 The Consultant should have good knowledge of ship hydrodynamics and the impact of biofouling on vessel performance and its fuel consumption. Solid understanding of the different approaches for preventing and managing biofouling is also essential. Familiarity with specific issues related to GHG emissions from shipping would be considered an asset.

13.3 The Consultant should also have solid drafting skills. Additionally, capacity to present recommendations and to coordinate a team of experts providing instructions in a practical and clear, understandable manner, is essential.

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**14 TENTATIVE ASSIGNMENT START AND END DATE**

Start: 22 March 2021

Delivery of Draft 3: 30 September 2021

End: 15 November 2021

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