INTEGRATED AIR AND MISSILE DEFENCE CENTRE OF EXCELLENCE

IFB FINCON 22-11

Study Report

"Analysis of the related Physical Phenomena and Aerodynamic Performance of Hypersonic Vehicle(s) and possible ways of exploiting those data in order to improve Surveillance Capabilities"

PART III

SPECIAL PROVISIONS & TECHNICAL SPECIFICATIONS (STATEMENT OF WORK)

December 2022

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PART III

NATO UNCLASSIFIED
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1. Statement of Work (SOW)

1.1 The current Statement of Work (SOW) covers the special provisions and technical specifications that shall be covered by the Contractor for the services requested.

2. General Specifications

2.1 The requested services refer to the creation and launch of four (4) deliverable products-services, as described below in a specific and defined timeframe:

2.1.1 Writing and delivery of a study report under the subject: “Analysis of the related Physical Phenomena and Aerodynamic Performance of Hypersonic Vehicle(s) and possible ways of exploiting those data in order to improve Surveillance Capabilities”.

2.1.2 Writing and delivery of an extended abstract of the abovementioned study/report and creation of the geometry models of the vehicles to be used for the simulation studies.

2.1.3 Writing and delivery of an extended abstract of the abovementioned study report and delivery of the produced simulation data, concerning “performance” and “phenomena” caused on these vehicles, from their flight at hypersonic speeds.

2.1.4 Publishing of the abovementioned study report into a scientific journal or magazine.

3. Technical Specifications - Description of Deliverables

3.1 Deliverable “1”: Study Report

3.1.1 Subject:

“*Analysis of the related Physical Phenomena and Aerodynamic Performance of Hypersonic Vehicle(s) and possible ways of exploiting those data in order to improve Surveillance Capabilities.*”

3.1.2 Pillars:

The Study Report should be divided into three (3) stages/chapters, which will provide: (a) the development of digital geometrical model(s) of typical hypersonic vehicle(s) using CAD (Computer-Aided Design) software, (b) the performance of flow simulations around the corresponding geometrical models in relevant flow conditions (using Computational Fluid Dynamics software), and the subsequent analysis of the related physical phenomena (including but not limited to flow disturbances, temperature rise, heat-flux, possible chemical reactions, plasma formation, etc.), and of the aerodynamic performance of the model(s) (Aerodynamic Lift, Drag, and Pitching Moment Coefficients, center of pressure, etc.), and (c) what are the possible ways of exploiting those data in order to improve the Alliance’s Air and Missile Defense Capabilities.

3.1.2.1 Stage/Chapter 1

At this stage, a reference should be made to the development of the digital geometrical model(s) to be used for the flow simulation(s). It is proposed that 2 different geometrical models should be developed for CFD simulations in different flight regimes: The first one should be resembling the ScramJet-powered Hypersonic Vehicle type, while the second one should be resembling the Hyper-Glide Vehicle (HGV) (wave-rider) type of hypersonic vehicles. The creation of the first type can be based on the North American X-15, the Lockheed SR-71 “Blackbird”, or similar geometries. The creation of the second type will either follow a standard scientific procedure for the design of such vehicles (wave-riders), or use of an existing geometry from the open literature. The simulations for the first vehicle model will take place at the Atmosphere Low Layer regime (30 - 60 km) at a Mach number in the order of 5+. The simulations of the second model will take place at the Atmosphere High Layer (60 - 100 Km) at a Mach number in the order of 10. Simulations may include different flight conditions (level of flight, Mach number, and so on), which will be determined during the initial phase of this study.

3.1.2.2 Stage/Chapter 2

At this stage, reference should be made to the Endo-Atmospheric physical phenomena caused by the flight of the afore-mentioned vehicles. Specifically, a report should be provided on how such vehicles behave in their flight [aerodynamic performance of the model(s)] and what phenomena are present (flow, thermal, radiation, including but not limited to flow disturbances, temperature rise, heat-flux, possible chemical reactions, plasma formation, etc.). This report should analyse and provide data, as far as possible, for the performance and the "phenomena" observed in flight at hypersonic speeds.

3.1.2.3 Stage/Chapter 3

At this stage, a summary of the above, and a reference to the existing or ongoing possibilities of detecting the phenomena mentioned above is desirable, with the main objective being the presentation of proposals for the improvement of the Alliance’s Air & Missile Defense Surveillance Capabilities (with emphasis in Detection and Tracking).

3.1.3 Structure: Typical scientific/research paper.

3.1.4 Length of paper: Not less than twenty thousand (20.000) words (including any bibliographical references).

3.1.5 Language: English Language.

3.1.6 Delivery Date: By 22 December 2023.

3.1.7 Authors: From the side of the IAMD COE, the point(s) of contact as officer(s) of primary responsibility designated by the Director and notified in writing by the Centre may be mentioned in the paper. This/these person(s) will collaborate with the scientific staff of the Turbomachines & Fluid Dynamics Laboratory of the Technical University of Crete in order to carry the project on until its completion.

3.1.8 A written acknowledgement in the paper will clearly state the following: "*This study was funded by the Integrated Air and Missile Defence Centre of Excellence (IAMD COE) and any intellectual property resulting from the work covered by this will be property of the IAMD COE. This paper reflects only the IAMD COE policies and its author(s)' positions and it is not intended to create any legal obligations nor does it reflect NATO's policies or positions, or engage NATO in anyway.*".

3.2 Deliverable "2": An extended abstract of the study report of par 3.1 with additional information on the geometrical models of the vehicles to be used for the simulation cases.

3.2.1 Structure: Typical.

3.2.2 Length of abstract: Not less than four thousand (4.000) words.

3.2.3 Language: English Language.

3.2.4 Delivery Date: By 29 April 2023.

3.2.5 Authors: As above par. 3.1.7.

3.2.6 A written acknowledgement will be stated in the abstract as above par. 3.1.8.

3.3 Deliverable "3": An interim report of the study report of par. 3.1 with additional information on the performance and physical phenomena that were retrieved during the simulation of the afore-mentioned geometrical models.

3.3.1 Structure: Typical.

3.3.2 Length of abstract: Not less than ten thousand (10.000) words.

3.3.3 Language: English Language.

3.3.4 Delivery Date: By 30 August 2023.

3.3.5 Authors: As above par. 3.1.7.

3.3.6 A written acknowledgement will be stated in the abstract as above par. 3.1.8.

3.4 Deliverable "4": Publication of study report (as deliverable "1"), properly prepared in scientific format, into a scientific journal or magazine.

3.4.1 The selection of the scientific journal or magazine will be under the choice of the competent/responsible professor of the Turbomachines & Fluid Dynamics Laboratory (TurboLab) of the School of Production Engineering & Management of the Technical University of Crete (TUC) (hereinafter "responsible professor"), following the respective approval by the IAMD COE (see below par. 4.5.2.1).

3.4.2 Delivery Date: No later than 01 July 2024.

3.4.3 All costs regarding the publishing will be covered by the Contractor.

3.5 All the required documentation (report, documents for compliance, etc.) shall be written - submitted in English and should be signed by the Contractor.

3.6 On the last Friday of each month, the responsible professor and his team should provide the IAMD COE with a presentation/update on the progress of the study and findings so far. These presentations/updates may be used by the IAMD COE for internal purposes. Additionally, a presentation/update of a similar level can be requested from the respective professor at any time, with five (5) working days' notice.

3.7 Any details required for the above requirements will be provided by the IAMD COE competent official in written.

4. **Project Management**

4.1 The research project will be undertaken and managed by the responsible professor.

4.2 The responsible professor shall:

4.2.1 Ensure that all his/her associates, who will be working with him/her on this project, understand, respect, and will abide by all conditions of this agreement and all related agreements.

4.2.2 Devote his best endeavor’s to achieve the technical goals meet the reporting/delivering schedule defined herein.

4.2.3 Not assign, discuss, or sub-contract any part of the technical study outside of the scientific personnel of the Turbomachines & Fluid Dynamics Laboratory (TurboLab) without the prior written consent of IAMD COE.

4.3 Non-Disclosure

4.3.1 In the context of the Contract, the IAMD COE may disclose verbally or in writing, information about IAMD COE’s own intellectual property, pending or filed patents or research intensions and directions. This may be necessary to allow the responsible professor to fulfil the Contract. The responsible professor shall not disclose any of this information to any third party.

4.3.2 The responsible professor shall not make any commercial gains, by the sale of products or information related to any aspects of the Contract.

4.3.3 The responsible professor shall ensure that all project members will respect the commercial confidentiality of information supplied by the IAMD COE in relation to the work described in this agreement. The responsible professor shall obtain all project members’ agreement that they will not disclose to any third party any information or results related to this work.

4.4 Intellectual Property

4.4.1 Any intellectual property resulting from the work covered by the Contract will be the property of the IAMD COE. This includes reports, calculations, inventions, discoveries, or otherwise patentable material. Should the responsible professor or his/her team make, during the execution of this project, or at any time thereafter, an invention or inventive step based on or derived from the IAMD COE's disclosures, or work carried out within this project, the responsible professor shall disclose and assign any such inventions to the IAMD COE.

4.4.2 The responsible professor shall:

4.4.2.1 Disclose promptly to the IAMD COE full details of all inventions, discoveries, improvements, or other novel material whether patentable or not, arising from the work covered by this agreement.

4.4.2.2 Make available to the Centre all information required to make and pursue applications for patents arising from the work or related to the Contract, assisting the Centre into this purpose.

4.4.3 The IAMD COE will investigate each disclosure submitted by the responsible professor and, if it elects to file patent application thereon, agrees to pay all expenses in connection with the preparation and pursuance of such patent application or applications which it may decide to file as deemed appropriate. The appropriate research members of the responsible professor's team will be acknowledged as the inventors or co-inventors (as appropriate) for their intellectual contribution in any patent application or publication.

4.4.4 If the responsible professor petitions the IAMD COE in writing to release any of the rights to any inventions, discoveries, novel information or any patent granted thereon, which by this Agreement are assigned to IAMD COE, the latter will consider and act on such petition, but it is not obliged to release any of its rights to the responsible professor.

4.4.5 Any inventions, discoveries, or novel information, within the scope of the Contract and held by the responsible professor prior to the date of the contract award and not included in this or any earlier agreement will not be covered by the Contract.

4.4.6 The IAMD COE will:

4.4.6.1 Perpetually indemnify the responsible professor against any costs, losses, and expenses arising from the pursuance or future servicing of any patent arising from the work covered by this agreement or from any future commercial exploitation of any information or inventions arising from the work covered by this agreement howsoever those costs, losses, or expenses may arise.

4.4.6.2 Recognise the responsible professor's ownership of any invention or patentable idea, which is outside the scope of the current project. In such cases the IAMD COE will be open to negotiation on patent ownership, royalties etc. as part of a separate agreement. Patentable ideas within the scope of the project re-

main the property of the IAMD COE with the responsible professor (and the involved members of his team) receiving due acknowledgement.

4.5 Publication and Publicity

4.5.1 Any party may use the other party's name in publication or publicity material after informing in advance, in writing, the last one.

4.5.2 The IAMD COE:

4.5.2.1 Has the sole right to grant permission for publication and such permission must be obtained in writing prior to submission for publication of any information related to the matters covered by this agreement. The manuscript should be submitted to IAMD COE for consideration, at least twenty (20) days prior to the date of submission for publication.

4.5.2.2 Actively encourages and seeks publication but reserves the right to withhold permission if confidentiality is required for security reasons.

4.5.2.3 Agrees not to withhold, unduly, willfully, or unnecessarily, permission for publication.

5. **Guarantee**

5.1 No special guarantee is required by the Contractor.

6. **Delivery - Shipping costs**

6.1 All requested projects shall be completed, provided and delivered to the IAMD COE within the abovementioned deadlines (par. 3.1.6, 3.2.4 and 3.3.4).

6.2 Any delivery or shipping costs (e.g. for the publication, etc.) will be borne by the Contractor.

7. **Contractor's Standards**

7.1 The Contractor shall establish, document and implement a Quality Management System with procedures that satisfy the ISO 9001 standards.