ENODISE Aircraft Design Competition Rules

List of acronyms

AMSL	Above Mean Sea Level
ATM	Air Traffic Management
BLI	Boundary Layer Ingestion
DEP	Distributed Electric Propulsion
EPNL	Effective Perceived Noise Level
RfP	Request for Proposal
SEL	Sound Exposure Level
STEM	Science, Technology, Engineering and Mathematics
UAM	Urban Air Mobility
VTOL	Vertical Take-Off and Landing

Scope

The ENODISE project aims at developing the knowledge, tools and methods that will enable the design of more efficient and quieter air transport vehicles. The consortium is looking into disruptive architectures for existing transport aircraft as well as new transportation paradigms such as Urban Air Mobility, exploiting the concepts of Distributed Electric Propulsion (DEP), Boundary Layer Ingestion (BLI) and VTOL multi-copters. In ENODISE, the partners are focusing their efforts on small lab-scale sub-systems. The proposed design exercise aims at extrapolating this research towards full-scale, in order to evaluate and maximize the potential benefits while mitigating the drawbacks of those novel propulsion-airframe integration concepts.

Eligibility Requirements

The following eligibility criteria are of application:

- All students registered in a University located in an EU Member State or Horizon Europe Associated Country (hereinafter "students") are eligible and encouraged to participate.
- Teams will be composed of 2-6 students enrolled in a Master in Aerospace, Mechanical Engineering, … of which one member will be the elected team captain in charge of the communication with the ENODISE consortium through its coordinator.
- A maximum of 10 competing teams will be selected, on a first-come-first-serve basis, as long as they respect the present eligibility criteria.
- The ENODISE consortium partners are quite mindful of the gender balance issue in STEM, and though not an eligibility criterion, diversity in the teams' composition is strongly encouraged.
- Students must submit their letter of intent via email to the ENODISE Coordinator (enodise@h2020.eu, hereinafter after "coordinator") **between the 1 April 2023 and the 31 October 2023**, to be eligible to participate. No extensions will be granted.
- More than one design may be submitted from students at any one school. At large student members may collaborate with each other even if they do not attend the same university.
- If a design group withdraws their final report from the competition, the team leader must notify the coordinator immediately.
- Design projects that are used as part of an organized classroom requirement are eligible and encouraged for competition.

Schedule

The schedule for the ENODISE design competition is the following:

- 15 February 2023: Request for Proposal issued by ENODISE consortium
- 1 April – 31 October 2023: teams registration
- 1 June 2024 – 31 August 2024: submission of design proposals
- September 2024: evaluation of the propositions by the jury
- 30 September 2024: proclamation of the results and award ceremony

All design proposals must be submitted via email at the ENODISE email enodise@h2020.eu.

Categories/Submissions

Each proposal can be submitted to one of the two following categories:

- Category A: single aisle medium-range transport (A320-like mission profile)
- Category B: six-passengers UAM electric VTOL aircraft (free design)

Upon registration, an expression of interest has to be submitted by the captain of each team, indicating:

- the team composition (names, emails) as well as the contact details of their academic advisor(s),
- the coordinates of the team captain,
- the category in which the proposal will be competing,
- the planned proposal submission date (within the abovementioned window).

The design proposal will be submitted in pdf format to the ENODISE coordinator (enodise@h2020.eu), and be named according to the following template:

ENODISE_[CatA or CatB]_[University]_[TeamCaptainName]_design_report.pdf.

The file size must not exceed 15 Mb.

The design proposal will contain a signature page for all participants, including students and academic supervisors, certifying that the proposed design is the result of the original work of the team members, and that the content of the material can be made publicly available through the ENODISE web site and the local repositories of the participating universities.

The main body of the design report won't exceed 50 pages in length, with double line spacing, Times New Roman with font size 11 pt, using an A4 page layout with a minimum margin (top, bottom, left and right) of 2 cm. It will detail the methods and tools used by the participants for their design, including all relevant references, and provide the results of the conceptual design. Additional information necessary for the reproduction of the results may be included in appendix, without page limit.

Copyright

All submissions to the competition shall be the original work of the team members.

Authors retain copyright ownership of all written works submitted to the competition. By virtue of participating in the competition, team members and report authors grant the ENODISE consortium a non-exclusive license to reproduce submissions, in whole or in part, for future ENODISE dissemination and communication actions.

Appropriate acknowledgment will accompany any reuse of materials.

Conflict of Interest

It should be noted that it shall be considered a conflict of interest for a design professor to write or assist in writing RfPs and/or judging proposals submitted if (s)he will have students participating in, or that can be expected to participate in this competition. A design professor with such a conflict must refrain from participating in the development of such competition RfPs and/or judging any proposals submitted in such competitions.

Award

The prize money provided for the competitions is funded through the ENODISE consortium. The winning team will be offered

- a financial support to have their design 3D-printed,
- a financial support to present their conceptual design at an international conference or in a journal paper.

Proposal Requirements

The proposal should address the topics listed on the RfP as comprehensively as possible, and indicate clearly the items that are not covered and the reasons why. It should describe the technical approaches, simplifying assumptions and background information used to comply with the requirements of the RfP. Trade-offs between conflicting requirements should be highlighted. All the above information should be sufficiently detailed and self-contained to permit the evaluation of the proposal.

The design proposal should privilege de-carbonized or low-CO2 solutions, minimize the needed energy integrated over all flight phases while minimizing the acoustic footprint during take-off, departure, approach and landing. Participants are welcome to use the information found in the ENODISE public report, as well as any other relevant source. Out-of-the-box and creative thinking is encouraged within the scope defined herewith, as long as it remains supported through engineering analysis.

The design report should contain at least the following:

- the overall aircraft layout
- the layout of the propulsive system and its integration with the airframe
- the flight path (altitude & speed, operational settings)
- a calculation sheet for the overall aircraft performance data (endurance, range, take-off and landing distances and compatibility with existing airport infrastructure, some considerations about the longitudinal/lateral static stability and maneuverability).

The teams are free to choose the modelling approaches and tools, from empirical correlations to high-fidelity CFD/CAA. All analytical modeling tools, data sources, computer codes, and technical resources used to generate, analyze, model and produce the design and associated report must be:

- sufficiently documented to assess their pertinence and limitations,
- available for inspection by the jury members, and
- generated by the students, independently from external codes subject to commercial restrictions as much as possible, or providing sufficient evidence that those restrictions aren't infringed.

Basis for Judging

The ENODISE Committee that developed the RfP will serve as the judges of the final reports. Reports will be evaluated according to the criteria below. Judges reserve the right to not award all three places. Judges' decisions are final, and candidates will be provided feedback via judging comments after the program has closed.

1. Technical Content (45 points)

Is there any flaw in the understanding of the RfP? Are the requirements met? Is the theoretical background supporting the tools and methods used in the design exercise appropriate and well understood? What are the limitations or assumptions that had to be made to proceed? Have these assumptions been verified through intermediate validation steps? Are the results convincingly reliable, e.g. by the presentation of an adequate selection of intermediate results?

2. Organization and Presentation (20 points)

Is the design exercise presented along a logical and understandable sequence? Are the methods and results sufficiently well documented to permit verification? Is all the information presented pertinent? Are the figures of good enough quality? Is the English language correct (and intelligible for a non-native English speaker)?

3. Originality (25 points)

Does the treatment of the problem demonstrate creative thinking, while remaining supported by a solid engineering approach to demonstrate its feasibility? How did the team articulate its solution with respect to existing background knowledge? Are the pros/cons of the proposed design, compared with previously existing or alternative solutions, sufficiently detailed?

4. Other aspects (10 points)

Did the team consider related non-technical issues such as integration with existing ATM and airport infrastructure, psychological aspects driving passenger acceptance, etc.?

Out-scoped topics

The following aspects are not requested and will not be evaluated: structural design, cooling of the electric systems, business viability, safety and airworthiness certification, prediction of the pollutant emissions. A detailed design of the power generation/distribution/storage systems won't be required, the focus being placed on the aerodynamic and aeroacoustic aspects, but a macroscopic choice of the power generation solution will still be needed as it will affect the weight and its distribution, hence the aerodynamic performance.

Request for Proposals: aircraft mission profiles

The aircraft design requirements for each of the two categories A and B are given below. The two main aspects to address in each category are:

- the aerodynamic integration of the propulsive system with the airframe, exploiting to the largest possible extent the aero-propulsive benefits of innovative architectures such as Distributed Electric Propulsion (DEP), Boundary Layer Ingestion (BLI), multi-copter / convertible;
- the mitigation of the adverse aeroacoustic installation effects that may result from the close proximity of the propulsion system with the airframe or the interaction between propulsion units. Acoustic shielding, active/passive noise noise control approaches should be considered to this end.

For both categories, the teams will provide a quantified estimation of the required energy integrated over all phases of the missions described below (from the engines startup till their shutdown), based on a prediction of the aerodynamic performance accounting for the propulsor-airframe interactions and effects on the lift, drag, take-off distance, climb rate, etc.

Regarding noise, the analysis will be performed using the aviation EPNL / SEL noise metrics used for certification, to be assessed according to the ICAO Annex 16, Volume 1. For Category A, the regulations applying for the noise certification of subsonic jet and large propeller-driven aircraft will be observed, and for category B, those applying to small propeller-driven aircraft and helicopters will be followed.

Category A: single aisle medium-range transport

The category A aircraft should ensure a mission scenario of an Airbus A320-200 (180 seats), for a flight from London Heathrow Airport (EGLL) to Amsterdam Schiphol Airport (EHAM), respecting current ATM procedures. The aircraft architecture will remain a tube-and-wing concept, adapted to accommodate a new propulsion system that would be either based on the DEP or the BLI concept. Each team can decide

to address one or both concepts in their analysis. In either case, the propulsors have to be powered by electricity, but the technology used to generate the electricity is left at the appreciation of the team.

The aircraft will have to meet the following requirements:

- Power generation, distribution, and energy storage: the aircraft must have a power generation system capable of producing sufficient power to drive the electric motors throughout the flight. The power distribution and energy storage should be considered insofar as they affect the weight and its distribution. No detailed design of those systems is expected.
- Aerodynamics: the aircraft must have an aerodynamic design that is optimized for electric propulsion, including the integration of electric motors and power systems into the wing and fuselage. The aerodynamic benefits of DEP or BLI should be highlighted in terms of required energy to perform the mission profile, compared with the conventional engine configuration of the A320.
- Safety and reliability: the aircraft should be designed with safety and reliability in mind, considering the potential issues that could arise from the use of electric propulsion and the possible needs for redundancy. Precise certification procedures are however out-scoped.
- Noise footprint: the aircraft should have minimal noise footprint. The design should incorporate noise reduction measures to minimize impact on surrounding communities. The maximum permitted EPNdB levels defined in Chapter 3 for the noise certification of subsonic jet and large propeller-driven aircraft should not be exceeded at any of the flyover, take-off and approach measurement points defined by the ICAO Annex 16.

Category B: six-passengers Urban Air Mobility electric aircraft

The mission scenario corresponds to a new paradigm of air transportation, known as Urban Air Mobility, meant to reduce downtown traffic congestion and enable ultra-fast services within the urban and peri-urban environment, e.g. linking a regional airport to its nearby city center. In this instance we are considering a flight from Brussels South Charleroi Airport (EBCI) to the Brussels Schuman district (distant by about 43 km in straight line).

This aircraft will have to meet the following requirements:

- The aircraft must be capable of carrying a maximum of 6 passengers, including the pilot. It must have a maximum takeoff weight of 3,175 kg, and have a wing span of no more than 15 m.
- It must be powered by electric propulsion, with a battery range of at least 50 nautical miles on a single charge. It should have a maximum cruising speed of 150 knots and a maximum altitude of 4,500 feet AMSL.
- The aircraft should be designed to operate in urban environments, must be able to take off and land vertically (VTOL), and be equipped with redundant systems for increased safety. It should be able to operate in a wide range of weather conditions, with winds up to 25 knots.
- The design should incorporate noise reduction measures (operational or at the source through noise mitigation technologies) to minimize impact on surrounding communities. The aircraft must be able to comply with current aviation regulations and take-off / approach patterns, considering the measurement points defined for small propeller-driven aircraft and helicopters (take-off with max. take-off power at best rate of climb, overflight at a height of 150 m, and approach following a 6 degrees approach path).

Contact Details:

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