# 2010 – 2011 AIAA Foundation Graduate Team Aircraft Design Competition

## I. RULES

1. All graduate AIAA branch or at-large Student Members are eligible and encouraged to participate.

2. An electronic copy of the report in MS Word or Adobe PDF format must be submitted on a CD or DVD to AIAA Student Programs. Total size of the file(s) cannot exceed 60 MB. **A "Signature" page must be included in the report and indicate all participants, including faculty and project advisors, along with their AIAA member numbers**. Designs that are submitted must be the work of the students, but guidance may come from the Faculty/Project Advisor and should be accurately acknowledged.

3. *Design projects that are used as part of an organized classroom requirement are eligible and encouraged for competition.*

4. The prizes shall be: First place-$2,500; Second place-$1,500; Third place-$1,000 (US dollars). Certificates will be presented to the winning design teams for display at their university and a certificate will also be presented to each team member and the faculty/project advisor. One representative from the first place design team may be expected to present a summary design paper at an AIAA Conference in 2012.

Reasonable airfare and lodging will be defrayed by the AIAA for the team representative.

5. More than one design may be submitted from students at any one school. Projects should be *no more than 100 (total) double-spaced typewritten pages and typeset should be no smaller than 10pt Times* (including graphs, drawings, photographs, and appendix) on 8.5" x 11.0" paper. Up to five of the 100 pages may be foldouts (11" x 17" max).

6. If a design group withdraws their project from the competition, the team chairman must notify AIAA Headquarters immediately!

7. Team competitions will be groups of not more than ten AIAA branch or at-large Student Members per entry. Individual competitions will consist of only 1 AIAA branch or at-large Student Member per entry.

## II. COPYRIGHT

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

Any submission that does not contain a copyright notice shall become the property of AIAA. A team desiring to maintain copyright ownership may so indicate on the signature page but nevertheless, by submitting a proposal, grants an irrevocable license to AIAA to copy, display, publish, and distribute the work and to use it for all of AIAA's current and future print and electronic uses (e.g. "Copyright © 20__ by _____. Published by the American Institute of Aeronautics and Astronautics, Inc., with permission.).

Any submission purporting to limit or deny AIAA licensure (or copyright) will not be eligible for prizes.

## III. SCHEDULE AND ACTIVITY SEQUENCES

Significant activities, dates, and addresses for submission of proposal and related materials are as follows:

**A. Letter of Intent –** 11 March 2011
**B. Receipt of Proposal –** 10 June 2011
**C. Announcement of Winners –** August 2011

Groups intending to submit a proposal must submit a one page Letter of Intent along with the Intent Form (Item A) on or before the date specified above, at the following address or email (rachela@aiaa.org):

**AIAA Student Programs**
**Suite 500**
**1801 Alexander Bell Drive**
**Reston, VA 20191-4344**

The CD containing the finished proposal must be received at the same address on or before the date specified above for the Receipt of Proposal (Item B).

## IV. PROPOSAL REQUIREMENTS

The technical proposal is the most important factor in the award of a contract. It should be specific and complete. While it is realized that all of the technical factors cannot be included in advance, the following should be included and keyed accordingly:

1. Demonstrate a thorough understanding of the Request for Proposal (RFP) requirements.

2. Describe the proposed technical approaches to comply with each of the requirements specified in the RFP, including phasing of tasks. Legibility, clarity, and completeness of the technical approach are primary factors in evaluation of the proposals.

3. Particular emphasis should be directed at identification of critical, technical problem areas. Descriptions, sketches, drawings, systems analysis, method of attack, and discussions of new techniques should be presented in sufficient detail to permit engineering evaluation of the proposal. Exceptions to proposed technical requirements should be identified and explained.

4. Include tradeoff studies performed to arrive at the final design.

5. Provide a description of automated design tools used to develop the design.

## V. BASIS FOR JUDGING

*1. Technical Content (35 points)*
This concerns the correctness of theory, validity of reasoning used, apparent understanding and grasp of the subject, etc. Are all major factors considered and a reasonably accurate evaluation of these factors presented?

*2. Organization and Presentation (20 points)*
The description of the design as an instrument of communication is a strong factor on judging. Organization of written design, clarity, and inclusion of pertinent information are major factors.

*3. Originality (20 points)*
The design proposal should avoid standard textbook information, and should show the independence of thinking or a fresh approach to the project. Does the method and treatment of the problem show imagination?

Does the method show an adaptation or creation of automated design tools.

*4. Practical Application and Feasibility (25 points)*
The proposal should present conclusions or recommendations that are feasible and practical, and not merely lead the evaluators into further difficult or insolvable problems.

# VI. REQUEST FOR PROPOSAL

**General Aviation, 2-Seat Electrically Powered Aircraft.**

**Background**

With the increases in cost and concerns regarding future availability of conventional aviation fuel, plus the general environmental concerns associated with direct $CO_2$ output, there has been an emerging effort to produce a viable, electric powered aircraft suitable to General Aviation needs. The EAA (Experimental Aircraft Association) has embraced the concept, with prototype aircraft displays, presentations, forums at it's Oshkosh AirVenture airshow. The CAFÉ Foundation has conducted symposiums around the subject of supporting electric airplane development. As the recent advancements in electric motor system design and in storage (battery) technologies appears likely to continue, the state of the art is at the brink of developing a practical electric light general aviation aircraft.

To date, motor gliders exist that have used electric power for initial take-off and climb. Prototype light sport aircraft sized electric aircraft are tantalizing close to matching early General Aviation aircraft that had reached enough utility (payload, range, speed) for widespread market acceptance. This proposal is for such a step in aircraft development. Assuming near term battery storage technology capability (this is to exclude fuel cell type energy conversion devices), the basic capability outlined in the RFP is to be provided. Advancements in battery/storage technology energy densities (which have been progressing steadily in recent years, with added impetus being provided from the automotive industry), shall be counted on for increases in range and endurance (or increased sustained cruise speed).

**Project Objective**

This RFP asks for a VFR fixed wing, two seat general aviation aircraft that is electrically powered. The airplane is to be able to take-off from a typical general aviation sized airport, climb and cruise for a flight endurance total of one hour, while landing with a 30 minute reserve capability (at minimum level flight cruise setting). It shall generally be designed to meet FAA certification standards (Part 23). As the 'Light Sport Aircraft' category only allows for reciprocating engine types at this time, this RFP does not strictly constrain to those rules set (although the RFP does not exclude their use if the team so elects).

**General Design Requirements**:

Seating: Two (2)
Cargo/Baggage bay volume: $\geq$ 10 ft3
Useful load (people, cargo): $\geq$ 400 lbs
Take-off and Landing Performance @ Max Weight, standard day plus 15 degree F, sea level conditions: 1600' take-off and landing over a 50' obstacle.
Maximum altitude capability (achieved by arriving with at least 100 fpm rate of climb or greater, standard day conditions plus 15 degrees F) of 11,500' MSL or greater.
Sizing Mission, Pilot & passenger (Payload weight: 400 lbs, all conditions standard day plus 15 degrees F):

- 5 minute start up, taxi and run-up
- Take-off, sea level
- Climb to at least 5500' MSL but no more than 9500' with initial sea level rate of climb no less than 500 feet/minute
- Cruise at 80 knots true airspeed for 1 hour (time to descend at 80 knots from selected cruise altitude to 1500' may be deducted against the 1 hour total)
- Descend from 1500' and land (@ sea level) with 30 minutes best economy cruise power setting in reserve

The airplane shall be certifiable to appropriate FARs for approximately 2016 entry into service.

The airplane shall be rechargeable within 8 hour period (110/120 volt source, or 4 hours with 220/240 volt). The battery life (number of recharge cycles or years of use) shall be considered in the overall life cycle costs, but will be at least 500 cycles before replacement. A normal mission shall be assumed, but normal mission plus full 30 minute reserve usage shall not deplete the battery to a state that leads to significant economic damage to the battery.

It shall be readily parked in a standard 40' 'T' hangar with minimal effort (one person can prepare, preflight the airplane in less than 15 minutes).

Center of gravity loadability will accommodate:

- a single 120 lb pilot, no cargo, or
- two, 200 lb people. Or
- two, 170 lb people with 60 lbs cargo

Instrumentation will be typical of basic VFR. Minimum installation of a single VHF Communication radio, and an installed GPS.

The option to trade-off one passenger for an additional 150 lbs of battery shall be provided for.

Operating costs, fuel and maintenance (routine scheduled, non-routine, overhauls) shall be determined and compared to like class general aviation airplanes.

Airplane acquisition cost shall be commensurate with other new build 2 seat aircraft of this class. Production run of 100 and 500 units shall be assessed.

A balanced life cycle cost analysis is to be conducted demonstrating the difference in

Discussion and evaluation of the airplane should new battery developments allow similar sized and weight batteries to replace the original selected technology, but with twice the energy density of those initially selected.

**Supporting Data**

The technical proposal must convincingly demonstrate that the design can satisfy the mission requirements, that a system architecture is viable, weight and cost efficient. The proposal should satisfy the following tasks to show how the design would be developed.

1. Justify the final design, and describe the technologies, motor, system and powersource selection and technical approach used to meet the mission requirements. All major integrated installation considerations shall be described (including any ther-

mal/cooling considerations of the overall system)
2. Provide carpet plots used to finalize the final selected design
3. Include a dimensioned 3-view general arrangement drawing
4. Include an inboard profile showing the general internal arrangement
5. Include an illustrated description of the primary load bearing airframe structure, and state rational for material selection
6. Show an estimated drag build-up and drag polar for the cruise configuration, the take-off configuration, and the landing configuration
7. Show a weight breakdown of the major components and systems and center of gravity travel.
8. Provide performance estimates, review the sizing mission, the maximum range mission, explain altitude profiles selected, the increase in range and performance with the optional battery capacity and finally, the expected range or speed capability with the future battery concept.
9. Demonstrate aircraft stability for all flight and loading conditions.
10. Describe any advanced technologies or design approaches and their relative benefits as used to obtain performance improvements. Address risk mitigation if these technologies fail to materialize, including cost increase and performance decrements.
11. Provide flyaway cost and life cycle cost estimate for production run of 500 and 1500 units.
12. Compare overall life cycle cost to conventional airplane thru typical major overhaul life (2000 hrs).

## Letter of Intent Form

Use this file, to indicate the names and AIAA Member numbers of all team members. Page two allows for the Letter of Intent to be written.

This form may also be downloaded from the AIAA Web site in the Students and Educators area under Design Competitions (http://www.aiaa.org/content.cfm?pageid=210).