

# 2011 – 2012 AIAA Foundation Undergraduate Individual Aircraft Design Competition

## I. Rules – General

1. All undergraduate 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 20 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 and signatures.* 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.

Each proposal should be no more than 100 double-spaced pages (including graphs, drawings, photographs, and appendices) if it were to be printed on 8.5” x 11.0” paper, and the font should be no smaller than 10 pt. Times New Roman. Up to five of the 100 pages may be foldouts (11” x 17” max).

3. Design projects 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.

The first place design winner will be expected to present a summary design poster at the 2010 AIAA Aviation Technology, Integration and Operations Conference (ATIO). **\*The winning report will be published as part of the 2010 ATIO conference.\***

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

5. More than one design may be submitted from students at any one school.

6. If a design group withdraws their project from the competition, the team leader 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 — 19 March 2012
- B. Proposal delivered to AIAA Headquarters — 11 June 2012
- C. Announcement of Winners — August 2012

Groups intending to submit a proposal must submit a Letter of Intent (Item A), with a maximum length of one page to be received with the attached form on or before the date specified above, at the following address:

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

The Letter of Intent should contain the names of participants, project title, name(s) of faculty/project advisor(s), and contact information for the team leader and project/faculty advisor(s).

### **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

### Unlimited Class Air Racer

#### Background

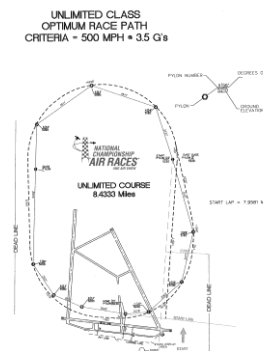
Each year, the National Championship Air Races are held in September at Reno Stead Airport. Over approximately a week, several classes of aircraft are raced, culminating in the popular Unlimited Class. This class has been dominated for decades by modified examples of classic piston-engined, propeller-driven fighters. The few truly competitive aircraft have been extensively modified and appear to have reached the zenith of what may be achievable using this approach. There have been a few examples of specially-designed Unlimited Class air racers, but they have not proven competitive. In order to reinvigorate this sport, new clean-sheet designs are needed that are competitive with the best current racers.

### Project Objective

This RFP asks for an original aircraft design capable of beating the best race times ever posted by Unlimited Class Air Racers at the National Championship.

This design must both meet all of the explicit Unlimited Class rules as well as not violate the spirit of the race. For example, turbo-charging would be allowed, but turbo-compounding would not because the addition of a power turbine would mean that the aircraft is not solely piston-engined. Similarly, a motor-jet would not be allowed. While there is no explicit requirement for the pilot to be on board, a UAV would undoubtedly be disqualified on safety grounds. Similarly, even if cutting pylons deliberately while taking the time penalty or some other exceptional maneuvering are technically winning strategies, extreme cases would be disqualified on safety grounds. Be creative, but don't violate the spirit of the race.

In order to prove that your design meets the Project Objective, you must develop a performance analysis capability that simulates your aircraft on the racecourse, including entry through the "chute", under typical race conditions, with an output of the lap times of the race.



Also, while there are many aircraft design/analysis methods available, none have been developed with this class of aircraft in mind. So, the designer must put together as

consistent of a set of data for an aircraft in this class as possible to validate/calibrate their chosen method. Luckily, there are several unmodified fighters that are raced and some should have sufficient publically available data for this purpose. Once the methods are shown to be realistic, then the new design can be performed with greater confidence.

### **General Design Requirements:**

#### **Class Rules:**

- Piston-driven aircraft
- Empty weight greater than 4500 pounds
- Capable of pulling 6 G's

#### **Operating conditions:**

- Stead Airfield (KRTS) near Reno NV during 14-18 September
- Altitude of 5,100 ft MSL (50 ft AGL)
- Temperature of 78 deg F
- Pressure of 29.95 in

#### **Miscellaneous:**

- FAA Experimental certification basis
- Takeoff and Landing performance appropriate for Stead Airfield, with consideration of Engine-Out emergency operation
- Pilot visibility should be appropriate for safe race operations
- Ferry capability of 500 nmi

#### **Notes:**

- All performance to be computed at representative race day atmospheric conditions except for the Ferry flight cruise, which is at standard atmospheric conditions.

### **Supporting Data**

The technical proposal must convincingly demonstrate that the analysis methodology is realistic and that the design that results from it satisfies the requirements. The proposal should satisfy the following tasks to show how the design would be developed.

1. Present the validation dataset collected, show how it was used, and explain any method calibration performed.
2. Justify the final design, and describe the technologies and technical approach used to meet the mission requirements.
3. Provide sizing plots used to guide the design selection. Describe sensitivity studies used.
4. Include a dimensioned 3-view general arrangement drawing.
5. Include an inboard profile showing the internal arrangement.
6. Show a weight breakdown of the major components and systems. Show weight and CG envelope to cover the following loadings:
  - a. Race
  - b. Ferry
  - c. Takeoff
  - d. Landing
7. Show estimated component drag build-ups (parasite) and drag polars (+ lift dependent profile, induced, and trim) for all conditions. Remember to account for compressibility and cooling drag.
8. Show estimated propulsion performance including engine power, fuel flow, and propulsive efficiency for all conditions. Remember to account for compressibility.
9. Show estimated stability for all flight and loading conditions. The pilot's force required to attain the maximum of 6g load must also be reasonable, but not so light that the aircraft is easily over controlled. For stick controls, this force must be between 15 and 35 lbs.
10. Include an illustrated description of the primary load bearing airframe structure, and state rationale for material selection.

11. Include descriptions of the major aircraft systems.
12. 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.
13. Provide flyaway cost estimate for production run of 1 and 10 units. Provide fixed and hourly cost estimates.

Intent Form

2011/2012  
AIAA Foundation  
Undergraduate Individual Aircraft Design Competition  
Request for Proposal:  
**Unlimited Class Air Racer**

Title of Design Proposal: \_\_\_\_\_

Name of School: \_\_\_\_\_

<b>Designer's Name</b>	<b>AIAA Member #</b>	<b>Graduation Date</b>	<b>Degree</b>
_____	_____	_____	_____

\_\_\_\_\_  
E-mail

In order to be eligible for the 2009/2010 AIAA Foundation Undergraduate Individual Aircraft Design Competition, you must complete this form and return it to AIAA Student Programs **before 19 March 2010**, at AIAA Headquarters, along with a one-page "Letter of Intent" as noted in Section III, "Schedule and Activity Sequences." For a nonmember, a student member application and member dues payment should also be included with this form.

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Signature of Faculty Advisor	Signature of Project Advisor	Date
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Faculty Advisor – Printed	Project Advisor – Printed	Date
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