# 2006 - 2007 AIAA Undergraduate Team 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 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 2007.

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. Schedule and Activity Sequences

Significant activities, dates, and addresses for submission of proposal and related materials are as follows:
A. Letter of Intent — 17 March 2007

B. Proposal delivered to AIAA Headquarters — 15 June 2007
C. Announcement of Winners — August 2007

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

# III. 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.

# IV. 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.

# V. Request for Proposal

## An Inter-Theater Tactical Transport with Austere STOL Capability

.

### 1. OPPORTUNITIES DESCRIPTION

In order to support the US Army's need for future tactical warfare mobility, the United States Air Force (USAF) Air Mobility Command (AMC) has a requirement for an inter-theater tactical transport with austere Short Take-Off and Landing (STOL) field capability. Such a vehicle would permit the AF to deliver a Future Deployable Armored Vehicle (FDAV) vehicle and support equipment to landing areas of opportunity and not necessarily dedicated air fields. The vehicle would also need to be self deployable from the continental United States (CONUS) and would need to integrate seamlessly into the national and international air-space system by possessing commercial airliner speeds and cruise altitudes.

### 2. PROJECT OBJECTIVE

The AMC-X will be capable of carrying outsized payloads into austere landing zones. The payload is nominally defined as one (1) Future Deployable Armored Vehicle (FDAV) Vehicle with dimensions of; 560" long –by- 128" wide –by- 114" high ft (including an additional 12 inch wide escape path around the vehicle) and weighing at 25 tons. Additional support equipment raises the nominal payload weight to 60,000 lbs. The aircraft should be able to land within 2000 – 3000 ft critical field length onto unimproved surfaces with a California Bearing Ratio (CBR) of 4 – 6. The aircraft will need to be able to conduct all weather landing and take-off operations.

The aircraft will need a range of at least 3000 nm for the ferry mission (full fuel, minimum payload) from the continental United States (CONUS) to other non-austere initial deployment locations. In flight refueling capability is also desired to extend the range-payload envelope to transoceanic distances with substantial payload. The aircraft will need to possess a top speed of at least M=0.8 and have a service ceiling of at least 30,000 ft. This will permit the AF to conduct peacetime operations in conjunction with commercial traffic in the Air Traffic Management (ATM) environment. The radius of action for the austere FDAV delivery mission is 500 nm at best speed and altitude. No particular survivability technologies are specifically identified for this RFP, but rudimentary survivability during the FDAV delivery mission will need to be considered and may affect best altitude and speed. Complete integration into the future network-centric battlefield is desirable but will not need to be evaluated for this RFP. Since Air Force operations are ongoing 24/7, acoustic mitigation in and around commercial airports and outlying communities during peacetime should also be considered.

### 3. DESIGN REQUIREMENTS AND CONSTRAINTS

#### 3.1 Design Mission

#### 3.1.1 General Design Requirements

**Payload:**

One Future Deployable Armored Vehicle (FDAV) weighing 25 tons plus 5 tons of support equipment. The FDAV requires a volume of 560" long –by- 128" wide –by- 114" high ft (including an additional 12 inch wide escape path around the vehicle) to fit in the aircraft. Assume the center of gravity of the vehicle is located at 280" longitudinally

by 64" laterally, by 48" height above the ground.
The aircraft structural design shall meet MIL Spec regulations for transport aircraft.
The flight crew complement is 2 (pilot and copilot).
The cabin crew complement is 1 loadmaster.

### 3.1.2 Required Mission Performance

1. Warm-up and taxi at idle power for 8 minutes.
2. Takeoff fuel allowance is equal to the fuel consumed during 2 minutes of operation at maximum takeoff power.
3. Balanced field takeoff length must not exceed 2,500 ft. on a hot day (95°F) at sea level. See FAR 25.
4. Cruise/climb to best cruise altitude.
5. Cruise at best cruise altitude and $M_{cruise} \geq 0.8$ for 500 nautical miles (nmi) less distance traveled during climb out.
6. Descend to 1000 ft for 100 nm. Speed M=0.6
7 Allocate 5 minutes at ¾ take off power for landing if powered lift is used. If powered lift is not required, use idle power. Landing zone is blacktop (CBR=4 - 6) with a useful area of 3000 feet by 150 feet. 50 foot obstacles are 250 feet from either end of the runway. Use balanced field length of 2500 feet. Since the landing zone may be oriented in a less than optimal direction, the aircraft needs to be able to land in a 25 knot crosswind with a 5 knot tailwind component..
8 Take-off under combat rules, and mirror outbound mission segments for the return. "Combat rules" take-off defines the distance to climb over a 50 foot obstacle from a standing start, however, there is no assumed engine failure which is used for the balance field length calculations.

## 3.2 Transoceanic Ferry Mission

### 3.2.1 General Design Requirements

### Payload:

10 tons of bulk cargo with a density of 20 lb/ft^3 when properly packed in the aircraft.

The flight crew complement is 2 (pilot and copilot).
The cabin crew complement is 1 loadmaster

### 3.2.2 Required Mission Performance

1. Warm-up and taxi at idle power for 8 minutes.
2. Takeoff fuel allowance is equal to the fuel consumed during 2 minutes of operation at maximum takeoff power.
3. Balanced field takeoff length must not exceed 2,500 ft. on a hot day (95°F) at sea level. See FAR 25.
4. Cruise/climb to best cruise altitude.
5. Cruise at best cruise altitude and $M_{cruise} \geq 0.8$ for 3200 nautical miles (nmi) less distance traveled during climb out. Aerial refueling is permitted to achieve the range; however the number of rendezvous and quantity of fuel transferred must be noted.
6. Descend to sea level. Conduct a normal approach to a runway of 2500 ft or less. No credit is taken for range on descent, but fuel used is included in the block fuel usage..
7. Allocate 5 minutes at ¾ take off power for landing if powered lift is used. If powered lift is not required, use idle power. Use balanced field length of 2000 feet.
8. Taxi in and park at gate using idle power for 10 minutes.
9. Reserve fuel must accommodate a missed approach plus 150 nmi diversion plus 45 minute hold at 5,000 ft.

## 4. DATA REQUIREMENTS

The technical proposal must convincingly demonstrate that the design team can provide a superior and cost effective solution to the need identified by this RFP. The proposal should satisfy the following tasks to show how the team would develop the design of a new aircraft.

1. Justify the final design and describe in detail the technologies and technical approach used to meet the mission requirements.

2. Provide carpet plots used to optimize 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 rationale for material selection.

6. Include a V-n diagram.

7. Show an estimated drag build up and drag polar for the cruise configuration, the takeoff configuration and the landing configuration.

8. Show a weight breakdown of major components and systems, and center of gravity travel.

9. Provide performance estimates and demonstrate aircraft stability for all flight and loading conditions.

10. Describe any advanced technologies and their relative benefits as used to obtain performance improvements. Address risk mitigation if these technologies fail to materialize including potential cost increases or decrement to performance.

11. Provide flyaway cost and life cycle cost estimates for a production runs of 150, 500, and 1500 aircraft.

## APPENDICES

Appendices will be included in the RFP to cover the final details and will be included at the web site:

- Engine performance decks , weights, dimensions, and scaling equations.
  Survivability guidelines, weight, and cost indexes are available at:

  http://www.aiaa.org/tc/sur/index.html

Intent Form

2006/2007
AIAA
Undergraduate Team Aircraft Design Competition
Request for Proposal: **An Inter-Theater Tactical Transport with Austere STOL Capability**

Title of Design Proposal:
_____

Name of School:
_____

| **Designer's Name** | **AIAA Member #** | **Graduation Date** | **Degree** |
|---|---|---|---|
| _____ | _____ | _____ | _____ |
| Team Leader | | | |
| _____ | | | |
| Team Leader E-mail | | | |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |
| _____ | _____ | _____ | _____ |

In order to be eligible for the 2006/2007 AIAA Undergraduate Team Aircraft Design Competition, you must complete this form and return it to AIAA Student Programs ***before 17 March 2007***, at AIAA Headquarters, along with a one-page "Letter of Intent" as noted in Section II, "Schedule and Activity Sequences." For any nonmember listed above, a student member application and member dues payment should also be included with this form.

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