

2007/2008 AIAA Undergraduate Team Space Design Competition

I. RULES

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 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 2008.

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.

II. SCHEDULE AND ACTIVITY SEQUENCES

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

- A. Letter of Intent – 14 Mar 2008**
- B. Receipt of Proposal – 13 June 2008**
- C. Announcement of Winners – Aug 2008**

Groups intending to submit a proposal must submit a one page Letter of Intent along with the signed attached Intent Form (Item A) 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 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).

III. GENERAL INFORMATION

The technical proposal is the most important factor in the award of a contract. It should be specific and complete. A well-written proposal should:

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 factors in the evaluation of the proposals.
3. Direct particular emphasis at the 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 an engineering evaluation of the proposal. Exceptions to proposed technical requirements should be identified and explained.

4. Include tradeoff studies performed to arrive at the proposed design concept.
5. Address risk areas with the proposed design and suggest mitigation approaches to be implemented.
6. Show key business case assumptions including methods of generating profits, including the \$1 Billion prize and return on investment.

IV. REQUEST FOR PROPOSAL

Capture the Flag for the 2007/2008 AIAA Undergraduate Teams Space System Design Competition

1. OPPORTUNITY DESCRIPTION

A mysterious entrepreneur has set up a prize for the return of Apollo artifacts from the Moon to Earth. The Apollo 11 site is off-limits, but all of the subsequent missions landing sites are eligible for recovery operations. Points are awarded for returning certain articles:

- | | |
|----------------------------|------------|
| 1) US Flag | 150 points |
| 2) Moon Buggy Antenna | 250 points |
| 3) Alan Shephard Golf Ball | 500 points |
| 4) Other Discarded items | 100 points |

The first team to return with items worth 250 points or more will be awarded a \$1 Billion prize by the entrepreneur. A deadline has been set to perform this mission before the 40th Anniversary of the last Apollo landing.

Each students design team would be responsible for selecting a launch vehicle, determining a method for transfer from the Earth to the lunar surface, a vehicle for landing on the lunar surface, a method to recover the Apollo artifacts, and a return recovery vehicle. Also since this is assumed to be a privately funded endeavor, the team should discuss the budget for performing this mission as well as a business plan to secure funding.

2. PROJECT OBJECTIVE

The objective is design a mission to return the desired objects to Earth, and to keep total costs at a level where the venture is profitable. Other means beyond just the

entrepreneur's prize to earn profits are encouraged as long as their amounts and expenses are justified in the business plan.

Proposers need to examine the orbital mechanics involved, develop a mission concept, generate a conceptual vehicle design for spacecraft and payload(s), select a launch vehicle, and describe the concept of operations for obtaining and returning the objects.

3. DESIGN REQUIREMENTS AND CONSTRAINTS

The undergraduate team shall choose items to be returned based on points value and ability to easily return them to Earth. A corresponding feasible mission concept should be developed to return the objects to Earth with a business plan that makes the \$1 Billion prize economically effective.

The team shall present their rationale for target objects to return and determine from information on the Apollo missions its approximate location. Sample return missions of any type are very propulsion driven so accurate calculations of delta-V and propellant required to perform the mission are critical. The team shall develop a 2 to 3 level work breakdown structure for a system to perform the mission, including the payload(s) needed, the space vehicle(s) needed to support those payload(s), and the major subsystems. The team shall select a launch vehicle(s) based on the launch capability required and shall examine any launch constraints, including launch window constraints. The team shall develop a concept of operations plan that describes the sequence of events necessary to capture and return the objects addressing ground operations for command and control and for processing of payload data.

Key constraints include:

1. Items returned no later than the 40th Anniversary of the last Apollo landing. The Apollo 11 site is off-limits, but all other mission sites are available for object recovery.
2. Full life cycle costs cannot make the business plan to include the \$1 Billion prize and any other means of generating profits to not close. Costs include all mission development, launch services, and mission operations.

4. DATA REQUIREMENTS

The proposal report shall provide an overall engineering description and complete baseline design of the most promising mission concept, with supporting design trade information. The report shall include references, a cost estimate with a discussion of the method used to identify the costs, and a mission schedule. Additionally, the report shall provide an estimate of the likelihood of mission success, an assessment of mission and project risks, and a discussion of mitigation strategies. Business case information will also be provided, including key assumptions and a discussion of return on investment.

The following is a suggested report format with examples of key data needed in each section:

- 1) **Object Selection** – This section provides the rationale used for selecting target objects to be returned including assessment of potential points versus the ability to locate and capture the object robotically. A determination of approximate location on the Moon of the selected target object and means of

determining its location must also be presented.

- 2) **Mission Objectives and Requirements Definition** - A set of high-level mission objectives needs to be developed to provide a basis for developing requirements. This section includes traceability from mission objectives to mission requirements and from mission requirements to requirements for the various mission elements (flight system, launch vehicle, mission operations system).
- 3) **Trade Studies** – The multiple options that were explored to meet the requirements defined in the previous section should be discussed. Results from these trade studies should be included here along with a rationale for final concept selection.
- 4) **Technical Summary of Selected Option** – This section includes a description of the flight system, launch vehicle, and concept of operations to accomplish the mission objectives. At a minimum, tables detailing trajectory design, flight system lower-level masses and power budgets, and mission operations events must be included along with corresponding summary information. Any planned resource margins (mass, power, etc.) must be clearly identified and substantiated.
- 5) **Management Plan, Schedule, and Cost Estimate** – This section describes the plan for managing all phases of the mission, provides a detailed schedule for implementation activities from project start through item return, and includes a cost estimate organized to a Work Breakdown Structure (WBS). The basis of estimate for all cost elements must be clearly described. An

assessment of potential project risks must also be included.

6) Summary

7) References

A Compliance Matrix must be included to identify RFP requirements and where they are addressed in the proposal. RFP requirements and data needed include:

- Item return no later than 40th Anniversary of last Apollo landing
- Identification of target items and locations
- Definition of mission objectives and traceability of mission objectives to project requirements
- Description of basis for object selection and method of object capture
- Results from trade studies
- Trajectory design details
- Launch vehicle selected, cost and other characteristics
- Definition of concept of operations
- Lower-level flight system mass and power requirements and margin
- Project schedule details
- Multi-level WBS with life cycle cost estimate
- Total life cycle cost such that the venture is profitable with the \$1 Billion prize and other means of generating revenue
- Basis of estimate for costs
- Assessment of potential project risks

5. ADDITIONAL CONTACTS, DATA and REFERENCES

All questions pertaining to this RFP should be directed to: Dr. Todd Mosher, via email at tmosher@microsatsystems.com. It is planned that all questions and answers will be posted at the AIAA Space Systems Technical Committee web site, <http://www.aiaa.org/tc/ss/>, which can also be accessed through the AIAA homepage at www.aiaa.org. From the “Inside AIAA” top

menu, click on “Technical Committees” on the left-hand menu, and scroll down to the Space Systems Technical Committee.

REFERENCES:

- 1) Larson, W. J., and Wertz, J. R., editors, Space Mission Analysis and Design, Third Edition, Microcosm, Inc. and Kluwer Academic Publishers, 1999.
- 2) Brown, C. D., Elements of Spacecraft Design, AIAA, 2002.
- 3) Isakowitz, S. J., Hopkins, J., and Hopkins, J. P., Jr., International Reference Guide to Space Launch Systems, Fourth Edition, AIAA 2004.
- 4) NASA JSC Cost Estimating and Models Web Site <http://www.jsc.nasa.gov/bu2/>
- 5) Johnson-Sheehan, R., Writing Proposals, Longman Publishing Group, 2001.
- 6) Blanchard, B. S., Systems Engineering and Analysis, Third Edition, Prentice Hall, 1998.

V. BASIS FOR JUDGING

1. Object(s) Selection and Method of Capture (15 percent)

The proposal should define criteria used for object(s) selection and describe the method of capturing the object(s) for return to Earth.

2. Requirements Definition (25 percent)

Trajectory design and propulsion system requirements should be defined for the

selected lunar location to derive mission design requirements. Requirements for the object return mission should also be defined to support selection of payload elements and flight system capabilities. The mission and payload requirements should then be used to define requirements for the rest of the project elements (flight system, ground system, launch vehicle, mission operations, etc.).

3. Technical Content (40 percent)

All spacecraft flight hardware subsystems should be fully defined including specification of mass and power characteristics. Launch vehicle interfaces and performance should be characterized. Ground system and mission operations system designs should be defined.

4. Programmatic (20 percent)

Programmatic considerations include derivation of an implementation schedule and definition of required life cycle costs to meet project requirements. The approaches used to define schedule and cost requirements should be fully explained. A description of the business case including return on investment should also be included. If alternative means of profits are assumed, beyond the \$1 Billion prize, justification for them must be provided and referenced.

The design should provide a feasible and practical solution to the challenge posed with credit given for innovative solutions. The design proposal should be thorough in addressing all of the requirements and constraints in the proposal request. The report should be organized in a manner that is easy to follow and understand. Proposals should also adhere to any additional format guidelines outlined in this request.

