

# 2004/2005 AIAA FOUNDATION Undergraduate Team Space Design Competition

## I. RULES

1. All groups of 3 to 10 undergraduate AIAA branch or at-large Student Members are eligible and encouraged to participate.
2. The competition will be conducted and scored electronically. A Microsoft Word or Adobe PDF file of the submittal shall be e-mailed to the following address: [hgross@integrity-apps.com](mailto:hgross@integrity-apps.com). **Note: an ftp site may be made available. Please check the AIAA site for updates.** The following documents must be delivered to the AIAA Student Programs Department: one hardcopy of the signature sheet bearing the names, student numbers, and signatures of the project leader and the participating AIAA Student Members; one disk/CD of the submittal in PC format. Designs that are submitted must be the work of the students, but guidance may come from the Faculty Advisor and should be accurately referenced and acknowledged.
3. Design projects that are used as part of 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. Certificates will be presented to members of the winning design team 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 will be expected to present a summary design paper at an AIAA Conference in 2005. The AIAA Foundation will defray reasonable airfare and lodging for the team representative.

5. More than one design may be submitted from students at any one school. 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 22" max).
6. If a design group withdraws its project from the competition, the team chairman must notify the AIAA National Office immediately!

## 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 Mar 2005**
- B. Receipt of Proposal – 10 June 2005**
- C. Announcement of Winners – Aug 2005**

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:

**Mr. Stephen Brock  
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. PROPOSAL**

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. Provide a description of automated design tools or specialized software used to develop the design.

## **IV. REQUEST FOR PROPOSAL**

### **Mission to Rendezvous with and Divert an Incoming Asteroid**

#### **1. OPPORTUNITY DESCRIPTION**

On July 4, 2004, NASA/JPL's Near Earth Asteroid Tracking (NEAT) camera at the Maui Space Surveillance Site discovered a ~0.205 km diameter Apollo asteroid designated 2004WR. This asteroid has been assigned a Torino Impact Scale rating of 9.0 on the basis of subsequent observations that indicate there is a 95% probability that 2004WR will impact the Earth. The expected impact will occur in the Southern Hemisphere on January 14, 2015 causing catastrophic damage throughout the Pacific region.

#### **2. PROJECT OBJECTIVE**

Your mission is to design a space system that can rendezvous with 2004WR in a timely manner, inspect it, and remove the hazard to Earth by changing its orbit and/or destroying it. The orbital elements of 2004WR are given in Appendix 1. The references list additional information on near-Earth asteroids.

You need to examine the orbital mechanics involved, develop a mission concept, generate a conceptual vehicle design for your spacecraft and payload(s), select a launch vehicle, and describe your mission operations plan. The fate of billions of people is in your hands. Good luck!

### 3. DESIGN REQUIREMENTS AND CONSTRAINTS

The undergraduate team shall develop a mission concept to inspect asteroid 2004WR and to destroy it or modify its orbit sufficiently so that it no longer poses a hazard to Earth. The inspection shall include characterization and determination of the asteroid's material properties, and the mission concept shall include a description of the destruction/orbit modification approach to eliminating the asteroid as a threat. The team shall determine the asteroid's orbital properties and calculate the delta-V and propellant required to perform the mission. 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 mission operations plan that addresses ground operations for command and control.

### 4. DATA REQUIREMENTS

The final 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.

### 5. ADDITIONAL CONTACTS, DATA and REFERENCES

All questions pertaining to this RFP should be directed to: Dr. Harry Gross, via email. He can be reached at [hgross@integrity-apps.com](mailto:hgross@integrity-apps.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/index.htm>, which can also be accessed through the AIAA homepage at [www.aiaa.org](http://www.aiaa.org). In the "About AIAA" section, click on "Technical Committees," and scroll down to the Space Systems Technical Committee.

#### REFERENCES:

- 1) Near Earth Object Program Homepage  
<http://neo.jpl.nasa.gov/neo/pha.html>
- 2) Space Weather Homepage  
<http://www.spaceweather.com/>
- 3) Larson, W. J., and Wertz, J. R., editors, Space Mission Analysis and Design, Third Edition, Microcosm, Inc. and Kluwer Academic Publishers, 1999.
- 4) Brown, C. D., Elements of Spacecraft Design, AIAA, 2002.
- 5) Isakowitz, S. J., Hopkins, J., and Hopkins, J. P., Jr., International Reference Guide to Space Launch Systems, Fourth Edition, AIAA 2004.

- 6) NASA JSC Cost Estimating and Models Web Site  
<http://www.jsc.nasa.gov/bu2/>
- 7) Johnson-Sheehan, R., Writing Proposals, Longman Publishing Group, 2001.
- 8) Blanchard, B. S., Systems Engineering and Analysis, Third Edition, Prentice Hall, 1998.

## V. BASIS FOR JUDGING

### 1. Technical Content (50 percent)

The proposal should present in a clear and consistent manner a concept that will satisfy the mission objectives as outlined in the Request for Proposal. Sufficient technical detail about the assumptions, theories, and models used should be included to demonstrate understanding of the objectives and to provide the evaluators with a thorough understanding of the subsystems and other system design information as identified in the proposal request. Key assumptions must be clearly outlined and justified. Technical references and source material must be properly documented.

### 2. Practical Application and Feasibility (25 percent)

The design should provide a feasible and practical solution to the challenge posed in the proposal request. Potential technical hurdles and risks should be clearly identified, and realistic solutions to meet those challenges should be presented and discussed. The design should assess and demonstrate the technical feasibility of the proposed baseline system concept as well as include development (i.e., non-recurring) and life cycle cost estimates for the proposed system. Any environmental impacts

of the system should be discussed and evaluated.

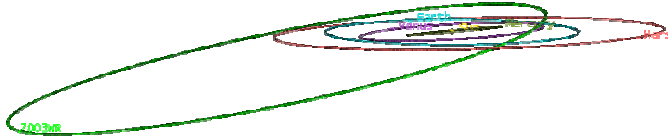
### 3. Originality and Creativity (10 percent)

Credit will be given for innovative solution(s) to the challenge described in the proposal request.

### 4. Organization and Presentation (15 percent)

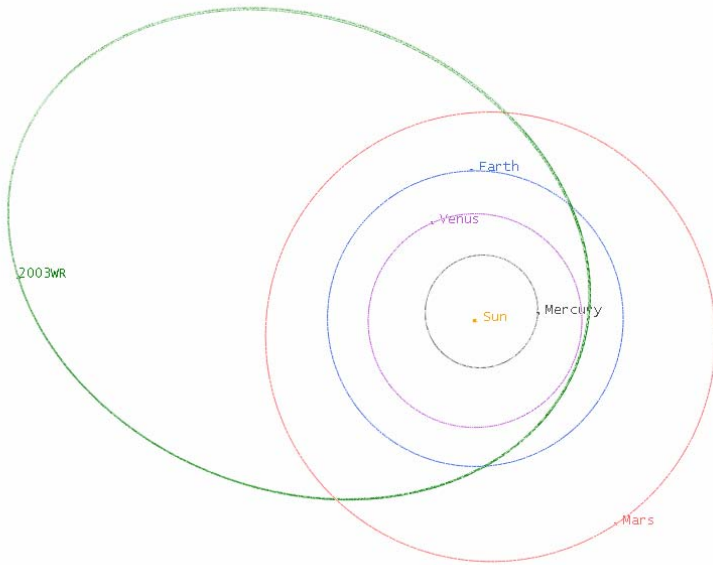
The design proposal should be thorough in addressing all of the requirements and constraints in the proposal request. The report should be organized in a manner consistent with standard scientific and engineering research reports and should be easy to follow and understand. Proposals should also adhere to any additional format guidelines outlined in this request.

### Appendix 1: Orbital Elements for Object 2004WR



Sun MeanECI J2000 Axes  
24 Jul 2004 07:00:00.00 Time Steps 67:00 sec

2004WR  
Epoch 53200 TDB  
a 2.15374076 AU  
e 0.649820926  
i 11.6660258°  
w 66.2021796°  
Node 114.4749665°  
M 229.8987151°  
q 0.7542 AU  
Q 3.5533 AU  
P 3.16 yr



Intent Form

2004/2005

AIAA FOUNDATION

Undergraduate Team Space Design Competition

Request for Proposal: Mission to Rendezvous with and Divert an Incoming Asteroid

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

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

Designer's Name	AIAA Member #	Graduation Date	Degree
Team Leader			
Team Leader E-mail			
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
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In order to be eligible for the 2004/2005 AIAA FOUNDATION Undergraduate Team Space Design Competition, you must complete this form and return it to the AIAA Director of Student Programs **before 17 March 2005**, 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