

## Request for Proposal

### Pluto Orbiter

#### 1. Opportunity Description

The recent flyby of the Pluto-Charon system by New Horizons has shown a more dynamic system than was envisioned prior its initial exploration. Due to complex terrain forms and atmospheric phenomena that were both directly observed and inferred from the available data, a longer term mission to study the dynamics of the Pluto-Charon system could be scientifically valuable, especially as the system progresses on its orbit further from the Sun. Basing the instrumentation load on New Horizons (updated to current norms), utilize available literature on launch vehicle performance, trajectories and TRL 6 or higher in-space propulsion systems to design a spacecraft and mission that can achieve orbital insertion into the Pluto-Charon system with a primary mission length of no more than 25 years with a minimum of a one year Pluto orbital duration.

#### 2. Project Objective

The objective of this project is to propose an orbital exploration mission of the Pluto-Charon system using a spacecraft with the minimum nominal instrument load (i.e. dry mass) of New Horizons.

#### 3. Design Requirements and Constraints

The undergraduate team (class) shall propose space exploration mission, including definition of mission architecture and design of its key elements that meets the following requirements and constraints:

1. The exploration mission shall be an orbital exploration of the Pluto-Charon system.
2. The proposed exploration mission architecture and timeline is constrained by a single launch of a vehicle chosen by the team.
3. While not constraining for the purposes of this project, basic consideration should be given to scientific merit and economics of the proposed mission.
4. Substitutions/additions to the New Horizons instrument baseline may be made, but inclusion/deletion should be scientifically justified for the proposed mission.
5. In-space propulsion subsystem is not included in the New Horizons baseline mass and does not count against the baseline spacecraft mass total.
6. Factors such as reliability, affordability, and extended missions should be considered.
7. Earlier arrival (i.e., additional time on orbit) in the Pluto system will be judged preferentially.
8. The emphasis of this project is on the technical aspects of the exploration mission architecture and design of its key elements. The project will require a multi-disciplinary team of students. Traditional aerospace engineering disciplines such as structures, propulsion, flight mechanics, orbital mechanics, and optimization will be involved. Teams will make significant design decisions regarding the configuration and characteristics of their preferred system. The design

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team should also identify and address any risks and challenges that are unique to the proposed system.

### **4. Data Requirements**

The final proposal report shall provide an overall engineering description of the design concept and detailed design information for major components and subsystems. At a minimum, the final proposal report shall contain the following:

1. Key trade studies and a justification for selection of the overall concept and each of the major subsystems.
2. Description of proposed flight sequence and mission timeline.
3. Details of propulsion, vehicle sizing, trajectory, loads, structural, and payload capability analysis. Critical technologies and their current Technology Readiness Level (TRL). Discussion of any required technological breakthroughs or plans for developing technologies to the required maturity.
4. Discussion of design and concept of operation. Systems that are unique to the proposed design, such as vehicle(s), propulsion subsystem(s), propellant and power subsystems, thermal protection subsystem, and communication subsystems should be addressed in considerable detail.
5. Subsystems, such as avionics, guidance, navigation, and control which are not the focus of this project, do not require much attention, unless their mass fraction is expected to have significant mission architecture implications.
6. Discussion of risk mitigation strategies for key technical and programmatic risks.
7. Drawings of the overall vehicle(s) and key components or subsystems.
8. Estimate of development and operation life cycle cost.

### **5. Additional Contacts, Data and References**

All technical questions pertaining to this RFP should be directed to Mike Fuller of Orbital ATK via email at [mike.fuller@orbitalatk.com](mailto:mike.fuller@orbitalatk.com). Any updates to this RFP will be posted on the AIAA Design Competitions web site <http://www.aiaa.org/DesignCompetitions/>

#### **References:**

- 1) *International Reference Guide to Space Launch Systems*, 4th Edition, 2004. Steven J. Isakowitz, Joseph P. Hopkins, Jr., and Joshua B. Hopkins, editors.
- 2) *Title 14 Code of Federal Regulations Parts 400-499*, Chapter III Commercial Space Transportation

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### AIAA Education Series

- 1) *Design Methodologies for Space Transportation Systems*, 2001. Walter E. Hammond, author. (Note: design software is included with the textbook).
- 2) *Elements of Spacecraft Design*, 2002. Charles D. Brown, author.
- 3) *Space Vehicle Design*, 2nd Edition, 2004. Michael D. Griffin and James R. French, authors.
- 4) *Aerothermodynamics of Gas Turbine and Rocket Propulsion*, 3rd Edition, 1997. Gordon C. Oates, author. (Note: design software is included with the textbook).
- 5) *Spacecraft Propulsion*, 1996. Charles D. Brown, author. (Note: design software is included with the textbook).
- 6) *Modern Engineering for Design of Liquid-Propellant Rocket Engines*, Progress in Astronautics and Aeronautics Series, 1992. Dieter K. Huzel and David H. Huang, editors.

## Design Competition Rules

### Eligibility Requirements

- All AIAA Student members are eligible and encouraged to participate. Membership with AIAA must be current to submit a report and to receive any prizes.
- Students must submit their letter of intent and final report via the online submission to be eligible to participate. **No extensions will be granted.**
- More than one design may be submitted from students at any one school.
- If a design group withdraws their final report from the competition, the team leader must notify AIAA Headquarters immediately.
- Design projects that are used as part of an organized classroom requirement are eligible and encouraged for competition.

### Schedule

- Letter of Intent — 10 February 2018 (11:59 pm Eastern Time)
- Proposal delivered to AIAA Headquarters — 10 May 2018 (11:59 pm Eastern Time)
- Announcement of Winners — 31 August 2018 (11:59 pm Eastern Time)
  - Engine Design Competition dates
    - Letter of Intent – 14 February 2018 (11:59 pm Eastern Time)
    - Proposal submitted, via online submission site to AIAA Headquarters – 16 May 2018 (11:59 pm Eastern Time)
    - Round 1 evaluations completed – 30 June 2018 (11:59 pm Eastern Time)

Round 2 presentations at AIAA Propulsion and Energy Forum 2018

### Categories/Submissions

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- Team\_Submissions
  - Team competitions will be groups of not more than ten AIAA Student Members per entry.
- Individual\_Submissions
  - Individual competitions will consist of only one AIAA Student member per entry.
- Graduate
  - Graduate students may participate in the graduate categories only.
- Undergraduate
  - Undergraduate students may participate in the undergraduate categories only.
- Letter of Intent (LOI)
  - A Letter of Intent indicating interest in participating in the design competitions is required before submitting a final report.
  - All Letters of Intent must be submitted through the online submission system.
  - Letter of Intent must include student's names, emails, AIAA membership numbers, faculty advisor(s) names, emails, and project advisor(s) names and emails.  
Incomplete LOI's will result in the Team or Individual being ineligible to compete in the competition.
- Submission of Final Design Report

Each team or individual must provide an electronic copy their design report as outlined below to the online Submission site

  - An electronic copy of the report in Adobe PDF format must be submitted to AIAA using the online submission site. Total size of the file cannot exceed 20 MB.
  - Electronic report files must be named: "2018\_[university]\_DESIGN\_REPORT.pdf"
  - A "Signature" page must be included in the report and indicate all participants, including faculty and project advisors, along with students' AIAA member numbers and signatures.
  
  - Electronic report should be no more than 100 pages, double-spaced (including graphs, drawings, photographs, and appendices) if it were to be printed on 8.5"x11.0" paper, and the font should be no smaller than 10 pt. Times New Roman.
    - Engine Design Competition is limited to 50 pages.

## Copyright

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

Authors retain copyright ownership of all written works submitted to the competition. By virtue of participating in the competition, team members and report authors grant AIAA non-exclusive license to reproduce submissions, in whole or in part, for all of AIAA's current and future print and electronic uses. Appropriate acknowledgment will accompany any reuse of materials.

## Conflict of Interest

It should be noted that it shall be considered a conflict of interest for a design professor to write or assist in writing RFPs and/or judging proposals submitted if (s)he will have

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students participating in, or that can be expected to participate in those competitions. A design professor with such a conflict must refrain from participating in the development of such competition RFPs and/or judging any proposals submitted in such competitions.

### **Awards**

The prize money provided for the competitions is funded through the AIAA Foundation. The monetary awards may differ for each competition, with a maximum award of \$1,000. The award amounts are listed below.

The top three design teams will be awarded certificates. One representative from the first place team *may be* invited by the Technical Committee responsible for the RFP to make a presentation of their design at an AIAA forum. A travel stipend *may be* available for some competitions, with a maximum travel stipend of \$750 which may be used to help with costs for flight, hotel, or conference registration to attend an AIAA forum.

### **Aircraft Design Competitions**

- Graduate Team Aircraft - Advanced Pilot Training Aircraft
- Undergraduate Team Aircraft – Hybrid-Electric General Aviation Aircraft (HEGAA)
  - 1<sup>st</sup> Place: \$500; 2<sup>nd</sup> Place: \$250; 3<sup>rd</sup> Place: \$125
- Undergraduate Individual Aircraft – Close Air Support Aircraft (A-10 Replacement)
  - 1<sup>st</sup> Place: \$1,000; 2<sup>nd</sup> Place: \$500; 3<sup>rd</sup> Place: \$300

### **Engine Design Competition**

- Undergraduate Team Engine –Candidate Engines for a Next Generation Supersonic Transport
  - 1<sup>st</sup> Place: \$500; 2<sup>nd</sup> Place: \$250; 3<sup>rd</sup> Place \$125

### **Space Transportation Competition**

- Undergraduate Team Space Transportation – Pluto Orbiter
  - 1<sup>st</sup> Place: \$500; 2<sup>nd</sup> Place: \$250; 3<sup>rd</sup> Place: \$125

### **Space Design Competition**

- Undergraduate Team Space Design – Lunar Prospecting
  - 1<sup>st</sup> Place: \$500; 2<sup>nd</sup> Place: \$250; 3<sup>rd</sup> Place: \$125

### **Structures Design Competition**

- Graduate Team Structures – Fuselage Design
- Undergraduate Team Structures – Supersonic Wing
  - 1<sup>st</sup> Place: \$500; 2<sup>nd</sup> Place: \$250; 3<sup>rd</sup> Place: \$125

### **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:

- Demonstrate a thorough understanding of the Request for Proposal (RFP) requirements.
- 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.
- 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.
- Include tradeoff studies performed to arrive at the final design.
- Provide a description of automated design tools used to develop the design.

### **Basis for Judging**

The AIAA Technical Committee that developed the RFP will serve as the judges of the final reports. They will evaluate the reports using the categories and scoring listed below. The judges reserve the right to not award all three places. Judges' decisions are final.

#### ***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

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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.