2025-2026 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 Adobe PDF format must be submitted to AIAA Student Programs. All materials, including letters of intent and final reports, **must be submitted online via www.aiaa-awards.org – AIAA will not accept for submission any materials mailed to the AIAA office.**
3. A "Signature" page must be included in the report and indicate all participants, including faculty and project advisors, along with their AIAA member numbers.
4. Design projects that are used as part of an organized classroom requirement are eligible and encouraged for competition. Designs submitted must be the work of the students, but guidance may come from the Faculty/Project Advisor and should be accurately acknowledged.
5. The top three design teams will be awarded certificates for their accomplishment. Monetary awards pending funding availability. Certificates will be presented to the winning design teams for display at their universities, and a certificate also will be presented to each team member and the faculty/project advisor. Representative from each of the top three place design teams will be offered an opportunity to present the team's work at one of AIAA's Forum or Conference. Teams are responsible for their own travel arrangements and conference registration.
6. Report should be *no more than 100 (total) double-spaced typewritten pages and typeset should be no smaller than 10 pt Times* (including graphs, drawings, photographs, and appendices) on 8.5" x 11.0" paper. Up to five of the 100 pages may be foldouts (11" x 17" max).
7. More than one design may be submitted from students at any one school. Team competitions will be groups of not more than ten (10) AIAA branch or at-large Student Members per entry. Individual competitions will consist of only one (1) AIAA branch or at-large Student Member per entry.

II. 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 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. Emphasis should be directed at identification of critical, technical problem areas. Descriptions, sketches, drawings, systems analyses, 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 and provide clear and concise rationale for decisions.
5. Provide a description of automated design tools used to develop the design.

III. 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? Did the report clearly show understanding of the RFP requirements and design provided satisfied the requirements? Did the tools and methods used to evaluate the design sound, with clear validation of the methodology? Did the report provide appropriate description of the trades and analysis with clear rational and justification for the results?

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. Are all of the Figures, Graphs, and Tables clear and easy to read and understand? Is the report clear of grammatical and spelling errors?

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. Are the cost, schedule, and risk assessments well motivated and validated with reasonable assumptions on technology and system maturation as well as appropriate margin?

IV. REQUEST FOR PROPOSAL

Heliophysics Science Observer & Communication Platform

Background

The 2024 National Academies of Sciences' decal survey in Heliophysics described in detail the significant accomplishments of robotic missions to our understanding of the solar system and lays out the foundation for future priorities for exploration[1]. As humanity reaches farther beyond the confines of our magnetosphere, our understanding of the solar systems and space weather remains a critical priority to enable exploration. As the report mention, the broad theme for the next decade for Heliophysics revolves around improving our understanding of our Sun, space weather, and their impacts on our infrastructure and human health. And with the strong desire for crewed exploration beyond the confines of low Earth orbit, our ability to understand, predict, and provide early warning for space weather related events in support of human exploration will be the upmost priority.

Having the ability the monitor space weather phenomena is not impactful for mission planning if the ability to communicate the status to the crew is hindered by communication disruption. For any crewed missions to

[1] National Academies of Science, Engineering, and Medicine. "The Next Decade of Discovery in Solar and Space Physics." 2024.

Mars, communication delays and disruptions is a key challenge that must be addressed[2]. The ability to provide early warning of space weather events to crew in transit to/from Mars, on the surface of Mars, and/or on the surface of the Moon can help reduce the overall mission risk associated with these missions. This Request for Proposal seeks innovative mission concept of operations and system designs to support the next decade of Heliophysics science investigation, space weather monitoring and analysis, as well as provide communication support for crewed missions to the lunar and Martian surface.

Design Requirements and Constraints

- Design an integrated comprehensive mission to send one or more exploration assets to space to meet the National Academies of Science's Heliophysics priority investigations as outlined in the 2024 decadal survey for solar and space physics as well as NASA's Moon to Mars Objectives[3] and to provide communication capability for potential crewed missions to Mars.
- The spacecraft (or a constellation of spacecrafts) shall provide:
  - Scientific instruments to support our understanding of the local cosmos, including ability to monitor and detect solar and space weather phenomena, and enable the capability to provide early warning for crewed missions.
  - Ability to provide line of sight between the Earth and Mars to enable near constant communication capability during the RFP specified mission period.
- The proposal shall define specific mission objectives, describe the process to select the instrumentation to meet those science objectives, and show how the chosen mission objectives meets the National Academies decadal objectives and NASA's Moon to Mars objectives.
- The mission design shall provide spacecraft and system analysis to show the capability for line-of-sight communication between Earth and Mars for the full Earth-Mars synodic cycle between 2036 and 2049.
- Perform trade studies on various mission designs at the architecture and system levels to demonstrate the fitness of the chosen mission and system design. Trades should include system architecture, launch vehicles, instruments, orbital mechanics, spacecraft subsystem level designs, and other mission level system trades, including analysis of single vs multiple assets. It is highly desirable to use technologies that are already demonstrated on previous programs or currently in the NASA technology development portfolio. Trades should be assessed on the bases of benefit, risk, and cost.
- Perform mission analysis to evaluate the flight profile for the asset(s) and describe the mission profile for observation measurement and to show how the mission provide adequate coverage as specified by the RFP and provide discussion on the communication capabilities for the design.
- Discuss selection of subsystem components and the values of each of the selection and how the design requirements or scientific objectives drove the selection of the subsystem.
- Discuss the instruments selected to address the primary science objectives, and the data collection, analysis, data processing, and transmission process to address the objectives.

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[2] NASA's Moon to Mars Architecture White Paper, "Mars Communications Disruption and Delay." 2023.
[3] NASA's Moon to Mars Strategy and Objectives Document. 2022.

- The cost for the mission and capability development in support of its activities shall not exceed $400 Million US Dollar (in FY25), including development, hardware, launch, and operation cost of the mission through the primary mission phase.
- The mission should launch no later than December 31, 2035, with the system designed to operate into late 2040s.

Deliverables

This project will require a multi-disciplinary team of students. Traditional aerospace engineering disciplines such as structures, propulsion, flight mechanics, orbital mechanics, thermal, electric power, attitude control, communications, sensors, environmental control, and system design optimization will be necessary. In addition, economics and schedule will play a major role in determining design viability. Teams will make significant design decisions regarding the configuration and characteristics of their preferred system. Choices must be justified based both on technical and economic grounds with a view to the extensibility and heritage of any capability being developed.

The following is a list of information to be included in the final report. Students are free, however, to arrange the information in as clear and logical a way as they wish with the exception of a 5-page executive summary which must be place at the beginning of the report.

1) Requirements Definition – the report should include the mission and design requirements at the vehicle, system, and subsystem level. The requirements definition should demonstrate the team's understanding of the *RFP Design Requirements and Constraints* and lay the foundation for the design decisions that follow.
2) Concept of Operation – a detailed concept of mission operation should be included to describe all phases of the mission and to demonstrate the realization of the mission requirements in the *RFP Design Requirements and Constraints*. The report should show that the team has performed historical analysis of similar concepts to evaluate the merits and deficiencies of previous designs and demonstrate that alternative concepts were considered while providing justification for the chosen concept.
3) Trade Studies – the report should include the trade studies for the vehicle architecture, mission operations, and subsystem selections, and must discuss in detail how the system level requirement are developed from mission requirements by describing the pro and cons of each subsystem options. The report must discuss how each subsystem level decision is made, with description of the selection metrics and their associated weightings when appropriate and provide detailed discussions on how each decision impact system level metrics such as cost, schedule, and risk.
4) Design Integration and Operation – the report should discuss how the trades selected in section 3 are integrated into a complete architecture. This section should discuss design of all subsystems: structures, mechanisms, thermal, attitude control, telemetry, tracking, and command, electric power, propulsion, payload and sensors, and the mission concept of operations. Discussion on the extensibility of the overall system design and how it can support future exploration mission should be included. The report must clearly describe all the tools and methods utilized for the system and subsystem design and provide brief description of the inputs, outputs, and assumptions for the design. A discussion on the validation of the tools and methods must be included.
5) Cost Estimate – a top level cost estimate covering the life cycle for all cost elements should be included. A WBS should be prepared to capture each cost element including all flight hardware, ground systems, test facilities, and other requirements for the design. Estimates should cover design, development, manufacture, assembly, integration and test, launch operations and checkout, in-space operations, and

final delivery. Use of existing/commercial off-the-shelf hardware is strongly encouraged. Advanced technology utilization must be fully costed with appropriate cost margin applied. A summary table should be prepared showing costs for all WBS elements distributed across the various project life cycle phases. The report should discuss the cost model employed and describe the cost modeling methods and associated assumptions in the cost model. The cost analysis should provide the appropriate cost margin based on industry standards.

6) Mission and operation summary – an integrated roll up of all the subsystems into a mass and power Work Breakdown Structure, showing mass and power budget, broken into subsystems, with description of the margin assigned to each system based on industry standards. A summary table should be prepared showing all mass, power, and other resource requirements for all flight elements/subsystems with the appropriate mass and power margins clearly labeled and discussed.
7) Schedule – A mission development and operation schedule should be included to demonstrate the mission meets the schedule deadline established in the RFP. Schedule margin should be applied to appropriate areas with funded schedule reserve detailed in the cost estimate. Any advanced technology assumption should have corresponding technology development schedules and costs associated with the technology and appropriate contingency plans should be discussed.
8) Summary and References. A concise, 5 page "Executive Summary" of the full report must be included and clearly marked as the summary at the beginning of the report. The executive summary should provide a clear sense of the project's motivation, process, and results. References should be included at the end. A compliance matrix, listing the page numbers in the report where each these section as well as the items identified under the *Design Requirements and Constraints* and *Deliverables* sections can be found, is mandatory.

Supporting Data

Technical questions can be directed to Patrick Chai (patrick.r.chai@nasa.gov) or studentprogram@aiaa.org