

Request for Proposal (RFP)

Rapid Reaction Satellite Launcher

Need

The military services of the United States and its allies have a need for a rapid response capability to launch small satellites into low earth orbit from bomber (B-52, B-2, and B-1) and fighter (F-15E) aircraft. Such a rapid response launch capability would be needed to quickly repair gaps in space-based position, navigation and timing (PNT), communications, and intelligence, surveillance, and reconnaissance (ISR) services that might arise due to enemy action. The rapid response launch capability could also be used to add space-based services in support of special operations missions.

Objective

The objective of this project is to design a rapid reaction satellite launch vehicle system. Participants shall provide engineering analysis and total system design associated with this system. The teams shall determine a system concept that best satisfies mission requirements and goals. The teams shall describe their design process, the physical and performance characteristics of the final system design and its components, an operational concept, cost estimate, development plan, and necessary support equipment and other resources necessary to comply with the Technical Requirements.

Technical Requirements

The overall requirement of this Design Competition is to develop a rapid reaction satellite launch vehicle system. Emphasis should be on maximizing system performance and effectiveness, while minimizing the system's cost and complexity.

Top-level requirements for the system are described below:

- Each launcher shall be capable of placing a single payload with the following metrics into low earth orbit. Design and analysis of the satellite payload are not required.
- Mission Orbit Parameters:
 - Circular Orbit (flight path angle = 0° at insertion)
 - Altitude = 825,000 ft. (251.46 km)
 - Velocity = 25,440 ft/s (7.75 km/s)

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- Satellite Payload Design Parameters:
 - Threshold:
 - 12U form factor (20 cm by 20 cm by 30cm)
 - Gross weight 52.8 lbm
 - Objective:
 - Cube 12 inches by 12 inches by 12 inches
 - Gross weight 100 lbm
- Launch Vehicle size and weight constraints during carriage:
 - Threshold: Internal carriage on bomber aircraft
 - Bounding box 32 inches by 32 inches by 240 inches
 - Gross weight 25,000 lbm
 - Objective: External carriage on fighter aircraft
 - Bounding box 24 inches by 24 inches by 240 inches
 - Gross weight 5,000 lbm
 - Size constraints need not apply post-launch.
- No hardware modifications to the host platforms are permitted.
- Capable of ejector or gravity release from the host platform.
 - Assume release is at Mach 0.85 at 40,000 feet, standard day.
- Insertion of satellite payload into orbit must be completed within 24 hours of receipt of mission approval. All integration and mission-specific pre-launch activities (payload to launch vehicle, launch vehicle to host platform, fueling, etc.) shall be completed within this time.
- The rapid reaction satellite launch vehicle system, including energetics and/or propellants, shall be compatible with safe storage, transportation, and handling requirements for at least 10 years without maintenance.
- Assume a production run of 10 launch vehicles per year for 10 years, plus 5 launch vehicles for developmental testing.

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For the purpose of determining technology availability and program planning, design and development starts October 2024, and the system initial operational capability (IOC) shall occur no later than December 2032.

Teams are encouraged to describe alternate designs and cost sensitivities for enhanced capability beyond the minimum requirements as well as suitability for the rapid reaction satellite launch vehicle system to be adapted to other missions and/or launch platforms.

Designs shall adhere to standard engineering practices for health, safety, and environmental impact. Where appropriate, teams shall evaluate performance improvements offered by design choices versus cost, hazards to personnel, manufacturability, and maintenance considerations.

Where not specified, requirements shall be derived by the project team based on reasonable, justified assumptions that should be documented in the submitted proposal.

In case of conflicting or unachievable requirements, teams shall identify which constraints or requirements proved infeasible, clearly explain the trade-offs involved, and provide a solution that attempts to satisfy as many requirements as closely as is feasible.

The AIAA Missile Systems Technical Committee (MSTC) may be contacted with critical questions the team needs resolved to proceed with the project (see the Additional Information section below).

Data Requirements

The team shall provide a final technical proposal documenting the design of the rapid reaction satellite launch vehicle system clearly and concisely. The proposal shall include pertinent analyses and trade studies supporting the design decisions. A full description of the rapid reaction satellite launch vehicle system solution is expected, including its performance capabilities and operational limits. Further details of proposal contents are described below.

Concept of Operation

The team shall formulate and describe a complete concept of operation, including a notional timeline. The concept of operation shall include descriptions of how the launcher system will be configured and prepared for use. Additionally, the concept for all support equipment required for transportation, assembly, integration, checkout, and operation of the launch vehicle system, and the number and function of personnel to set-up and operate the system shall be described.

Performance Assessments

Description of the design's capability for the performance requirements shall be provided. Data products shall include, at a minimum:

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- A time history of the design mission trajectory (flight performance parameters), including as a minimum, altitude, range, fuel/propellant flow rate, weight, net thrust, lift, drag, velocity, angle of attack and Mach number.

Systems Analysis

The teams shall describe design and analysis techniques, the system design process, data sources (references), assumptions, and derived requirements. Data products shall include, at a minimum:

- Scaled drawing of the launch vehicle system, including dimensions and center of gravity location as well as an inboard profile drawing illustrating sufficient volume for all necessary components and systems.
- Aerodynamic characteristics, propulsion characteristics and weight statement of the recommended design.
- Analysis results to show that the recommended design has sufficient aerodynamic stability and is controllable.
- Analysis results quantifying the aerothermal environment and showing that the design can survive various environments (stratosphere, upper atmosphere, space, etc.).
- The physical and performance characteristics of the preferred concept shall be compared to all requirements.
- Documentation of key trade studies and decisions including the methods and rationale for how the final concept was selected and why it best satisfies the requirements described in this RFP.

Cost Estimate

The total cost of the complete system, to include acquisition, maintenance, and operating cost (per mission), shall be estimated and documented. The estimate should include the cost of the launch vehicle (tooling, materials, labor, overhead, other expenses and reasonable profit), support equipment unique to the design, supplies to maintain the system, and any other costs. Unique equipment that cannot readily be used for other purposes must be included in the system cost, but the cost of equipment commonly used for other purposes need not be included.

Development Plan

A sequenced development plan shall be described to highlight activities (such as design, test and evaluation) needed to be ready to produce the new components needed for the system. This plan should include details of required ground testing, and a list of the facilities that would be utilized.

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Deliverables

A written final design report conforming to the submission guidelines is due for judging as specified below in the AIAA design competition rules. The Imperial system of units shall be used in documentation (feet, lbs., etc.). Metric units (in parenthesis) alongside Imperial unit values are acceptable.

Analysis Tools

All analytical modeling tools, data sources, computer codes, and technical resources used to generate, analyze, model and produce the design and associated report must be:

- i.) Available for inspection, download, and/or sale to all individuals and entities regardless of nationality as allowed by US export laws; or
- ii.) Generated personally by the students on the team without the use of codes falling under restriction i or substantial material assistance by individuals or entities outside of the team.

Teams are required to list all computer codes used along with the URL where they may be obtained under the conditions above.

Competition Timeline

It is unclear at present if AIAA will select the 2023-2024 MSTC Missile Design Competition as an official AIAA competition. It is expected that this determination will be made in the summer of 2023.

If this competition is accepted as an official AIAA competition, the timeline for the competition will be that posted on the AIAA Design Competitions web site:

<https://www.aiaa.org/get-involved/students-educators/Design-Competitions>

If this competition is not accepted as an official AIAA competition, this competition will still be held by MSTC as an unofficial competition with the following timeline:

- 1 August 2023: Teams may begin working on their design
- 1 October 2023: Emails due to the AIAA MSTC point of contact Peter Cross at peter.g.cross@gmail.com giving notice of planned participation in the competition
- 15 May 2024: Written reports due to AIAA MSTC point of contact
- 1 July 2024: Announcement of winners

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Additional Information

All technical questions pertaining to this RFP should be directed to the AIAA MSTC point of contact Peter Cross via email at peter.g.cross@gmail.com or the MSTC design competition subcommittee at aiaaMSTC@gmail.com.

Any updates to the RFP, as well as questions and answers related to the competition and RFP will be posted on the AIAA Engage “Missile Systems: Public Forum” website:
<https://engage.aiaa.org/space-and-missiles/communities/community-home?CommunityKey=e7efeb09-17d2-4a1f-80f4-7451de96b516>

Teams have the option of requesting mid-term and/or final design reviews with MSTC. Design reviews are completely optional and have no bearing on competition scoring.