

Request for Proposal (RFP)

Low-Cost Anti-Missile Missile

Need

The military services of the United States and its allies have a need for short- to medium-range missile defense systems capable of protecting against large salvos of threat missiles. The key to defeating these salvos of hundreds to thousands of incoming threat missiles includes a low-cost interceptor. According to various news reports, as an example, the Tamir missile used by the Iron Dome air defense system is about \$50K per missile. However, as threat salvo size increases it necessary for interceptor cost to decrease to preserve economically feasible defenses.

Objective

The objective of this project is to design a low-cost interceptor for a short- to medium-range missile defense 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 low-cost anti-missile missile. Emphasis should be on minimizing system cost while meeting system performance and effectiveness requirements.

Top-level requirements for the system are described below:

- Interceptor cost should not exceed \$10k per missile.
- Interceptor installations must provide the following capabilities for area defense from missile threats:
 - Horizontal defense radius of 5 mi (8km)
 - 360° of azimuthal coverage
 - Maximum engagement altitude of 30,000 ft

2024-2025 Open Division Missile Systems Design Competition – Low-Cost Anti-Missile Missile

- Threats can be assumed to have the following characteristics:
 - Ground ranges of 0.5 to 60 miles (1 to 100 km)
 - Up to 3 g's of non-ballistic maneuvering capability
 - Speeds up to Mach 3
 - Unitary missile
 - Minimum size: 4 inches in diameter, 8 feet in length, 100 lbm mass
 - Maximum size: 24 inches in diameter, 20 feet in length, 4000 lbm mass
- The anti-missile missile must be capable of being launched from:
 - Threshold: fixed, ground-based launcher installations
 - Objective: mobile ground-based launchers (e.g., trucks or tanks)
 - Objective: ship-mounted launchers
 - Compatibility with existing launcher systems is desired.
- The missile must be able to go from a dormant state to launch in less than 1 second. It can be assumed that immediately prior to launch the battle management system will provide the interceptor an estimate ($\pm 5\%$ error) of the threat system's azimuth, range, altitude, and velocity.
- The interceptor design can include command data links or in-flight updates or not (up to the team).
- The low-cost anti-missile missile, 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 1000 missiles per year for 10 years, plus 100 missiles for developmental testing.

For the purpose of determining technology availability and program planning, design and development starts October 2025, and the system initial operational capability (IOC) shall occur no later than December 2030.

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

2024-2025 Open Division Missile Systems Design Competition – Low-Cost Anti-Missile Missile

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 low-cost anti-missile missile system clearly and concisely. The proposal shall include pertinent analyses and trade studies supporting the design decisions. A full description of the low-cost anti-missile missile 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. Additionally, the concept for all support equipment required for operation of the low-cost anti-missile missile system and the number and function of personnel to 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:

- A time history of the interceptor 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.
- A time history of the threat trajectory, including as a minimum: altitude, range, velocity, and Mach number.

2024-2025 Open Division Missile Systems Design Competition – Low-Cost Anti-Missile Missile

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 missile 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, stability, propulsion characteristics, and weight statement of the recommended design.
- Details on the design of the guidance, navigation, and control systems.
- Analysis results quantifying the aerothermal environment and showing that the design can survive relevant environments.
- 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, shall be estimated and documented. The estimate should include the cost of the missile 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. Identify manufacturing and technology options to lower the cost of various sub-systems.

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.

Deliverables

A written final design report conforming to the submission guidelines is due for judging as specified in the AIAA design competition rules. The Imperial system of units shall be used

2024-2025 Open Division Missile Systems Design Competition – Low-Cost Anti-Missile Missile

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 2024-2025 MSTC Missile Design Competition as an official AIAA competition. It is expected that this determination will be made in the summer of 2024. Competition timeline will therefore follow one of two options:

Official AIAA Competition

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>

One additional item requested but not on the official timeline is:

- 1 October 2024: 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

Unofficial Competition

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 2024: Teams may begin working on their design
- 1 October 2024: 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 2025: Written reports due to AIAA MSTC point of contact
- 1 July 2025: Announcement of winners

2024-2025 Open Division Missile Systems Design Competition –
Low-Cost Anti-Missile Missile

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.