Request for Proposal

Supersonic Aerial Target

Need

The military services of the United States and its allies maintain a variety of air defense systems to protect against threats such as aircraft and cruise or ballistic missiles. These air defenses may include short-, medium-, and long-range intercept missiles launched from aircraft, ships, ground vehicles, or other fixed land-based defense sites as well as anti-aircraft artillery guns or directed energy systems. In order to develop new air defenses or train operators in the use of existing defensive systems, realistic targets are needed. These targets require performance characteristics representative of the threat systems the air defenses are designed to engage.

Objective

The objective of this project is to design a Supersonic Aerial Target that is adaptable to different flight profiles and payload packages. The target is launched from a fixed ground site to a desired cruise altitude and speed and is capable of endgame maneuvers. Participants shall provide engineering analysis and total system design associated with a target system capable of representing a variety of supersonic airborne cruise missile threats. The teams shall determine a target system concept that best satisfies mission requirements and goals. The teams shall describe their design process, the physical and performance characteristics of the final target 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 supersonic target system launched from a fixed ground location. Emphasis should be on maximizing the variety of airborne threats the target can realistically represent while minimizing the system's cost and complexity. When reviewing the requirements in this section, refer to the conceptual diagram of the target system's flight profiles and phases of operation illustrated in Figure 1.

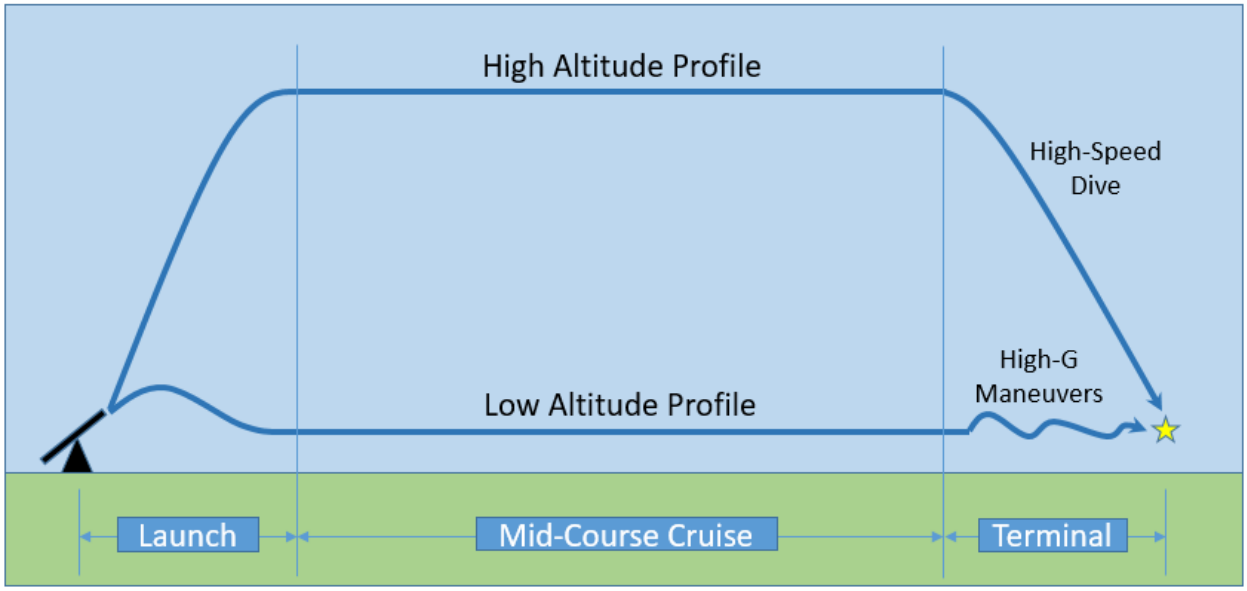

Figure 1: Supersonic Aerial Target Flight Profiles

Top-level requirements for the target system are described below:

- The target system shall be capable of achieving a threshold range of 60 nautical miles and an objective range of 150 nmi at the end of the terminal phase. A minimum range is not specified, but the target shall be capable of transitioning to the terminal phase any time after cruise conditions are attained. As such, the team shall determine the minimum distance required to complete the launch phase and begin cruise flight.

- The target system shall be capable of operating between sea level and a maximum altitude of 65,000 feet. Within this envelope, the target system shall be capable of performing high altitude "high diver" and low altitude "nap of the earth" or "sea skimming" flight profiles employed by threat supersonic cruise missiles.

- For a high diver profile, the target system shall be capable of cruising between 5,000 and 65,000 feet above sea level at a speed between Mach 2.0 and 4.5 and performing a terminal dive between 10° and 75°. The terminal impact speed shall be between Mach 0.9 and Mach 3.5.

- For a low altitude profile, the target system shall be capable of cruising between 15 and 200 feet above the surface at a speed between Mach 2.0 and 3.5 and performing terminal high-g maneuvers during the final 20 nmi of the trajectory. Terminal maneuvers shall consist of back and forth turns up to 15g in the lateral plane and climbs and dives up to 7g in the vertical plane for up to 45 seconds of flight time. The terminal impact speed shall be between Mach 2.0 and Mach 3.5.

- The target system shall be equipped with guidance, navigation and control systems capable of maintaining course within ±1500 ft of the programmed trajectory during the

mid-course cruise phase and achieving a 50 ft Circular Error Probable (CEP) at the end of the terminal phase.

- The target system, including fuel and/or propellants, shall be compatible with safe storage, transportation, and handling requirements for at least 10 years without maintenance. Liquid fuels may be stored separately and loaded prior to launch. A disposable booster rocket may be used for launch to the desired cruise altitude.

- The target system shall be capable of launching from a launch rail at a fixed ground site between sea level and 3500 ft elevation. Assume the launcher can be pointed in any azimuth angle and elevation can be set anywhere between 0° (horizontal) and 90° (vertical). The design team shall determine a launch rail length required for safe employment of the target vehicle and recommend elevation angle limits for each launch profile.

- The target system shall be compatible with modular payloads. At a minimum, the payload consists of a transponder beacon and telemetry module that transmit status data for tracking and a flight termination system for range safety. Volume shall also be provided for additional payload modules to simulate electronic signals emitted by the threat (such as a guidance radar) or a decoy system. The equipment bay to carry payload modules must provide a cylinder at least 3.5 ft (1.1 m) long by 10 inch (25.4 cm) diameter and the total payload weight shall not exceed 500 lb.

- The target system may reuse components of existing targets, missiles, or other flight vehicles to reduce cost. Teams may propose existing propulsion systems, flight control systems, electronics, or other components capable of meeting performance requirements.

- Assume a production run of 350 units plus 15 units for developmental testing.

For the purpose of determining technology availability and program planning, design and development starts October 2021, and the system initial operational capability (IOC) shall occur no later than December 2026.

Teams are encouraged to describe alternate designs and cost sensitivities for enhanced capability beyond the minimum requirements as well as suitability for the target vehicle to be adapted to other applications. For example, the target is expected to be expendable but teams may propose methods for making it recoverable and reusable if practical to do so.

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.

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 vehicle concept clearly and concisely. The proposal shall include pertinent analyses and trade studies supporting the design decisions. A full description of the vehicle 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 target will be configured and prepared for use. Additionally, the concept for all support equipment required for transportation, integration, checkout, and operation of the target 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:

- 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 vehicle including its 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.

- The physical and performance characteristics of the preferred vehicle concept shall be compared to all requirements.

- Documentation of key trade studies and decisions including the methods and rationale for how the final vehicle 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, set-up, and operating cost (per month), shall be estimated and documented. The estimate should include the cost of the 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. The estimate shall include the cost of the target system but not the payload modules. Costs for any proposed modifications to existing launch equipment or development of new such equipment must be included. 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.

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 with equivalent Imperial unit values (with either value alongside in parenthesis) are acceptable.

Additional Information

All technical questions pertaining to this RFP should be directed to the AIAA MSTC point of contact Dustin Otten via email at dustin.otten@lmco.com or the MSTC design competition subcommittee at aiaaMSTC@gmail.com.

Any updates to this RFP will be posted on the AIAA Design Competitions web site http://www.aiaa.org/DesignCompetitions/