MAE 155A
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Armed Unmanned Surveillance Aircraft

(AUSA)

Request for Proposal (RFP) #1

1.0 Background

The combat effectiveness of Unmanned Aerial Vehicles (UAVs) that have medium-to-long endurance, such as the Predator and the Global Hawk, has become increasingly apparent. The Predator has evolved from an earlier focus only on Intelligence, Surveillance, and Reconnaissance (ISR) missions to a role that includes attack missions and weapons carriage (Hellfire missiles). Those two missions have evolved and merged so that one vehicle is now capable of performing both medium-to-long endurance ISR and attack on the same mission. Modifications to the entire Predator fleet and to some of the Global Hawk aircraft (to increase their surveillance and/or attack capabilities) are underway. Furthermore, a joint program office in the Defense Advanced Research Projects Agency (DARPA) was established to involve the US Air Force, Navy, Boeing, and Northrop Grumman in developing new Unmanned Combat Air Vehicle (UCAV) systems. This new class of lethal UAVs poses a new set of challenges for design engineers. Emerging unmanned systems technologies will be designed into the systems along with new mission, vehicle, and weapons concepts.

The need exists for fresh thinking and good ideas for new operational and aircraft concepts as the Department of Defense (DoD) rethinks their requirements for new aircraft and weapons. We, the MAE 155A team, have been asked to develop and recommend aircraft conceptual designs which can provide attractive, viable, and affordable solutions to a particular future mission requirement. We have been provided with a description of a new mission that is being studied since it appears to be important for the USAF and USN. It requires an aircraft that can rapidly deploy with minimum support, survive in a moderate air defense environment, and effectively gather ISR data for an extended period, transmit it continually to off-board sites for evaluation, and respond quickly (within seconds) to deliver precision-guided tactical weapons to targets within "view". Subsonic cruise speeds are sufficient. No specific signature requirements have been defined, but cruise altitudes during the mission must be at or above 25,000 feet to improve survivability. Cost targets are not yet decided, however, take-off gross weight will be used as approximately proportional to the expected per-unit flyaway cost. The program is titled Armed Unmanned Surveillance Aircraft (AUSA).

In order to achieve a viable overall outcome; that is, an aircraft concept that offers good-to-excellent mission performance, supportability in the field, and affordable cost - <u>all design requirements</u>

specified in this Request For Proposals are subject to modification. Any modification, however, must be justified in terms of its impact on US defense needs and the cost or savings of that impact.

Proposals in response to RFP #1 will be separate individual efforts.

2.0 Requirements

2.1 Design an unmanned ISR/Attack capable aircraft; i.e., "AUSA".

2.2 The design should be cost effective and perform the design mission, which is a combination ISR and Attack (ISR/A) mission. The first major segment is flown at best cruise Mach number and best cruise altitude (BCM/BCA) for 1,000 NM, followed by a ten-hour ISR and attack segment at or above 25,000 ft at best endurance Mach and altitude. The final major segment is a cruise at BCM/BCA for return to base (RTB). Attachment 1 provides specific information on the entire mission.

2.3 Attachment 2 specifies other performance requirements.

2.4 Attachment 3 specifies payload and weapons carriage requirements.

3.0 Other Required Capabilities and Characteristics

3.1 "Crew": The aircraft must be designed for unmanned operation; however, communications must be reliably maintained with off-board station(s). That means that ISR and other mission and vehicle information must be reliably transmitted from the vehicle, and guidance/navigation & controls information and "consent to fire weapons" commands are received by the vehicle with secure & "fail-op, fail-safe" operation.

3.2 Maintenance: The design must allow easy access to and removal of primary elements of all major subsystems. Unique support equipment and supportability costs should be minimized.

3.3 Structure: Design limit load factors are +3 and –1.5 vertical g's in the fully-loaded configuration. The structure should withstand the maximum mission dynamic pressure plus 500 psf. A factor of safety of 1.25 shall be used on all design ultimate loads (or a different value, if justified). Primary structures should be designed for durability and damage tolerance. Design service life is 12,000 hours.

3.4 Fuel/Fuel Tanks: Primary design fuel is standard JP-8 (6.8 lb/gal = 50.87 lb/ft^3) jet engine fuel. External fuel tanks may be carried for the design mission, but if carried, must be retained for the entire mission.

3.5 Stability: A closed loop automated flight control system must provide reliable static and dynamic stability. For this unmanned aircraft, there are no handling qualities constraints.

3.6 Balanced Observables: Radar, IR, visual, acoustical, and electromagnetic signatures will not be specifically addressed in this effort; however, internal carriage of payload is required. Payload is discussed in Attachment 3.

3.7 Operation: The aircraft must operate on a standard day from 4,000 ft sea-level runways, and from shelters, maintenance facilities, and from austere bases with minimal support equipment. The aircraft must be capable of all-weather penetration and weapon delivery.

3.8 Cost: Flyaway cost per aircraft, total acquisition cost, and life-cycle cost will not be estimated in this design effort; however, all practical measures will be taken to minimize total life-cycle costs, and a brief discussion of those measures is required.

4.0 Measures Of Merit

Conceptual Designs will be evaluated on mission performance (Attachment 1), other performance requirements (Attachment 2), and payload and weapons carriage (Attachment 3). Supportability and cost considerations are deferred for now.

The following measures of merit, with estimates of their uncertainty, must be reported:

4.1 Weight summary (TOGW, W_e, W_f, W/S, W_f/W) including external tanks, if used.

4.2 Aircraft geometry and key systems (wing characteristics, fuselage and wing layout, inlet, engine and diffuser, landing gear, and payload bay). This includes a 3-view sketch to scale.

4.3 Mission Parameters (Mach numbers, velocities, altitudes, and fuel burn by mission segment) and a mission profile sketch.

4.4 Maximum Lift Coefficient and Maximum Thrust Required (selected to meet Take-off and Landing and/or maneuver requirements).

4.5 Performance at altitude in mid-mission at "maneuver weight" (50% internal fuel) and at sea-level at TOGW.

4.5.1 1-g Maximum-Thrust Specific Excess Power

4.5.2 Instantaneous Turn Rate and Radius

4.5.3 Sustained Turn Rate and Radius

4.6 Gas turbine engine description from the text Table E.2 and pages 859 - 862. (selected to meet requirements.)

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Attachment 1

ISR/Attack Mission

Configuration: 2,000 lb payload: ISR sensors and/or weapons

Phase	Description
1	Take-off and acceleration allowance (computed at sea level standard day).
2	Climb from sea level to optimum cruise altitude
3	Cruise out at optimum speed and altitude for 1000 NM
4	Cruise during ISR/Attack segment for 10 hours at best endurance M and altitude ($\geq$ 25,000 Feet)
5	Maneuver allowance: Additional fuel required to perform four sustained 360 degree turns per hour during the ISR/Attack segment.
6	Cruise back at optimum speed and altitude
7	Descend to sea level (no distance credit or fuel used)
8	Reserves: fuel for 30 minutes at sea level at speed for maximum endurance

Note: Base all performance calculations on standard day conditions with no wind.

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Attachment 2

Minimum Performance Requirements/Constraints

Criteria	Requirement
Mission Performance	
Mission Radius	1000 nm
Maximum Takeoff Distance, Std Day at Sea Level	4,000 ft
Maximum Landing Distance, Std Day at Sea Level	4,000 ft
Performance at Maneuver Weight (50% Internal Fuel) for 2,000 pound Payload	
• 1-g Specific Excess Power-Maximum Thrust	
• BCM/BCA	250 ft/sec
• Sustained Load Factor– Maximum Thrust	
• BCM/BCA	2 g's
• Maximum Instantaneous Turn Rate at BCM/BCA	15.0 deg/s
• Maximum Sustained Turn Rate at BCM/BCA	10.0 deg/s

Note that we will defer detailed consideration of other aircraft subsystem requirements, such as:

- Hydraulic and/or Electrical Subsystems, and
- Thermal Management Subsystems (e.g., for avionics cooling)

which require space and power and which have a weight, supportability, and cost impact.

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Attachment 3

Required Payload Bay & Weapons Carriage Capability

Payload Bay Dimensions

- 120 inch Length
- 22 inch Width
- 16 inch Depth

Note: There can be multiple "bays", but each must provide at least 30" L, 22" W, and 16" D.

Weapons and/or Avionics (ISR) Sensors & Processors

- (8) 250 lb small smart bombs, or
- (2) 1,000 lb JDAMs, or
- (1) 2,000 lb JDAM, or
- 2,000 lb ISR package, or
- Combinations of above tailored for each mission.

Note: This allows for a modular payload concept where the ISR/weapons mix would be determined and installed on the flight line before each mission. As the weapons may be mixed and matched, the ISR package may be tailored among: synthetic aperture radar (SAR), electro-optical (EO), imaging infrared (IIR), or other emerging sensors, laser designators, signal intelligence (SIGINT), electromagnetic intelligence (ELINT), etc., and must also include the processors and other avionics components needed for each mission. Emerging weapons such as Directed Energy (DE) or variable lethality weapons may also be considered in future development phases.