# Request for Proposal

# Advanced Pilot Training Aircraft

## Background

Due to the age of the T-38C fleet and changing needs for trainer aircraft to support modern combat aircraft like the F-22, the Air Force hopes to field an Advanced Pilot Training Aircraft (APTA) in the next 10 years. This trainer will have the capability to train pilots in the skills they need to transition to operational aircraft. APTA must be a suitable platform to train pilots in basic aircraft control, airmanship, formation, instrument flying, navigation, air-to-air and air-to-ground employment, and advanced crew/cockpit resource management.

In addition to conventional pilot training there are five fighter flying training requirements that lend themselves to two-seat instruction prior to students performing them solo. These are sustained high-g operations, air-refueling, night vision imaging systems operations, air-to-air intercepts, and data-link operations. Currently, since there are no two-seat F-22s or F-35s, these training tasks are accomplished in two-seat F-16s. The APTA will need to have performance and systems capabilities to allow it to take over these training functions as the F-16 fleet retires. Note that air-refueling training capability only requires a receiver mechanism for standard Air Force flying boom refueling. It is not required to actually transfer fuel, so no internal refueling plumbing is required.

## Statement of Objectives (Requirements)

Design an advanced pilot training aircraft and select a commercial off-the-shelf (COTS) engine to meet the performance requirements listed in the attachments below.

- Attachment 1 provides specific information on the design mission.
- Attachment 2 specifies minimum performance requirements.
- Attachment 3 specifies crew station and systems requirements.
- Attachment 4 specifies engine design requirements.

## Other Required (Threshold) or Desired (Objective) Capabilities and Characteristics

1. Crew of Two (Threshold / Objective): The cockpit will be designed for two pilots seated in tandem, with the student pilot in front. Both cockpits will have complete controls and heads-up displays. Pilots and their personal equipment weigh 550 lbs.
2. Maintenance/Servicing (Threshold / Objective): The design must allow easy access to and removal of primary elements of all major systems. Minimize requirements for

unique support equipment—development of any new support equipment will be included in NRE.

3. Structure (Threshold / Objective): Design limit load factors are +9 and -3 vertical g's in the clean configuration at maximum gross weight. The structure should withstand a dynamic pressure of 2,133 psf (M=1.2 at sea level). A factor of safety of 1.5 shall be used on all design ultimate loads. Primary structures should be designed for durability and damage tolerance. Design service life is 30,000 hours.

4. Fuel/Fuel Tanks (Threshold / Objective): Primary design fuel is standard JP-8 or Jet-A (6.8 lb/gal = 50.87 lb/ft3) jet engine fuel. All fuel tanks will be self-sealing. If external fuel tanks are required (this is not desirable) limit them to conformal fuel tanks that must be retained for the entire mission.

5. Stability (Threshold / Objective): Closed loop (automated flight control system working) static and dynamic stability and handling characteristics will be evaluated against MIL-STD-1797 and Mil-F-8785 requirements. Unaugmented subsonic longitudinal static margin (S.M.) shall be no greater than 15% and no less than -5%. Maximum c.g. excursion for all loading conditions must not exceed 7% M.A.C. A redundant digital flight control system is mandatory for designs that are statically unstable in the longitudinal axis.

6. Cost. Costs requirements are broken into per unit production costs (recurring) and non-recurring (NRE) costs. Per unit production costs are defined as the average incremental cost for an additional aircraft. Due to learning curve, this cost will be affected by the number of aircraft bought. NRE will consist of all research, development, developmental test, and production preparation costs. If unique support equipment is required, the cost of developing this equipment will be included in NRE. NRE costs will be considered fixed given no delays in the planned development program but may also vary with number of aircraft purchased due to production tooling. When able, report both Development and Production NRE costs. Report flyaway costs for aircraft buys ranging from 100 to 700 in 100-aircraft increments. For initial estimates plan on 8 flight test aircraft (1 iron bird, 2 for avionics and refueling equipment tests, 3 for performance & flying qualities, and 2 for spare/attrition).

   - Total NRE costs will not exceed $1B in constant 2018 dollars (threshold) / $500M (objective)
   - Per unit cost will not exceed $20M in constant 2018 dollars (threshold) / $10M (objective)
   - All practical measures including reducing operations cost will be taken to minimize total life cycle costs.

## Measures Of Merit

Designs will be evaluated against design mission performance, other performance requirements, cost and the Measures of Merit described below. The following measures of merit will be reported:

1. Weight summary (GTOW, We, mission Wf, W/S, T/W, Wf /Wto) including external tanks, if used, and weight statements are required.
2. Aircraft geometry and systems integration (wing and control surface area, fuselage size and volume, frontal cross sectional area distribution, wetted area, inlet and diffuser, landing gear, sensor and avionics locations, crew station, etc.)
3. Mission duration, radius or range, fuel burn by mission segment for design mission.
4. Take-off and landing distance at max gross weight including standard day and icy runway balanced field length at sea level. For single-engine designs runway length requirements may be approximated by adding take-off and landing distance together. For multi-engine designs actual balanced field length should be considered.
5. Performance at combat weight (50% internal fuel) for pilot training design mission loadings.
    1. Maximum Mach Number at 36,000 ft
    2. 1-g Maximum Thrust Specific Excess Power Envelope
    3. 5-g Maximum Thrust Specific Excess Power Envelope
    4. Energy Maneuverability Diagram at 15,000 ft MSL
    5. L/D vs Mach at 36,000 ft\
    6. V-n diagram showing response to 30 ft/s equivalent sharp-edged vertical gust
6. Non-recurring expenses (NRE), per unit production cost, per unit flyaway cost, operations costs and total life cycle costs. Show cost trades for aircraft buys of 100 to 700 units.
7. A pictorial of a model of the aircraft is required. This may be a CAD model or photographs of a physical model. Mock-ups or animations of systems integration, crew stations, and landing gear are required.
8. Document a) concept selection trades and b) concept development trades.
9. Develop and present the alternative concepts considered leading to the downselect of your preferred concept. The methods and rationale used for the downselect shall be presented. At a minimum a qualitative assessment of strengths and weaknesses of the alternatives shall be given, discussing merits, leading to a justification as to why the preferred concept was the best proposal response. Quantitative justification of why

the selected proposal is the best at meeting the proposal measures of merit(s) will strengthen the proposal.

10. Include the major trade studies conducted justifying the optimization, sizing, architectural arrangement and integration of the specifically selected proposal concept. Quantitative data shall be presented showing why your concept 'works' and is the preferred design compromise that best achieves the RFP requirements and objectives.

## Government Furnished Equipment (GFE)

GFE will be used to the maximum extent possible. GFE available or being developed for this aircraft is described in Attachment 5.

## Additional Contacts

All technical questions pertaining to this RFP should be directed to David Levy via e-mail at: dwlevy2@gmail.com.

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

# Attachment 1

## Pilot Training Mission

**Configuration: Clean or With Conformal External Tanks**

| Phase | Description |
|---|---|
| 1 | Fuel allowance for atart (35 lb/engine), warm-up/taxi (25 lb/min/engine -- plan on 30 minutes ground time), mil-power run-up (85 lb/engine) |
| 2 | Take-off and acceleration allowance (computed at sea level, 59 deg F). Fuel to accelerate to climb speed at take-off thrust (no distance credit) |
| 3 | Climb from sea level to optimum cruise altitude (min time-fuel burn/distance credit allowed) |
| 4 | Cruise out 150 nm at best cruise Mach and Best cruise Altitude (BCM/BCA) |
| 5 | Tanker rendezvous – 100 nm at 300 knots indicated airspeed (KIAS) at 20,000 ft MSL |
| 6 | Simulated or actual air refueling (full mechanical hookup required but fuel transfer optional, depending on whether aircraft is designed with a full air refueling system |

| | |
|---|---|
| | or not) – 20 minutes at 250 KIAS at 20,000 ft MSL |
| 7 | Climb from 20,000 ft MSL to BCM/BCA (Min time-fuel burn/distance credit allowed) |
| 8 | Cruise to practice area – 100 nm at BCM/BCA |
| 9 | Descend to 15,000 ft MSL |
| 10 | Air combat maneuvering training: Fuel required to maneuver for 20 minutes at 8-9 gs at 15,000 ft |
| 11 | Descend / climb to optimum cruise altitude (Min time-fuel burn/distance credit allowed) |
| 12 | Cruise back 150 nm at BCM/BCA |
| 13 | Descend to sea level (distance credit allowed) |
| 14 | Reserves: fuel for either 30 minutes or 10% of design mission time at 10,000 feet and speed for maximum endurance whichever is greater |

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

# Attachment 2

## Minimum Performance Requirements

| Criteria | Requirement Threshold | Requirement Objective |
|---|---|---|
| **Sustained g at 15,000 ft MSL** | 8 | 9 |
| **Ceiling** | 40,000 ft | 50,000 ft |
| **Minimum Runway Length** | 8,000 ft | 6,000 ft |
| **Payload (Expendable)** | 500 lbs | 1,000 lbs |
| **Range (Unrefueled)** | 1,000 nmi | 1,500 nmi |

| | | |
|---|---|---|
| **Cruise Speed** | 0.7M | 0.8M |
| **Dash Speed** | 0.95M | 1.2M |

# Attachment 3

## Crew Station and Systems Requirements

The APTA crew stations must include zero-zero ejection seats or similar escape systems which can accommodate 95th percentile large and small male and female personnel meeting USAFA size and weight requirements. These seats and other crew station components must allow full crew functionality in a sustained 9-g environment. Tandem seating is required with the student pilot in front. Both crew positions must provide adequate visibility for landing and air-to-air and air-to-ground employment practice. Ground access to crew stations must be achieved with onboard steps/ladders only. No externally-provided ladders, steps, or other access aids are allowed. Crew stations must provide commonality with F-22 and F-35 cockpits with provisions for heads-up displays (HUDs) and helmet-mounted displays (HMDs) as well as full glass cockpits and provisions for night-vision goggles. No expendable external stores or onboard sensors are required, provided use of these capabilities and features can be simulated by cockpit controls and displays.

# Attachment 4

## Engine Requirements

1. Select a commercial off-the-shelf engine or engines to reduce aircraft acquisition costs. The engine must provide adequate installed thrust for all portions of the design missions. A CAD model of the selected engine is required to ensure proper fit in the airframe. Ensure installation losses are properly accounted for.
2. Aircraft System Requirements:
   - Electrical and hydraulic systems require 150kw of power.
   - Environmental control systems require approximately 2% of engine mass flow.

# Attachment 5

## Government Furnished Equipment

| **Item** | **Volume [cu.ft.]** | **Weight [lbs]** | **Cost [$K]** |
|---|---|---|---|
| **Avionics Base Suite** | | | |

| | | | |
|---|---|---|---|
| Integrated Communication, Navigation, and Identification Avioncics (ICNIA) | 3.0 | 100 | 200 |
| 3 x Multi-Function Displays (MFDs) | 1.5 | 20 | 60 |
| Heads-Up Display | 1.6 | 35 | 20 |
| Data Bus | 0.5 | 10 | 10 |
| **Flight and Propulsion Control System** | | | |
| Vehicle Management System | 1.0 | 50 | 200 |
| **Systems and Equipment** | | | |
| Electrical System (2 engines) | 4.0 | 300 | 50 |
| Auxillary Power Unit (APU) | 2.0 | 100 | 50 |
| Ejection Seats (2) | 8.0 | 160 | 100 |
| Onboard Oxygen Generation System (OBOGS) | 1.0 | 35 | 10 |
| On-Board Inert Gas Generation System (OBIGGS) | 1.0 | 35 | 10 |

Note: These weights as well as the weight of the crew will be considered non-expendable payload.

# Design Competition Rules

## Eligibility Requirements

- All AIAA Student members are eligible and encouraged to participate. Membership with AIAA must be current to submit a report and to receive any prizes.
- Students must submit their letter of intent and final report via the online submission to be eligible to participate. **No extensions will be granted**.
- More than one design may be submitted from students at any one school.
- If a design group withdraws their final report from the competition, the team leader must notify AIAA Headquarters immediately.
- Design projects that are used as part of an organized classroom requirement are eligible and encouraged for competition.

## Schedule

- Letter of Intent — 10 February 2018 (11:59 pm Eastern Time)
- Proposal delivered to AIAA Headquarters — 10 May 2018 (11:59 pm Eastern Time)
- Announcement of Winners — 31 August 2018 (11:59 pm Eastern Time)
    - Engine Design Competition dates
        - Letter of Intent – 14 February 2018 (11:59 pm Eastern Time)
        - Proposal submitted, via online submission site to AIAA Headquarters – 16 May 2018 (11:59 pm Eastern Time)
        - Round 1 evaluations completed – 30 June 2018 (11:59 pm Eastern Time)

Round 2 presentations at AIAA Propulsion and Energy Forum 2018

## Categories/Submissions

- Team_Submissions
    - Team competitions will be groups of not more than ten AIAA Student Members per entry.
- Individual_Submissions
    - Individual competitions will consist of only one AIAA Student member per entry.
- Graduate
    - Graduate students may participate in the graduate categories only.
- Undergraduate
    - Undergraduate students may participate in the undergraduate categories only.
- Letter of Intent (LOI)
    - A Letter of Intent indicating interest in participating in the design competitions is required before submitting a final report.
    - All Letters of Intent must be submitted through the online submission system.
    - Letter of Intent must include student's names, emails, AIAA membership numbers, faculty advisor(s) names, emails, and project advisor(s) names and emails. Incomplete LOI's will result in the Team or Individual being ineligible to compete in the competition.

- Submission of Final Design Report
  Each team or individual must provide an electronic copy their design report as outlined below to the online Submission site
    - An electronic copy of the report in Adobe PDF format must be submitted to AIAA using the online submission site. Total size of the file cannot exceed 20 MB.
    - Electronic report files must be named: "2018_[university]_DESIGN_REPORT.pdf"
    - A "Signature" page must be included in the report and indicate all participants, including faculty and project advisors, along with students' AIAA member numbers and signatures.

    - Electronic report should be no more than 100 pages, double-spaced (including graphs, drawings, photographs, and appendices) if it were to be printed on 8.5"x11.0" paper, and the font should be no smaller than 10 pt. Times New Roman.
        - Engine Design Competition is limited to 50 pages.

## Copyright

All submissions to the competition shall be the original work of the team members.

Authors retain copyright ownership of all written works submitted to the competition. By virtue of participating in the competition, team members and report authors grant AIAA non-exclusive license to reproduce submissions, in whole or in part, for all of AIAA's current and future print and electronic uses. Appropriate acknowledgment will accompany any reuse of materials.

## Conflict of Interest

It should be noted that it shall be considered a conflict of interest for a design professor to write or assist in writing RFPs and/or judging proposals submitted if (s)he will have students participating in, or that can be expected to participate in those competitions. A design professor with such a conflict must refrain from participating in the development of such competition RFPs and/or judging any proposals submitted in such competitions.

## Awards

The prize money provided for the competitions is funded through the AIAA Foundation. The monetary awards may differ for each competition, with a maximum award of $1,000. The award amounts are listed below.

The top three design teams will be awarded certificates. One representative from the first place team *may be* invited by the Technical Committee responsible for the RFP to make a presentation of their design at an AIAA forum. A travel stipend *may be* available for some competitions, with a maximum travel stipend of $750 which may be used to help with costs for flight, hotel, or conference registration to attend an AIAA forum.

**Aircraft Design Competitions**

- Graduate Team Aircraft - Advanced Pilot Training Aircraft
- Undergraduate Team Aircraft – Hybrid-Electric General Aviation Aircraft (HEGAA)
    - 1st Place: $500; 2nd Place: $250; 3rd Place: $125
- Undergraduate Individual Aircraft – Close Air Support Aircraft (A-10 Replacement)
    - 1st Place: $1,000; 2nd Place: $500; 3rd Place: $300

**Engine Design Competition**

- Undergraduate Team Engine –Candidate Engines for a Next Generation Supersonic Transport
    - 1st Place: $500; 2nd Place: $250; 3rd Place $125

**Space Transportation Competition**

- Undergraduate Team Space Transportation – Pluto Orbiter
    - 1st Place: $500; 2nd Place: $250; 3rd Place: $125

**Space Design Competition**

- Undergraduate Team Space Design – Lunar Prospecting
    - 1st Place: $500; 2nd Place: $250; 3rd Place: $125

**Structures Design Competition**

- Graduate Team Structures – Fuselage Design
- Undergraduate Team Structures – Supersonic Wing
    - 1st Place: $500; 2nd Place: $250; 3rd Place: $125

## 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 of the technical factors cannot be included in advance, the following should be included:

- Demonstrate a thorough understanding of the Request for Proposal (RFP) requirements.
- 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.

- Particular emphasis should be directed at identification of critical, technical problem areas. Descriptions, sketches, drawings, systems analysis, 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.
- Include tradeoff studies performed to arrive at the final design.
- Provide a description of automated design tools used to develop the design.

## 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?

### *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.

### *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.