# SCOPE

This System Requirements Document (SRD) establishes the performance requirements for the United States Air Force (USAF) Advanced Pilot Training (APT) Aircraft System component of the APT program (REF: <https://www.fbo.gov>, search for APT).

# SYSTEM OVERVIEW

The APT program will replace the T-38C used in the USAF’s Specialized Undergraduate Pilot Training (SUPT) advanced phase fighter and bomber (F/B) track, and in the Introduction to Fighter Fundamentals (IFF) course. The APT program will provide student pilots with the foundational flying skills and core competencies required to transition into current generation F/B aircraft. The proposed design shall be land based (U.S. Air Force).

# REFERENCES

|  |  |  |
| --- | --- | --- |
| Document Number | Document Name | Date |
| FA8617-16-R-6219 | SYSTEM SPECIFICATION  for the  ADVANCED PILOT TRAINING (APT)  PROGRAM AIRCRAFT SYSTEM | 27JUN 2016 |
| MIL-STD-1472G | Human Engineering | 11 JAN 2012 |
| MIL-F-8785C[[1]](#footnote-1)  (use instead of MIL-STD-1797B) | Flying Qualities of Piloted Vehicles | NOV 1980 |
| MIL-STD-3013A | Glossary of Definitions, Ground Rules, and Mission Profiles to Define Air Vehicle Performance Capability | 9 SEP 2008 |
| MIL-STD-1333B[[2]](#footnote-2) | Aircrew Station Geometry for Military Aircraft | 9 JAN 1987 |

# SYSTEM REQUIREMENTS

## Configuration Definitions

Weapons = Weapon Systems Support Pod (WSSP)

CC Clean, cruise  
WC Weapons, cruise  
FC Ferry, cruise  
WTO Weapons, gear down, high lift devices positioned for take off  
WL Weapons, gear down, high lift devices positioned for landing

## Performance and Structural Characteristics

### Performance Ground Rules

Unless otherwise specified, the Performance and Structural Characteristics shall be met using the following rules:

1. Two-person aircrew (average nude aircrew member weight of 200 pounds each) wearing USAF Standard Personal Flight Equipment weighing 26.3 pounds (see Table 4‑1).
2. Jet A with military additives fuel grade with a density of 6.8 pounds per US gallon.
3. All aircraft systems and subsystems operating normally.
4. International Standard Atmosphere model as defined by MIL-STD-3013, Appendix A
5. Standard Configuration: Includes external store(s) required to accomplish SUPT and IFF training missions (SWaP-C margin requirements met).
6. No wind.
7. Design Missions as specified in Section 4.2.13 and 4.2.14.
8. Conventional metal construction should be used.

### Limit Loads

All loads resulting from the requirements of this specification are limit loads unless otherwise specified.

### Ultimate Loads

Ultimate loads shall be obtained by multiplying limit loads by a factor of safety of 1.5. These ultimate loads shall be used in the design of elements of the airframe and subsystems. The airframe and all subsystems shall not experience catastrophic failure when subjected to ultimate loads.

### Design Service Life

The aircraft shall meet a design service life of at least 22 years and 8000 flight hours per aircraft based on the usage and mission profiles described in section 7. (Note: Approximate usage rate is 360 flight hours per year.)

### Sustained Turn (High-G Maneuvering)

The high G maneuver shall be flown with a Standard Configuration, at 80% fuel weight (relative to maximum fuel capacity) and Standard Day conditions. The maneuver shall begin in level flight, wings level (±5 degrees of bank), at 15,000 feet PA, and at or below 0.9 Mach. From this point, the aircrew will immediately initiate bank and back pressure to achieve the highest maintainable G-loading. The G-loading shall be maintained for a minimum of 140 continuous degrees. The aircrew may begin reducing the load factor and rolling out after a minimum of 140 degrees in order to roll out at approximately 180 degrees of turn. Aircraft shall descend to no lower than 13,000 feet PA during any portion of the entire 180-degree maneuver. There is no power setting specified for this maneuver. Minimum acceptable load factor will be 6.5 sustained for a minimum of 140 degrees. The lowest load factor registered during the 140-degree period will establish G-loading for the maneuver. For example, if the aircraft maintains 7.2Gs for less than 140 degrees and then drops to 6.9Gs by the end of the 140-degree period, 6.9Gs will be used as the maximum G-loading. There is no requirement to exceed 7.5Gs.

### Negative Load Factor

The aircraft shall perform (without degradation to the aircraft structures, components, and systems) high-G maneuvering with instantaneous load factor of up to -3.0 g’s using the following additional performance ground rules: Fuel weight at least 50%, PA equal to 15,000 feet, airspeed no greater than 0.9 Mach and Standard Day.

### Instantaneous Turn Rate

The aircraft shall perform instantaneous turn rate of at least 18° per second using the following additional performance ground rules: Fuel weight at least 50%, 15,000 feet PA, airspeed no greater than 0.9 Mach and Standard Day.

### Sustained Turn Rate

The aircraft shall perform sustained turn rate of at least 12.5° per second using the following additional performance ground rules: Level flight, Fuel weight at least 50%, PA equal to 15,000, airspeed no greater than 0.9 Mach and Standard Day.

### Takeoff Distance

The aircraft (including all takeoff configurations) shall have a total takeoff distance no greater than 6400 feet using an 8000-foot, hard-surface runways using the additional worst case weather conditions performance ground rules: 10 knots tailwind, Runway Condition Reading (RCR 12) wet, zero runway slope, normal takeoff flap setting, maximum takeoff gross weight, and Density Altitude (DA) equal to 7464 feet (DA represents 97° F, dew point of 38° F, 4093 feet PA).

### Landing Distance

The aircraft (including all landing configurations) shall have a landing ground roll distance not greater than 7,000 feet that provides for flight operations on 8000-foot, hard-surface runways using the additional worst case weather conditions performance ground rules: 10 knots tailwind, (RCR 12) wet runway, zero runway slope, all possible flap settings, 80% fuel weight, DA equal 7400 feet (DA represents 97° F, dew point of 38° F, 4093 feet PA), and without the use of drag chute(s).

### Landing Sink Speed

The maximum landing touchdown vertical sink speeds of the aircraft center of mass for the airframe and landing gear shall not be less than 13 feet per second at the landing design gross weight[[3]](#footnote-3) and 10 feet per second at the maximum landing design weight[[4]](#footnote-4).

### Service Ceiling

Aircraft shall have a service ceiling of 40,000 ft in CC configuration (weight resulting from light off at full fuel) in standard atmosphere.

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### Design Mission – Profile 5, Cross Country[[5]](#footnote-5)

The aircraft shall have sufficient fuel capacity to complete the unrefueled training sortie illustrated and defined in Figure 4‑1.



Figure 4‑1 Specialized Undergraduate Pilot Training (SUPT) Profile 5, Cross-Country

### Design Mission – Profile 6, Close Air Support[[6]](#footnote-6)

The aircraft shall have sufficient fuel capacity to complete the unrefueled training sortie illustrated and defined in Figure 4‑2.



Figure 4‑2 Introduction to Fighter Fundamentals (IFF) Profile 6, Close Air Support

### Takeoff Climb Gradient Performance

The aircraft (including one-engine inoperative situations for two-engine aircraft) shall provide a climb gradient of at least 200 feet per nautical mile using the following additional performance ground rules: 8000-foot runway, Instrument Flight Rules (IFR), no wind, and 97° F, dew point of 38° F, 4093 feet PA (represents 7400 feet Density Altitude (DA)).

## Propulsion System

### Aircraft shall be powered with two turbo-jet or turbo-fan engines, which are currently in production.

### A self-contained onboard start capability is required.

## Fuel Subsystem

### Fuel for the design missions shall be contained internally.

### Aircraft shall have fuel dump capability.

### The aircraft shall have single point pressure refueling and single point pressure defueling through MIL-A-25896 servicing adapters.

### The aircraft shall be capable of being gravity refueled and gravity defueled.

### The aircraft with multiple, independent fuel tanks shall provide for automatic transfer of all the usable fuel to the engine(s) without action by the aircrew to control fuel sequencing while remaining within the allowable range of gross weight, balance and center of gravity limits.

### The aircraft shall have a fully integrated inflight refueling capability compatible with boom-equipped USAF Tankers for use in accomplishing air-to-air refueling operations, in both day and night lighting conditions.

## Crew Systems

### Human Performance and Human Engineering

The aircraft controls, displays, access panels and all other human-machine interfaces shall be developed, designed, and tested from a human-centered approach that considers the physical, cognitive and sensory skills, capabilities, and limitations of the personnel who operate, support, maintain, and train on the system, in accordance with the human engineering criteria of MIL-STD-1472. Student may use MIL-STD-1333 or Roskam for cockpit layout.

### Each cockpit shall provide for pilots to independently operate and control the aircraft through all phases of flight, and to individually perform all actions necessary to recover the aircraft, to include engine shut down (e.g. either pilot incapacitated situation).

### A crew of 2 (instructor/trainee) shall be accommodated in tandem, zero-zero ejection seats.

Table 4‑1 USAF Standard Personal Flight Equipment

|  |  |
| --- | --- |
| **Item Name** | **Nomenclature** |
| Anti-G Suit | CSU-13B/P with male connector |
| Oxygen Mask | MBU-20/P Non PBG |
| Oxygen Connector | CRU-60/P |
| Torso Harnesses | PCU-15A/P and PCU-16A/P with oxygen connector mounting bracket and Koch Modified Gen II Canopy Release |
| Life Preserver | LPU-38/P |
| Crew Helmet | HGU-55/P (High Speed) |
| Night Vision Goggles | AN/AVS 9 |
| Crew Coveralls | CWU-27/P |
| Crew Gloves | GS/FRP-2 |
| Crew Winter Jacket | CWU-45/P |
| Crew Summer Jacket | CWU-36/P |
| Crew Boots | USAF Authorized Safe-to-Fly  (Bellville, Daner, Wellco, and McRae Models) |
| Universal Water Activated Release (UW ARS) | PCU-63 |

### Cockpit Stowage

Each cockpit shall provide storage space measuring a minimum of 4 inches in width, 12 inches in length and 12 inches in height, within reach of the pilot, that secures personal gear consisting of one empty helmet bag and one flight publications bag, during all expected training maneuvers.

### Pin Stowage

Each cockpit shall provide storage space for all safety pins/flags removed from the cockpit systems (e.g., seat safety, canopy safety).

### Cockpit Display

#### Large Area Display (LAD)

The aircraft shall provide at least one large area display (LAD) in each cockpit with the same functionality and capability to display the same information with a viewable area of at least 150 square inches.

#### Head-up Type Display (HTD)

The aircraft shall provide in the front cockpit one Head-up Type Display and in the rear cockpit either one HTD or a high-definition display repeater mounted over the glare shield that displays the content of the front HTD.

### Standby Flight Instrument

The aircraft shall provide, at both aircrew positions, a dedicated standby flight instrument IAW that is located such that it can be viewed by the aircrew member with minimal head movement.

### Aircraft Entry and Exit

The aircraft shall provide an entry and exit means that is self-contained to accommodate both cockpits.

## Environmental Control System

### The cockpit shall be pressurized to provide an 8000 ft. cabin altitude at an aircraft altitude of 40,000 ft.

### The ECS or bleed air system shall provide pressurized air supply to anti-g suit trousers at each pilot position.

### The ECS shall maintain the canopy and interior surfaces of cockpit transparencies free of fog and frost for all ground and airborne operating conditions.

### Aircraft shall have an On-Board Oxygen Generating System (OBOGS).

### Aircraft shall have a backup oxygen system

### Emergency oxygen shall be provided to permit operation at 30,000 ft. for a period of 1 hour.

## Exterior Lighting

The aircraft shall have exterior lighting (including strip lighting) that is compatible with MIL-STD-3009 Type I, Class B or C, as applicable, night vision imaging system (NVIS), and provides for day and night formation flight in both IMC and VMC in all phases of flight.

## External Carriage

The aircraft shall have provisions to carry one non-jettisonable external pod identified in Table 4‑2

Table 4‑2 Stores Loadout

|  |  |  |  |
| --- | --- | --- | --- |
| Loadout # | Store Nomenclature | Number  Carried | Note |
| 1 | MXU Cargo/Travel Pod  - P/N402136-3  - NSN1680-01-538-0545  - Capacity 300 pounds  - Usable volume 4.75 cubic feet  - Load factor 5.0 g in symmetric flight  - Load factor 4.0 g in asymmetrical loading  - Total length 129.6 inches  - Max diameter 18.6inches  - Empty weight 104 pounds  - Interface MIL-STD-8591 | 1 | 140 lbs. worth of gear will be carried in the pod. |
| 2 | Next Generation Cargo Pod  - P/N 400850-3  - NSN 1680-01-459-1268  - Capacity 600 pounds  - Usable volume 19 cubic feet  - Load factor 7.3g  - Total length 153 inches  - Max diameter Elliptical 23.30 x 34.06 inches  - Empty weight 320 pounds  - Interface MIL-STD-8591 | 1 | 140 lbs. worth of gear will be carried in the pod. |
| 3 | Weapons Systems Support Pod (WSSP)  -Total length 144.5 inches  -Max diameter 10.3 inches (Excluding fins and hardback)  - Weight 386 lbs.  - Interface MIL-STD-8591  - Power requirements: 3 phase 400 Hz 115/200VAC @ 10A per phase | 1 | Growth path for future integration of EW Training Pods. (Note: WSSP characteristics are based on the ALQ-167) |

## Avionics Suite

### In addition to the crew station instruments, the aircraft contains an avionics suite weighing 300 pounds and occupying a volume of 4 cubic feet, as follows:

1. Two (2) Multi-band radios (l x w x h, 6 in x 6 in x 10 in, 12.75 pounds each)
2. Fifteen (15) avionics boxes (l x w x h, 8 in x 8 in x 6.5 in, 18.3 pounds each)

## Space, Weight, and Power with Cooling (SWaP-C) Margins

This requirement accommodates future (unplanned) installations of components. Space and weight margins are based on the volume of generic classes of components that would allow for future installation of components without changes to existing structure, mounting location, or other compartment features. Power margins require the allocation of generator and/or battery capacity such that the future capability can be added without changing the electrical system configuration or capacity. Cooling margins require allocation of cooling capacity such that the future capability can be added without changing the ECS configuration or capacity for the WSSP (Table 4‑2, Loadout # 3). The aircraft will need to meet the performance requirements defined in section 4.1 with SWaP-C margin requirements met.[[7]](#footnote-7)

### Space

The aircraft shall provide excess space to accommodate a minimum of 3 additional LRUs each conforming to either 1½ -Air Transport Radio (ATR) enclosure size (15.38” W x 19.62” L x 7.62” H) or 12 Modular Concept Unit (MCU) enclosure size (15.37” W x 12.67” L x 7.62” H) and associated Group A to the equipment bays.

### Weight

The aircraft shall provide equivalent weight to accommodate a minimum of 3 additional LRUs (88 lbs. each).

## Aircraft Maintenance Safety Protection Equipment (MSPE) Stowage

## The aircraft shall provide for internal stowage (not including cargo/travel pods) that accommodates the minimum flyaway items required for Maintenance Safety and Protection Equipment (e.g., grounding cable, engine covers, gear pins, pitot covers, AOA blocks). Assume 140 pounds and 10 ft3 required (36 in x 24 in x 20 in). This stowage space shall be accessible by ground maintenance personnel and shall be external to the cockpit.

# STABILITY REQUIREMENTS

## Static Stability **(AE460A):**

Pitching Moment Coefficient Cmα < 0

Directional Coefficient Cn > 0

Lateral Stability Coefficient Cl < 0

## Longitudinal Stability **(AE460B):**

Best range speed, standard atmosphere, CC configuration, and 60% fuel

Short period damping ratio: 0.35 – 1.30 desired  
 0.25 – 2.00 required

Phugoid damping ratio: >0.04 desired  
 >0 required

## Lateral – Directional Stability **(AE460B):**

Best range speed, standard atmosphere, CC configuration, and 60% fuel

Dutch roll damping ratio: >0.4 desired  
 >0.02 required

Dutch roll undamped natural frequency:  
 >1.0 desired  
 >0.4 required

Roll-mode time constant: <1.0 sec desired  
 <1.4 sec required

Spiral time to double amplitude:  
 >12 sec desired  
 >8 sec required

1. MIL-F-8785C is not for new design, but is sufficient for AE460 purposes. [↑](#footnote-ref-1)
2. MIL-STD-1333B was canceled without replacement, but is sufficient for AE460 purposes. [↑](#footnote-ref-2)
3. Maximum design gross weight minus all payload items expected to be expended, all external fuel, and 25% internal fuel. [↑](#footnote-ref-3)
4. Maximum design gross weight less the following: assist takeoff fuel, droppable fuel tanks, items expended during routine take-off, and fuel consumed or dumped during one go-around or 3.0 minutes, whichever results in the minimum amount of fuel. [↑](#footnote-ref-4)
5. Mission Profile from FA8617-16-R-6219, SYSTEM SPECIFICATION for the ADVANCED PILOT TRAINING (APT) PROGRAM AIRCRAFT SYSTEM [↑](#footnote-ref-5)
6. Mission Profile from FA8617-16-R-6219, SYSTEM SPECIFICATION for the ADVANCED PILOT TRAINING (APT) PROGRAM AIRCRAFT SYSTEM [↑](#footnote-ref-6)
7. Note to student: The power and cooling if left for future development, but it is good to be aware of the requirement when designing the systems, i.e. add a % of weight increase for the ECS system. [↑](#footnote-ref-7)