# SCOPE

This AE 460A/B project is the conceptual design of a SUPERSONIC BUISNESS JET.

# SYSTEM OVERVIEW

Supersonic commercial travel saw a few years of promise, but was not able to make it profitable due to fuel cost, high ticket prices, and excessive noise pollution, making overseas flights the only options for high speed routes. Since time is money, potential customers have been looking to the small business jet market to avoid long lines in airports and arriving at their destination in a reduced amount of time compared to major carrier aircraft or other business jet solutions.

The solution is required to be profitable by ensuring the customers will pay for convenience and rapid transit, while maintaining reduced noise pollution to ensure the public will allow travel over populated land.

The aircraft shall meet 14CFR25 along with the following design requirements.

# SYSTEM REQUIREMENTS

## Accommodations

### Aircraft shall accommodate three crew members, 2 pilots and one flight attendant.

### The cabin shall be pressurized to provide a 7500 ft. cabin altitude at an aircraft altitude of 60,000 ft.

### Cabin shall accommodate 10 to 19 passengers. It is left up to the team to determine the final configuration, trading off the passengers for creature comforts.

### Aircraft shall have at least 1 galley. It is up to the team to determine the amenities.

### Aircraft shall have at least 1 lavatory. It is up to the team to determine the amenities.

## Propulsion System

### Aircraft shall be powered by at least two turbojet or turbofan engines. Data for a conceptual engine called the F91 may be used for either choice.

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

### Aircraft shall have fuel dump capability.

## Avionics Suite

### An avionics suite weight shall be determined during the weight estimation.

### For every 300 lbs of avionics, the design shall accommodate 4 ft3 of volume.

## Structural Considerations.

### The structural load factor shall be determined per 14CFR25.

## Weight

### The maximum TOGW (Take-off Gross Weight) is not specified.

### Weight allowance of 200 lbs. is required for each crew member or passenger.

### Weight allowance of 50 lbs. per passenger for baggage.

### Weight allowance of 30 lbs. per crew member for baggage.

## Configurations:

CC Clean, cruise
CCTO Gear down, high lift devices positioned for takeoff
CCL Gear down, high lift devices positioned for landing

## Design Mission - Endurance.

### Warm-up, Takeoff, Transition (airport at 5000 ft altitude and 95°F day) – Fuel allowance for all engines operating idle power under static conditions for 5 minutes plus 2 minutes at maximum rated thrust.

### Climb to and maintain optimum altitude. Maintain optimum speed throughout climb. Credit is given for climb distance.

### Maintain optimum speed at optimum cruise altitude for 4000nm.

### Loiter at cruise altitude at best loiter speed for 1 hour prior to decent at destination.

### Descent to sea level. No credit is given for distance.

### Execute a missed approach, climb out to 10,000 ft. No credit given for distance.

### Fly to alternate airport for 200nm at <250 knots.

### Descent to sea level. No credit is given for distance.

### Commence landing approach with 1% of full fuel plus 100 lb.

## Design Mission – High Speed

### Warm-up, Takeoff, Transition (airport at 5000 ft altitude and 95°F day) – Fuel allowance for all engines operating idle power under static conditions for 5 minutes plus 2 minutes at maximum rated thrust.

### Climb to and maintain optimum altitude. Maintain optimum speed throughout climb. Credit is given for climb distance.

### Accelerated and maintain maximum speed at optimum cruise altitude for non-specified distance.

### Loiter at cruise altitude at best loiter speed for 1 hour prior to decent at destination.

### Descent to sea level. No credit is given for distance.

### Execute a missed approach, climb out to 10,000 ft. No credit given for distance.

### Fly to alternate airport for 200nm at <250 knots.

### Descent to sea level. No credit is given for distance.

### Commence landing approach with 1% of full fuel plus 100 lb.

## Performance Requirements

### Aircraft shall meet the Design Mission IAW Section 3.7 in CC configuration in standard atmosphere.

### Aircraft shall meet maximum level flight speed at 55,000 ft of M=2.0 (required), M=2.2 (desired), in CC configuration.

### Aircraft shall have a service ceiling of 65,000 ft in CC configuration (weight resulting from light off at full fuel) in standard atmosphere.

### Range at best cruise velocity and altitude shall be minimum of 4,000 NM (required), 4,600 NM (desired), in CC configuration in standard atmosphere.1

### Endurance: None specified, but team shall provide the endurance based on best loiter velocity and altitude in CC configuration in standard atmosphere.[[1]](#footnote-1)

### Sustained maneuver load factor per 14CFR25.

### Approach speed per 14CFR25.

### Maximum landing distance shall be per 14CFR25.

### Maximum takeoff run critical field length shall be per 14CFR25.

### Rate of climb, with one engine inoperative per 14CFR25.

# 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. Note: For Range and Endurance specifications 3.9.4 and 3.9.5, consider a complete flight from light off to touchdown. Standard conditions, field at sea level. Omit time, distance and fuel in conjunction for descent; the values will be little different from continued cruise or loiter at altitude. Allow for 20 min. at best loiter speed at sea level at commence of landing approach with 1% of full fuel plus 100 lb of fuel remaining. [↑](#footnote-ref-1)