Request for Proposal

High Capacity Short Range Transport Aircraft

Background

As the world economy has advanced, more of the world has access to commercial air travel. A recurring problem that arises with this increase in air travel is the congestion of major commercial airports. For example, the congestion at airports such as John F Kennedy International (JFK) and London Heathrow (LHR) result in delays, not enough flights to meet demand, and passengers needing to fly to smaller satellite airports. As many of the major world economies such as China and India mature, this problem will only become worse.

This Request for Proposal (RFP) is for the design of an aircraft that addresses this market problem. Specifically, a high capacity, short range transport aircraft designed to alleviate airport congestion, without the size and cost that comes with long range capability. This aircraft will have an entry into service (EIS) of 2029, with a passenger capacity of 400 in a dual class configuration, and 3,500 nautical miles of range.

This aircraft should be designed to best serve the market stipulated in the first paragraph. Historical trends of key airplane characteristics may not be appropriate for the non-standard combination of this large seat count and design range.

The aircraft is to be designed to meet all the requirements in General Requirements and the requirements in Mission Requirements. The objectives for designer optimization are listed in Design Objectives.

Requirements (M) = Mandatory Requirement (T) = Tradable requirement

General Requirements

- (M) Capable of taking off and landing from runways (asphalt or concrete)
- (M) Capable of VFR and IFR flight with an autopilot
- (M) Capable of flight in known icing conditions
- (M) Meets applicable certification rules in FAA 14 CFR Part 25
  - All missions below assume reserves and equipment required to meet applicable FARs
- (M) Engine/propulsion system assumptions documented
  - Use of engine(s) that will be in service by 2029

- Assumptions on at least specific fuel consumption/efficiency, thrust/power and weight should be specified.

Mission Requirements

- (T) Crew: 2 pilots, 8 flight attendants
- (M) 400 passengers in a dual class configuration
  - 50 passengers in Business class with 36" pitch, 21" width
  - 350 passengers in Economy class with 32" pitch, 18" width
  - 5 cubic feet per passenger for baggage
  - Galleys, Lavatories, and Exits to meet 14 CFR Part 25
  - Number of aisles appropriate to the passenger layout
- (M) Passenger/pilot/attendant and baggage weight assumptions
  - Passenger/pilot/attendant weight of 200 lb
  - Baggage weight per occupant of 30 lb
- (M) 3,500 nmi design range mission
  - ~~Reserve energy to meet 14 CFR Part 25 requirements~~
  - Reserves for:
    - Flight to alternate airport 200 nmi from destination airport
    - A 30 minute hold at the alternate airport
    - 5% contingency fuel, defined as 5% of non-reserve block fuel
- (M) Maximum takeoff length of 9,000' over a 35' obstacle to a runway with dry pavement (sea level ISA + 15 degrees C) at Maximum Takeoff Weight (MTOW)
  - Distance should be calculated to meet 14 CFR Part 25 requirements and be a balanced field length
- (M) Maximum Landing field length of 9,000' to a runway with dry pavement (Sea Level ISA +15 degrees C) at the end of the design range mission
- (T) Maximum Approach Speed of 145 KCAS at the end of the design range mission
- (T) Cabin pressurized to 8,000 ft pressure altitude at maximum flight altitude
- (M) Price of Jet-A Fuel is $3.00 / Gallon + $3.00 / Gallon Carbon Tax

Design Objectives

- Minimize operating cost of the aircraft based on a reference mission of 700 nmi. This mission represents key markets for this aircraft such as East Cost of the United States and Continental Europe. Operating cost should include at a minimum: fuel/energy cost, other consumables such as oil and tires, pilot and flight attendant cost, and maintenance cost. Including other costs will strengthen the proposal.
- Minimize production cost by choosing materials and manufacturing methods appropriate for the annual production rate that is supported by the team's assessment of the potential market size.
- Make the aircraft reliability equal or better than that of comparable aircraft.
- Make the aircraft maintenance equal or better than that of comparable aircraft.

Other Features and Considerations

- Flying qualities should meet CFR Part 25.
- List the equipment required.
- Consider what features will be basic and which will be optional to a customer.

Notes and Assumptions

Assume an EIS of 2029 when making technology decisions.

Proposal and Design Data Requirements

The technical proposal shall present the design of this aircraft clearly and concisely; it shall cover all relevant aspects, features, and disciplines. Pertinent analyses and studies supporting design choices shall be documented.

Full descriptions of the aircraft are expected along with performance capabilities and operational limits. These include, at a minimum:

1. A description or graphical representation of the aircraft sizing based on the requirements and design objectives given. This should describe or represent the quantitative justification for the wing area and thrust of the aircraft that was selected.
2. A description of the design missions defined for the proposed concepts for use in calculations of mission performance as per design objectives. This includes the selection of cruise altitude(s) and cruise speed/cruise Mach supported by pertinent trade analyses and discussion.
3. Aircraft performance summaries shall be documented and the aircraft flight envelope shall be shown graphically.
4. Payload range chart(s)

5. A V-n diagram for the aircraft with identification of necessary aircraft velocities and design load factors.
   Required gust loads are specified in 14 Code of Federal Regulations (CFR) Part 25.

6. Materials selection for main structural groups and general structural design, including layout of primary airframe structure as well as the strength capability of the structure and how that compares to what is required at the ultimate load limits of the aircraft. The maximum dive speed of the aircraft shall be specified.

7. Complete geometric description, including dimensioned drawings, control surfaces sizes and hinge locations, and internal arrangement of the aircraft illustrating sufficient volume for all necessary components and systems.

   - Scaled three-views (dimensioned) and 3-D model imagery of appropriate quality are expected. The three-view must include at least:

     1. Fully dimensioned front, left, and top views
     2. Location of aircraft aerodynamic center (from nose)
     3. Location of average CG location (relative to nose)
     4. Tail moment arms

   - Diagrams and/or estimates showing that internal volume requirements are met, including as a minimum the internal arrangements of the passenger cabin

     1. Cross-section showing passenger seats
     2. Layout of passenger cabin
     3. Layout of cockpit
     4. Layout of cargo and size and location of any unique cargo doors
     5. Fuselage centerline diagram

   - Diagrams showing the location and functions for all aircraft systems.

8. Important aerodynamic characteristics and aerodynamic performance for key mission segments and requirements

9. Aircraft weight statement, aircraft center-of-gravity envelope reflecting payloads and fuel allocation. Establish a forward and aft center of gravity (CG) limits for safe flight.

   - Weight assessment summary shall be shown at least at the following level of detail:

     1. Propulsion (engine core, nacelle, strut, fan, etc. as applicable)
     2. Airframe Structure
        1. Wing

2. Empennage
3. Landing Gear (including wheels tires and brakes)
4. Fuselage

3. Control system (flight controls linkages, hydraulics, wires, actuators bellcranks, engine controls etc.)
4. Payloads (Seats, Galleys, Lavatories, etc.)
5. Systems
    1. Instruments and Avionics
    2. Fuel/oil
    3. Hydraulic/pneumatic/electrical systems (if chosen)

10. Propulsion system description and characterization including performance, dimensions, and weights. The selection of the propulsion system(s), sizing, and airframe integration must be supported by analysis, trade studies, and discussion
11. Summary of basic stability and control characteristics; this should include, but is not limited to static margin, pitch, roll and yaw derivatives.
12. Summary of cost estimate and a business case analysis. This assessment should identify the cost groups and drivers, assumptions, and design choices aimed at the minimization of production costs.

- Estimate the non-recurring development costs of the airplane including engineering, FAA/EASA certification, production tooling, facilities and labor
- Estimate the fly away cost of each member of the family
- Estimate the price that would have to be sold for to generate at least a 15% profit
    - Show how the airplane could be produced profitably at production rates ranging from 10-20 airplanes per month or another production rate that is supported by a brief market analysis
- Estimate of direct operating cost on the 700 nmi reference mission
    - Fuel, oil, tires, brakes, and other consumable quantities
    - Estimate of maintenance cost per flight
    - Flight and cabin crew costs per flight
    - Including other costs will strengthen the proposal

13. A lifecycle Carbon Dioxide (CO2) emission estimate. This estimate should include CO2 emissions from manufacturing the aircraft as well as CO2 emissions while in service.

The proposal response will include trade documentation on the two major aspects of the design development, a) the concept selection trades, and b), the concept development trade studies.

The students are to develop and present the alternative concepts considered leading to the down-select of their preferred concept. The methods and rationale used for the down-select 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.

In addition, the submittal shall 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 their concept "works" and is the preferred design compromise that best achieves the RFP.

Specific analysis and trade studies of interest sought in proposals include:

- Mission performance and sizing for the definition of a mission profiles.
- Overall aircraft concept selection (airframe and propulsion system) vs. design requirements objectives

All concept and technology assumptions must be reasonable and justified for the EIS year.

Procured Data

No data is procured as part of this RFP.

Additional Contacts

All technical questions pertaining to this RFP should be directed to Andrew Dorsey at andrew.m.dorsey@boeing.com

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

Reference Material

FAA Part 25

Representative Aircraft Designs

(Keep in mind the range requirement in this RFP differs from the aircraft below)

Airbus A380

Boeing 747

Ilyushin 96-400

Boeing 777

Airbus A330