# New Mission Profiles

For passenger-carrying designs you will have to use mission definitions that are more complex that that given for the design specs. In the Breguet range equation, use the cruise sfc (suggested values are in Raymer Table 3.3) appropriate to the engine you have selected. In the endurance equation use a loiter sfc that is 105% of the cruise sfc. Assume loiter is at 10,000 ft and 250 KEAS. Aircraft will either fall under NBAA (National Business Aircraft Association) rules for bizjets, or FAR Part 121 for commercial aircraft.

## NBAA Operations

NBAA reserves requirements appear to be open to interpretation. The suggested weight fractions that you should use for your design are:

| Phase | | $W_{final}/W_{initial}$ | Value |
|---|---|---|---|
| 1 | Engine start and warm-up | $W_1/W_0$ | 0.99 |
| 2 | Taxi | $W_2/W_1$ | 0.99 |
| 3 | Takeoff | $W_3/W_2$ | 0.995 |
| 4 | Accelerate and climb to cruise altitude | $W_4/W_3$ | 0.98 |
| 5 | Cruise (using the Breguet range equation (3.5)). Assume cruise range is total mission range | $W_5/W_4$ | |
| 6 | Descent | $W_6/W_5$ | 0.99 |
| 7 | Land | $W_7/W_6$ | 0.99 |
| 8 | Takeoff | $W_8/W_8$ | 0.995 |
| 9 | Climb | $W_9/W_8$ | 0.98 |
| 10 | Cruise for 10% of mission range (use range equation). (This is a slight simplification) | $W_{10}/W_9$ | |
| 11 | Descent | $W_{11}/W_{10}$ | 0.99 |
| 12 | Land | $W_{12}/W_{11}$ | 0.99 |
| 13 | Takeoff | $W_{13}/W_{12}$ | 0.995 |
| 14 | Climb | $W_{14}/W_{13}$ | 0.98 |
| 15 | Fly to alternate (use range equation) | $W_{15}/W_{14}$ | |
| 16 | Descent | $W_{16}/W_{15}$ | 0.99 |
| 17 | Land | $W_{17}/W_{16}$ | 0.992 |
| 18 | Hold for 30 minutes at alternate (use endurance equation (3.7)) | $W_{18}/W_{17}$ | |

For this mission profile $W_{zf}/W_{to} = W_{18}/W_0$. Required operating weight empty is then defined as $W_{oe} = W_{zf} - W_{payload}$. You will have to do some research to establish an operating weight empty vs TOGW trend line.

## FAR Part 121 Domestic Operations

The domestic flight profile as defined in FAR Part 121 is as follows:

**§ 121.639   Fuel supply: All domestic operations.**

No person may dispatch or take off an airplane unless it has enough fuel—

(a) To fly to the airport to which it is dispatched;

(b) Thereafter, to fly to and land at the most distant alternate airport (where required) for the airport to which dispatched; and

(c) Thereafter, to fly for 45 minutes at normal cruising fuel consumption or, for certificate holders who are authorized to conduct day VFR operations in their operations specifications and who are operating nontransport category airplanes type certificated after December 31, 1964, to fly for 30 minutes at normal cruising fuel consumption for day VFR operations.
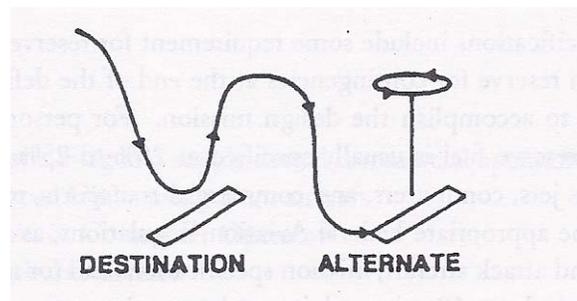


Figure 2.1 Domestic Reserves

Assume instrument flight rules (IFR) operations, i.e. 45 minute hold at alternate airport.  Assume the most distant alternate airport is 100 nm away from the airport to which dispatched.  The suggested weight fractions that you should use for your design are:

| Phase | | $W_{final}/W_{initial}$ | Value |
|---|---|---|---|
| 1 | Engine start and warm-up | $W_1/W_0$ | 0.99 |
| 2 | Taxi | $W_2/W_1$ | 0.99 |
| 3 | Takeoff | $W_3/W_2$ | 0.995 |
| 4 | Accelerate and climb to cruise altitude | $W_4/W_3$ | 0.98 |
| 5 | Cruise (using the Breguet range equation (3.5)).  Assume cruise range is total mission range | $W_5/W_4$ | |
| 6 | Descent | $W_6/W_5$ | 0.99 |
| 7 | Fly to alternate (use range equation) | $W_7/W_6$ | |
| 8 | Land and taxi in | $W_8/W_7$ | 0.992 |
| 9 | Hold for 45 minutes at alternate (use endurance equation (3.7)) | $W_9/W_8$ | |

For this mission profile $W_{zf}/W_{to} = W_9/W_0$.  Required operating weight empty is then defined as  $W_{oe} = W_{zf} - W_{payload}$.

## FAR Part 121 International Operations

Mission profile requirements for international operations are as follows:

**§ 121.645   Fuel supply: Turbine-engine powered airplanes, other than turbo propeller: Flag and supplemental operations.**

(a) Any flag operation within the 48 contiguous United States and the District of Columbia may use the fuel requirements of §121.639.

(b) For any certificate holder conducting flag or supplemental operations outside the 48 contiguous United States and the District of Columbia, unless authorized by the Administrator in the operations specifications, no person may release for flight or takeoff a turbine-engine powered airplane (other than a turbo-propeller powered airplane) unless, considering wind and other weather conditions expected, it has enough fuel—

(1) To fly to and land at the airport to which it is released;

(2) After that, to fly for a period of 10 percent of the total time required to fly from the airport of departure to, and land at, the airport to which it was released;

(3) After that, to fly to and land at the most distant alternate airport specified in the flight release, if an alternate is required; and

(4) After that, to fly for 30 minutes at holding speed at 1,500 feet above the alternate airport (or the destination airport if no alternate is required) under standard temperature conditions.

(c) No person may release a turbine-engine powered airplane (other than a turbo-propeller airplane) to an airport for which an alternate is not specified under §121.621(a)(2) or §121.623(b) unless it has enough fuel, considering wind and other weather conditions expected, to fly to that airport and thereafter to fly for at least two hours at normal cruising fuel consumption.

(d) The Administrator may amend the operations specifications of a certificate holder conducting flag or supplemental operations to require more fuel than any of the minimums stated in paragraph (a) or (b) of this section if he finds that additional fuel is necessary on a particular route in the interest of safety.

(e) For a supplemental operation within the 48 contiguous States and the District of Columbia with a turbine engine powered airplane the fuel requirements of §121.643 apply.

The use of the term "flag carrier" is somewhat archaic, since the term is no longer used except in the FARs.  The term may be defined as follows:

**Flag Carrier – Airline Flag Operations – A Flag Carrier is defined by the FAA as any scheduled operation conducted by any person operating any turbojet powered airplanes, or airplanes having a passenger-seat configuration of more than 9 passenger seats, excluding each crew member seat, or airplanes having a payload capacity of more than 7,500 lb. at the following locations between any point within the U.S. or any territory or possession of the US respectively, or between any point within the U.S. and any point outside the U.S. or between any point outside the U.S. and another point outside the U.S.**
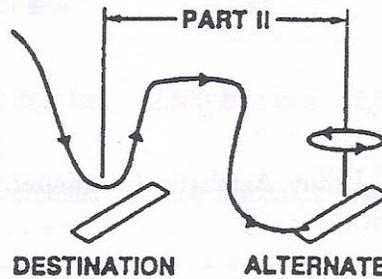
Figure 2.2 International Reserves

The suggested weight fractions that you should use for your design are:

| Phase | | $W_{final}/W_{initial}$ | Value |
|---|---|---|---|
| 1 | Engine start and warm-up | $W_1/W_0$ | 0.99 |
| 2 | Taxi | $W_2/W_1$ | 0.99 |
| 3 | Takeoff | $W_3/W_2$ | 0.995 |
| 4 | Accelerate and climb to cruise altitude | $W_4/W_3$ | 0.98 |
| 5 | Cruise (using the Breguet range equation (3.5)). Assume cruise range is total mission range | $W_5/W_4$ | |
| 6 | Descent | $W_6/W_5$ | 0.99 |
| 7 | Land | $W_7/W_6$ | 0.99 |
| 8 | Takeoff | $W_8/W_8$ | 0.995 |
| 9 | Climb | $W_9/W_8$ | 0.98 |
| 10 | Cruise for 10% of mission range (use range equation). (This is a slight simplification) | $W_{10}/W_9$ | |
| 11 | Descent | $W_{11}/W_{10}$ | 0.99 |
| 12 | Land | $W_{12}/W_{11}$ | 0.99 |
| 13 | Takeoff | $W_{13}/W_{12}$ | 0.995 |
| 14 | Climb | $W_{14}/W_{13}$ | 0.98 |
| 15 | Fly to alternate (use range equation) | $W_{15}/W_{14}$ | |
| 16 | Descent | $W_{16}/W_{15}$ | 0.99 |
| 17 | Land | $W_{17}/W_{16}$ | 0.992 |
| 18 | Hold for 30 minutes at alternate (use endurance equation (3.7)) | $W_{18}/W_{17}$ | |

For this mission profile $W_{zf}/W_{to} = W_{18}/W_0$. Required operating weight empty is then defined as $W_{oe} = W_{zf} - W_{payload}$

ADAC
Aircraft Design & Consulting