Performance

FAA Handbook Aeronautics

Chap 10

Aircraft Performance

- Landing distance
- Takeoff distance
- Rate of Climb
- Ceiling
- Payload
- Range
- Speed manuverability
- Stability
- Fuel economy

Factors

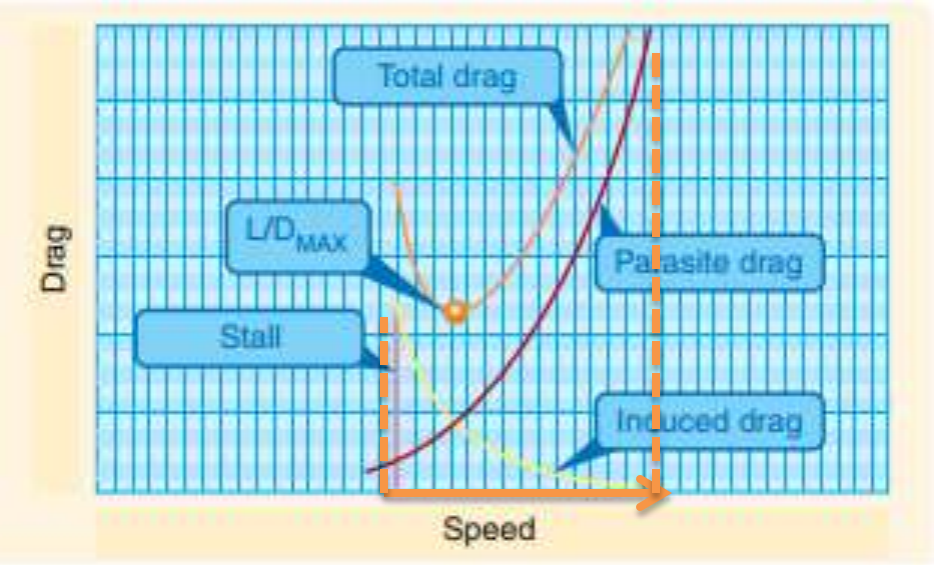
- Aerodynamic Characteristics → Power and Thrust at various conditions of flight
- Powerplant → power and thrust available at various flight conditions

Straight and Level Flight

- Steady, level flight:
  - Lift = Weight
  - Thrust = Drag

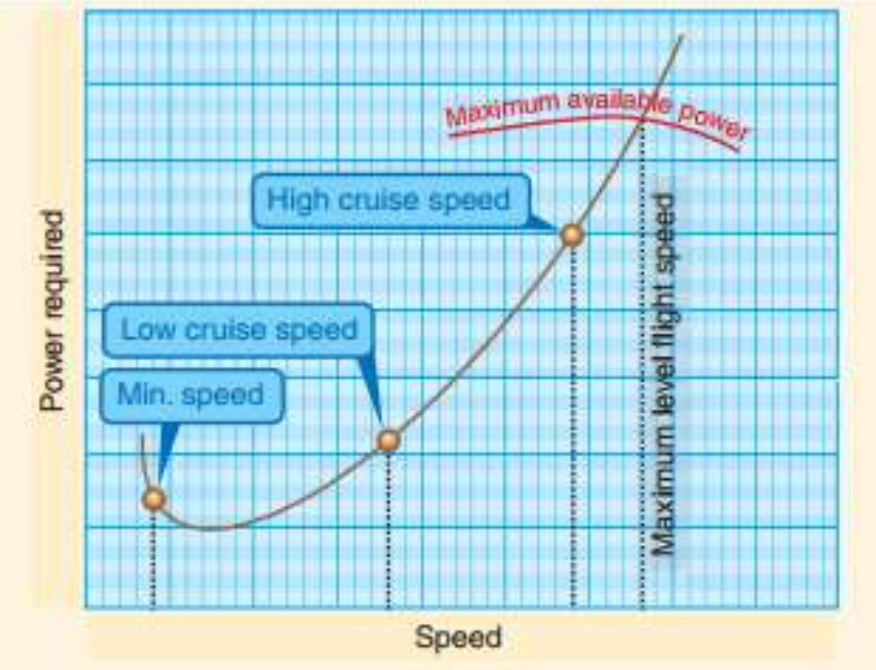
- Remember Drag = induced (from lifting) + parasite
  - Parasite drag from high speed
  - Induced drag from low speed

Effect of Speed on Drag



- Accelerating from 100 knots to 200 knots:
  - Parasite drag increases 4 X
    - Power required to overcome drag is 8 X
  - Induced drag is ¼
    - Power to overcome is ½

Min and Maximum Level-flight Speed



- Maximum speed for level flight when:
  - Max thrust is applied
- Minimum speed for level flight when:
  - Stall speed
  - “Stability” speed

Climb Performance

- Energy provided by:
  - Excess thrust required for level flight
    - Excess thrust = Max Thrust – Thrust for level flight (e.g. 70 = 200 – 130)
  - Trading off kinetic energy (i.e. speed) for potential energy (i.e. altitude)

Maximum Angle of Climb (degrees)

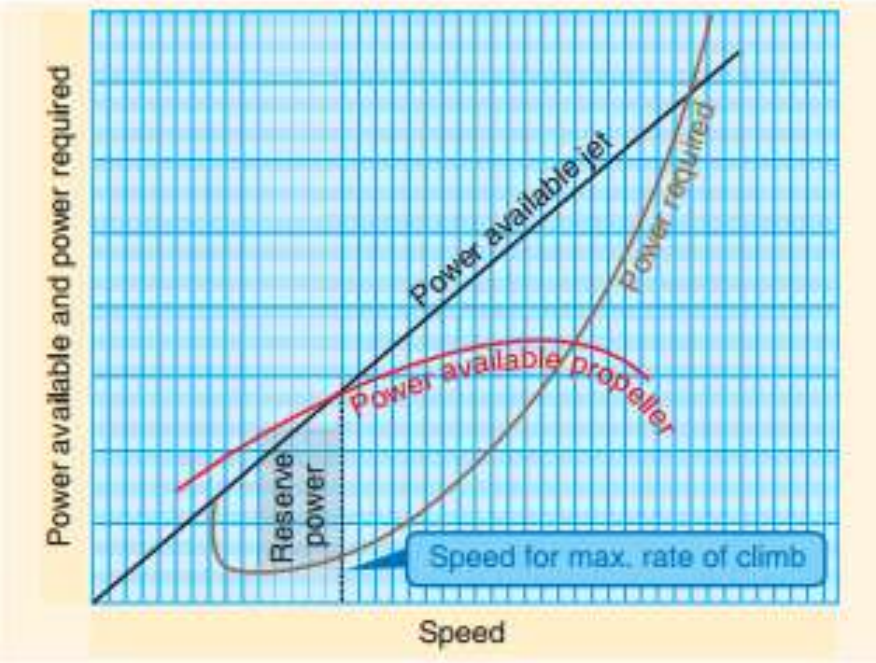
- Greatest difference between Thrust Available and Thrust required
  - Propeller driven aircraft, maximum excess thrust and angle of climb will occur at speed approx stall speed
- Important for obstacle clearance

Maximum Rate of Climb (ft/min)

- Greatest difference between Power Available and Power Required (i.e. Excess Power)
- Rate of Climb → Excess Power
- Angle of Climb → Excess Thrust

Impact of Speed on Climb Performance

- As speed increases → Excess power/Thrust decreases

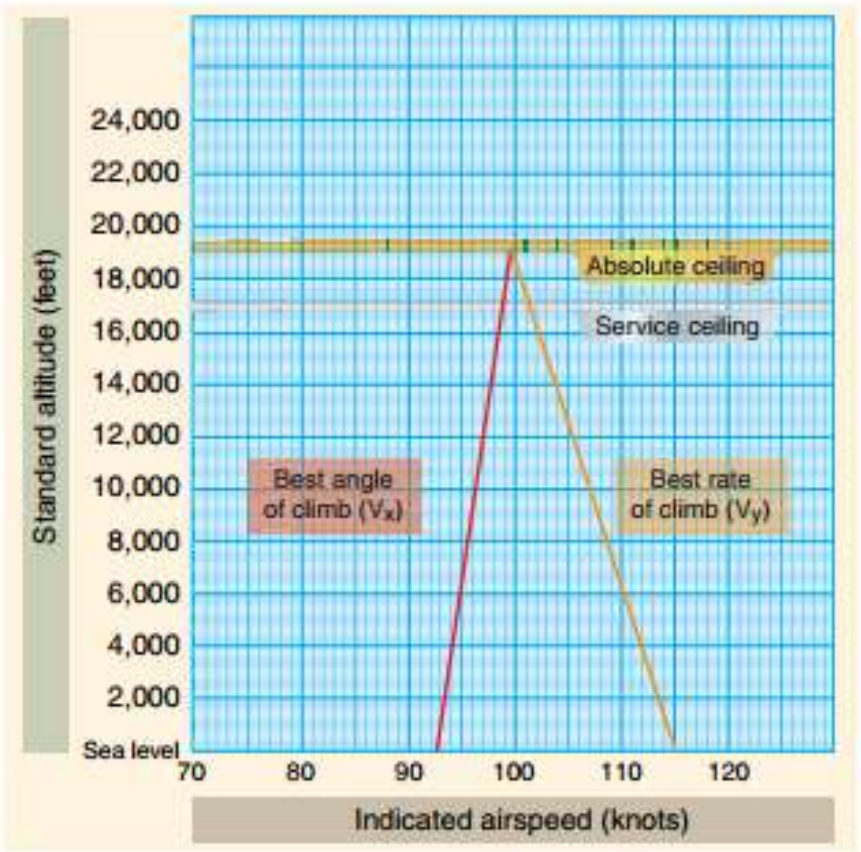


Impact of Weight On Climb Performance

- Change in weight:
  - Changes the drag and power required
  - Increase in weight reduces the rate-of-climb

Impact of Altitude on Climb Performance

- Increase in altitude increases power required (and decreases power available)
- Climb performance diminishes with altitude
- Absolute ceiling of the aircraft is where min and max speeds converge
  - = Zero rate of climb
  - = Coffin corner
- Service ceiling = Rate-of climb = 100 ft/min



Terminology

- Powerloading (pounds per horsepower)
  - Total weight/Rated Horsepower of engine
  - Determines takeoff and climb performance
- Wing loading (pounds per square foot0
  - Total weight/Wing area
  - Determines landing speed

Range Performance

- Range performance:
  - Extract maximum flying distance from a give fuel load
  - Fly a specified distance with minimum expenditure of fuel
- Ability to convert fuel energy into flying distance

Range vs Endurance

Endurance

Specific Endurance =

flight hours/pounds of fuel

OR

flight hours/hour / pounds of fuel/hour

OR

1/fuel flow (pounds or gallons)

- Maxuimum Endurance = minimum fuel flow

Range

Specific Range =

nm/ pounds of fuel

OR

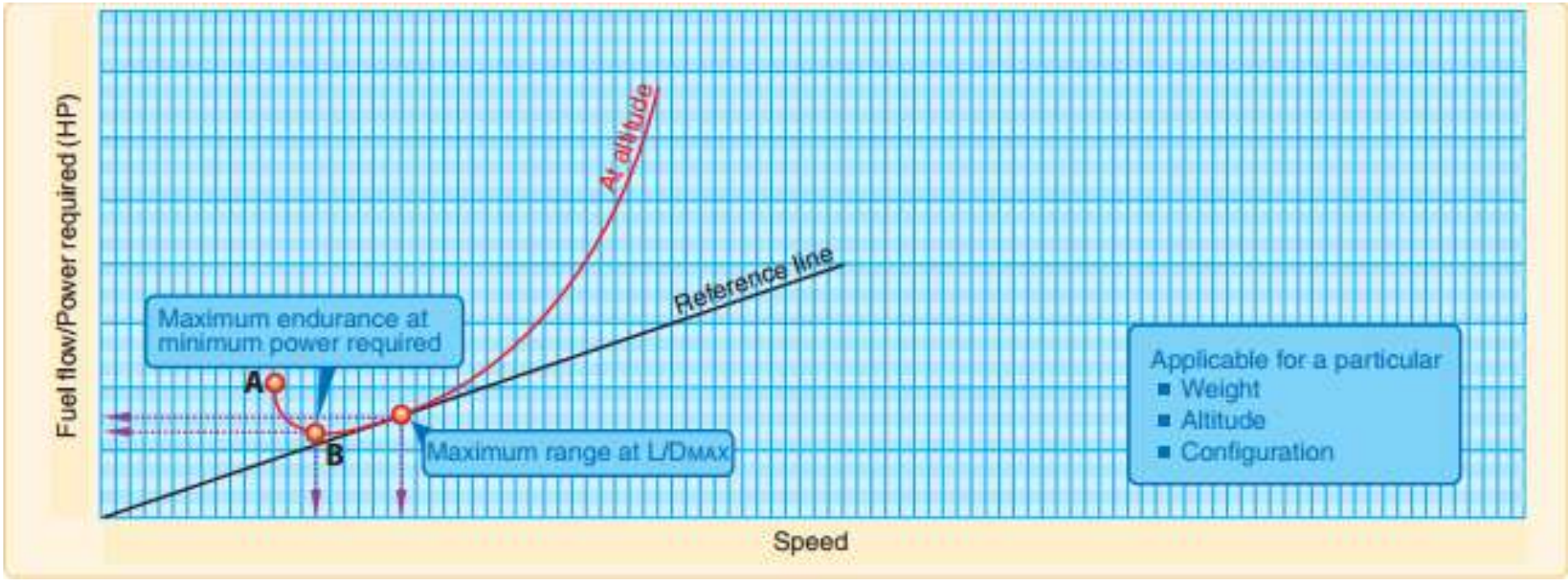
nm/hour / pounds of fuel/hr

OR

knots/fuel flow

- Maximum Range = maximum of speed per fuel flow

Range Vs Endurance



Specific Range

- Affected by:
  - Aircraft Gross Weight
  - Altitude
  - Aerodynamic configuration of the aircraft

Region of Reversed Command

- Normal command = higher airspeed requires higher thrust (at level flight)
- Reversed command = higher airspeed requires lower power (and lower airspeed requires higher thrust)
  - Low speed regionof flight