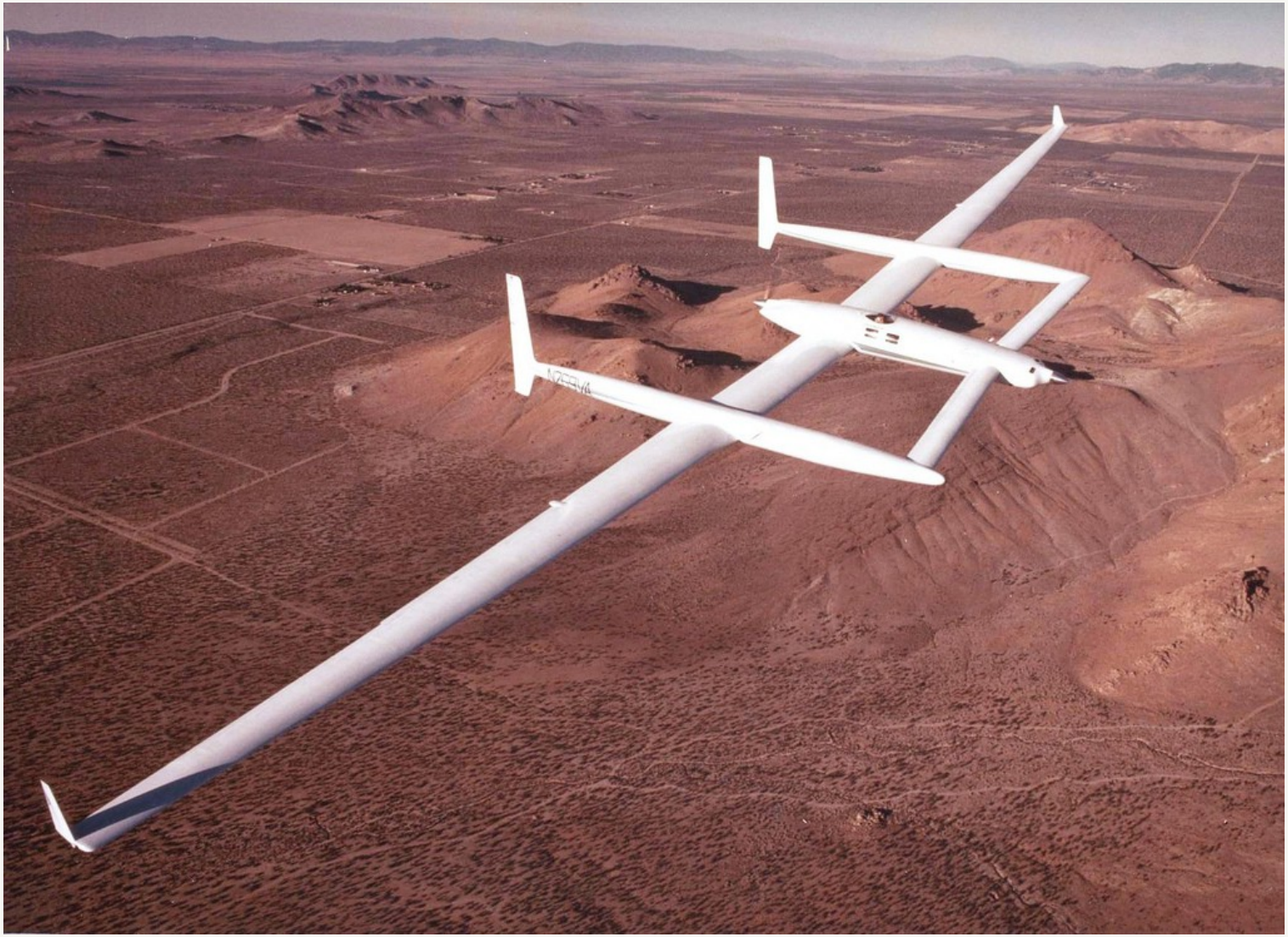
Exercise 10 – Range and Endurance



What You Will Learn:

- ✓ How To Set up the Airplane For:
  - maximum range
  - maximum endurance

Most Distance per Unit of Fuel

Most Time per Unit of Fuel.

Why Learn This:

- ✓ How To Set up the Airplane For:
  - maximum range

- Long cross-country: go further without refueling
- Minimize fuel consumption: fuel is expensive!

Factors Affecting Maximum Range:

Altitude

aircraft weight

fuel available

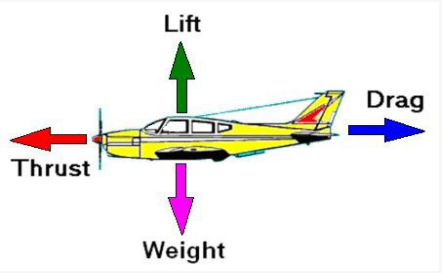
mixture

wind

Altitude

- ✓ Combustion engines are most efficient when throttle is fully open
- ✓ Best efficiency achieved when fully open throttle produces just enough power to fly at the airspeed that yields best L/D ratio
- ✓ At high altitudes, open throttle only produces a fraction of power it does at sea level – so at optimal altitude open throttle will produce the optimal power
- ✓ Generally, range increases with altitude.

Aircraft Weight



- At level flight, lift = weight
- A change in weight means a change in lift.
  - ~~Decrease AoA?~~
  - √ Decrease Power?

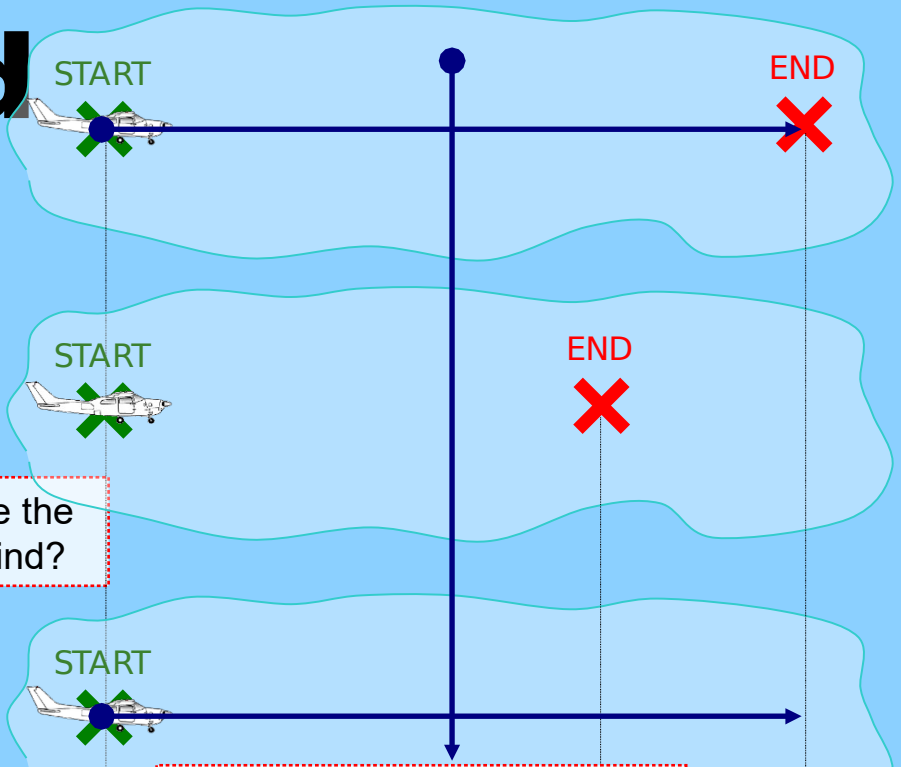
must maintain best AoA for the best L/D ratio!

- As Weight decreases Airspeed Increases
  Decrease Power to maintain Maximum Range

Mixture

- Mixture too rich = wasted fuel
- Lean mixture . Lean until we get the maximum RPM. Or the Engine runs a little rough. And than turn back 3-4 turns
- EGT? Some run 50 degrees lean of peak EGT, even less fuel

Wind



No Wind

Headwind

increase IAS by 5-10%

How can we reduce the effects of a headwind?

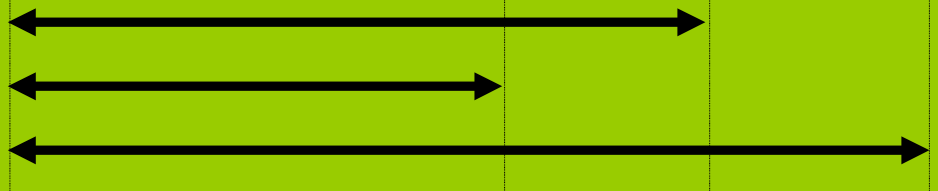
END

Tailwind

decrease IAS up to 5%

How can we further increase our range in a tailwind?

Wind generally has greater effect on range than altitude does.



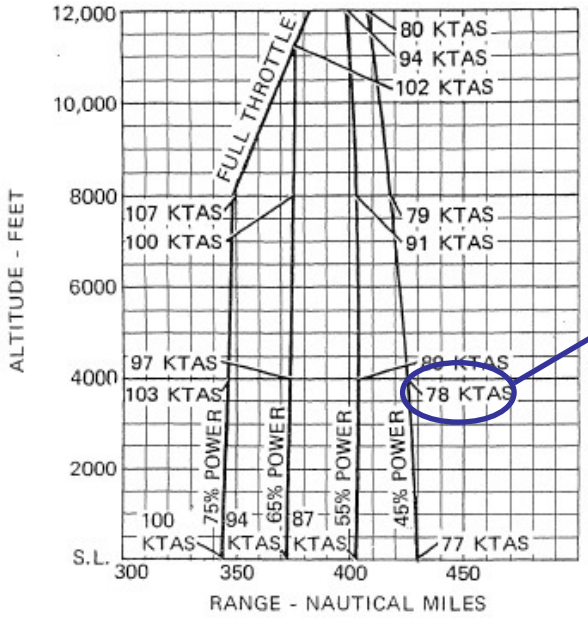
Determining Range from POH

RANGE PROFILE
45 MINUTES RESERVE
24.5 GALLONS USABLE FUEL

CONDITIONS:
1670 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature
Zero Wind

NOTES:
1. This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the distance during climb as shown in figure 5-6.
2. Reserve fuel is based on 45 minutes at 45% BHP and is 2.8 gallons.
3. Performance is shown for an airplane equipped with speed fairings which increase the cruise speeds by approximately two knots.

What conditions must exist in order for this graph to be accurate?



Find in YOUR POH: how far will you cruise at 45% power at 4000 feet?

+2 knots (2.5%)

Maximum Endurance

- Maximum Endurance

Most Time per Unit of Fuel.

Why Learn This:

- Maximum Endurance

Lost in Namibia.
Photo Shoot
Waiting for ATC clearance.
Waiting for weather to clear.

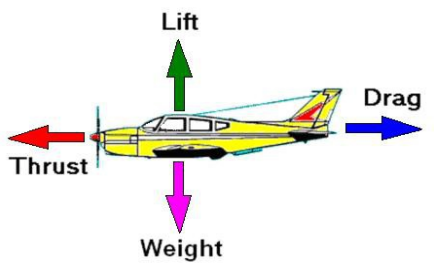
Factors Affecting Maximum Endurance:

aircraft weight

fuel available

mixture
Air Speed
Turbulence

Aircraft Weight

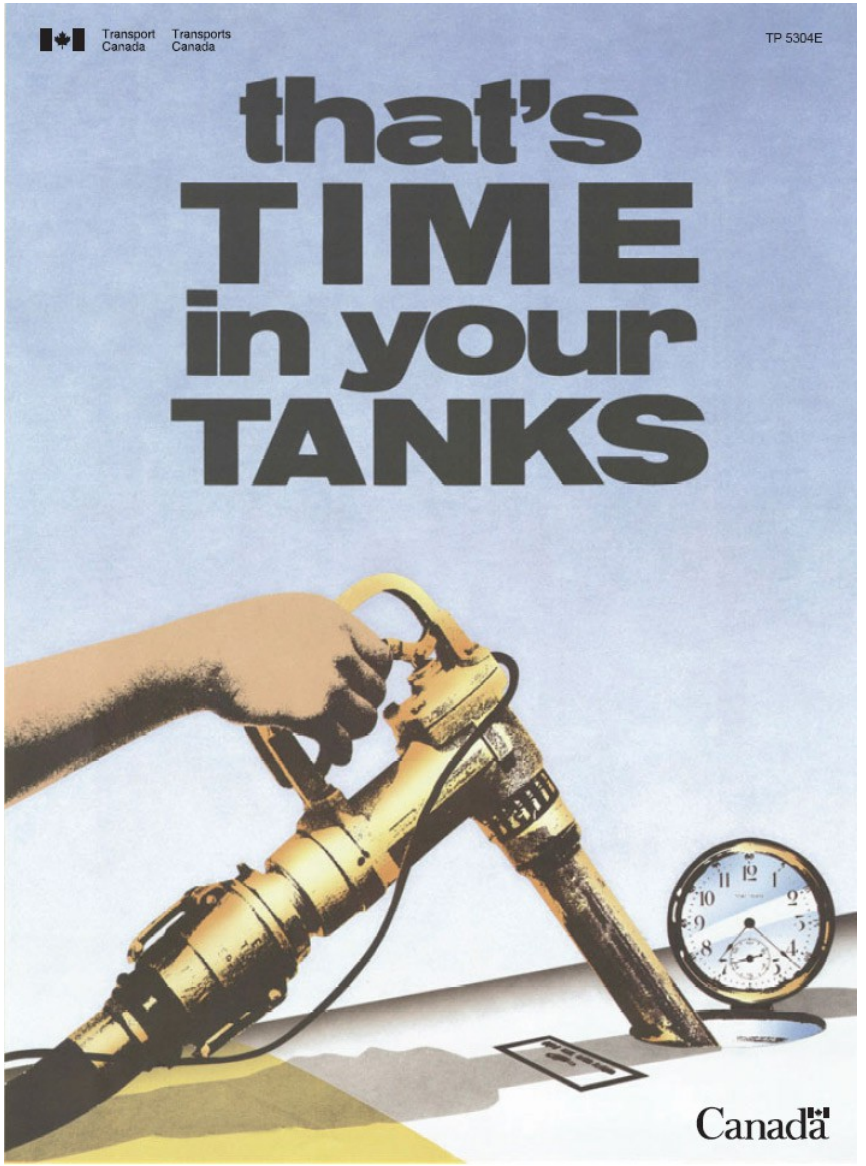


- ✓ At level flight, lift = weight
- ✓ Increase in weight means we must increase lift. How?
  - ~~increase~~ AoA? this will push you into the back side of the power curve
  - increase airspeed? ✓ but this means increasing power & burning more fuel…
- ✓ Higher weight ➔ decreased Endurance

Fuel Available

More Fuel =

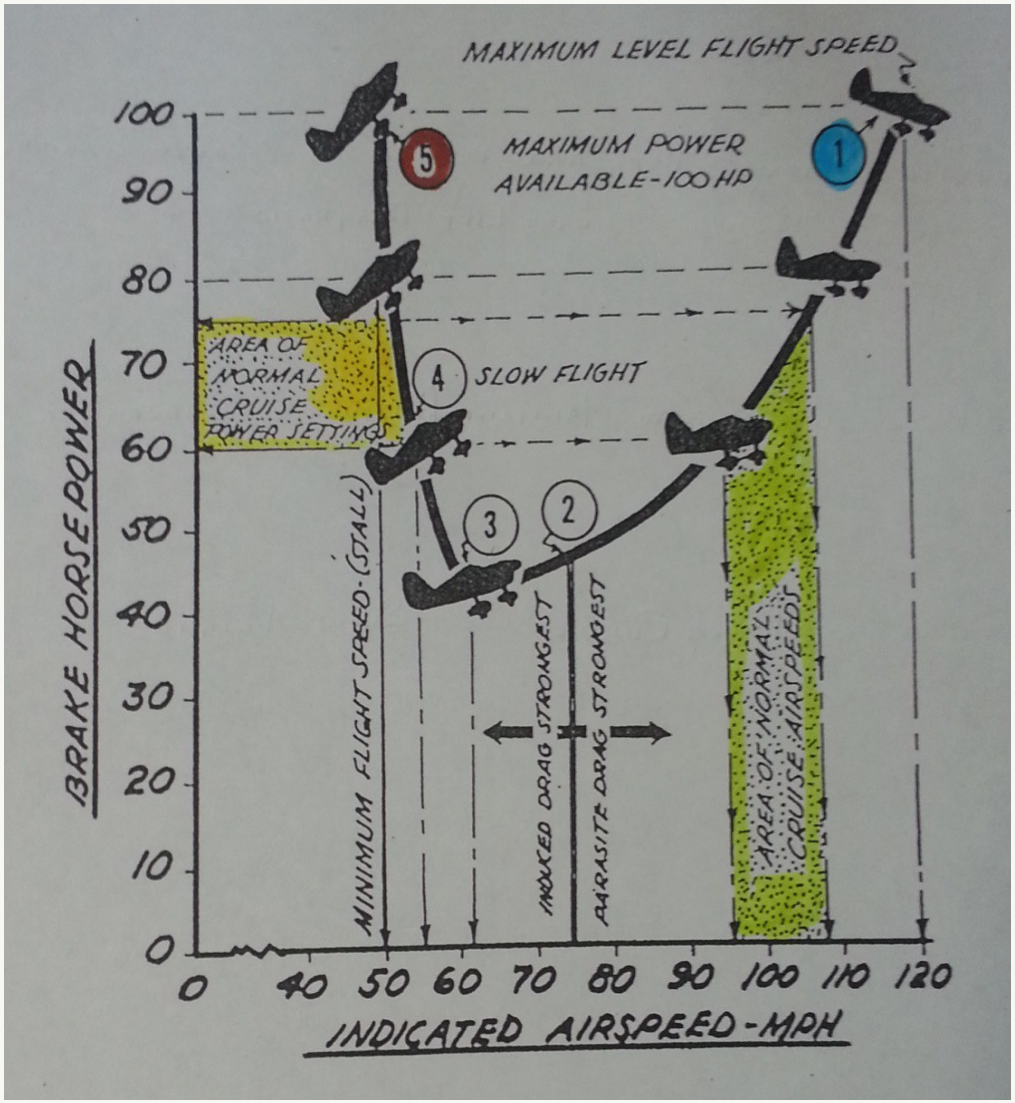
More Endurance



Mixture

- Mixture too rich = wasted fuel
- Lean mixture aggressively
- At low power settings, hard to ruin engine by detonation, over lean

Airspeed

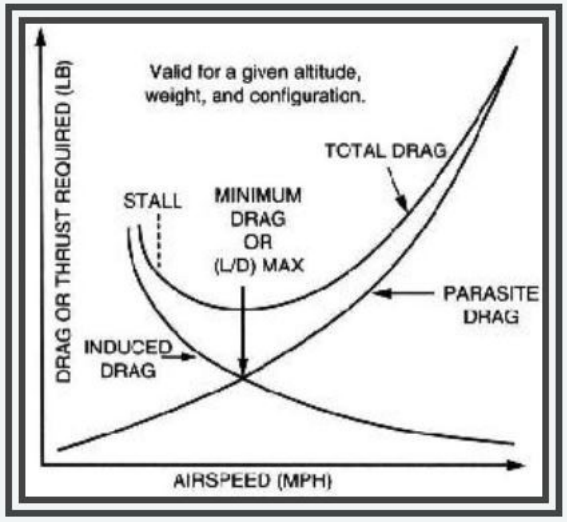


1) Max Speed and Power
2) Maximum Range:
   Parasite and Induced Drag are equal = Point of Max Range. Best Lift/Drag Ratio
3) Maximum Endurance:
   Remain Airborne with the least Power Setting
4) Slow Flight:
   Back Side of Power Curve= Slow Flight
5) Stall

Finding maximum endurance power

Light single-engine fixed-gear airplane-rule of thumb: multiply power-off stall speed by 1.5 to determine maximum-range airspeed

Experimental method-reduce power, stabilize, until more power needed to slow down. Then speed up again, use lowest power found.



Turbulence

- ✓ Turbulence will be constantly altering the aircraft's angle of attack
- ✓ When angle of attack increases, you will have to add power to maintain level flight
- ✓ Constant changes to AoA will require constant power changes:
- ✓ Increased power setting is advisable in this situation

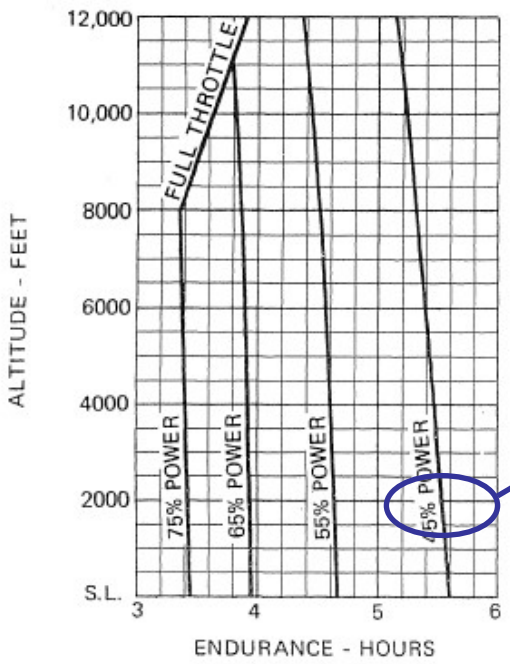
Determining Endurance from

ENDURANCE PROFILE
45 MINUTES RESERVE
24.5 GALLONS USABLE FUEL

CONDITIONS:
1670 Pounds
Recommended Lean Mixture for Cruise
Standard Temperature

NOTES:
1. This chart allows for the fuel used for engine start, taxi, takeoff and climb, and the time during climb as shown in figure 5-6.
2. Reserve fuel is based on 45 minutes at 45% BHP and is 2.8 gallons.

What conditions must exist in order for that figure to be accurate?



Find in YOUR POH: how long can you stay in the air at 2000 feet, 45% power?

SAFETY

- Look-out is critical when flying at best range and endurance airspeed: nose up, reduced visibility
- Lean, but avoid over-leaning the mixture
- close to slow flight regime and stall: watch your airspeed and attitude
- Control effectiveness is reduced, slow speeds, rudder still works well

Conclusion:

- ✓ This is the last basic flight manoeuvre!
- ✓ After mastering this exercise, we will explore the dark back side of the power curve and enter slow flight
- ✓ This exercise also prepares for cross-country flights
- ✓ Read for next lesson: Ex. 11, Slow Flight (FTM)

QUESTIONS?

The End