CPL Theory
Aerodynamics (CADA)

CAE Oxford
Aviation Academy

CADA 3 – Thrust and Power

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2. Related Documents

Related Documents	Document Identification

CADA 3 – Thrust and Power

Amendments made to this document since the previous version are listed below. All amendments to this document have been made in accordance with CAE OAAM's document management procedure.

Slide	Changes

THRUST

Thrust Available

Thrust is a force created by the propeller:

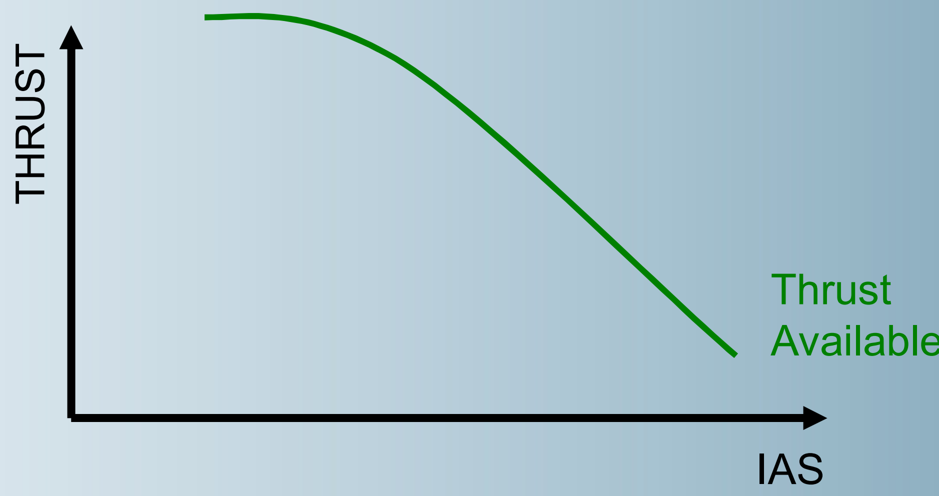
- Propeller thrust will be a maximum at low airspeed and will steadily decrease as airspeed increase

- The thrust from the propeller is proportional to the difference between the velocity of the propeller slipstream and the TAS of the aircraft

- Example: slipstream velocity = 150kts

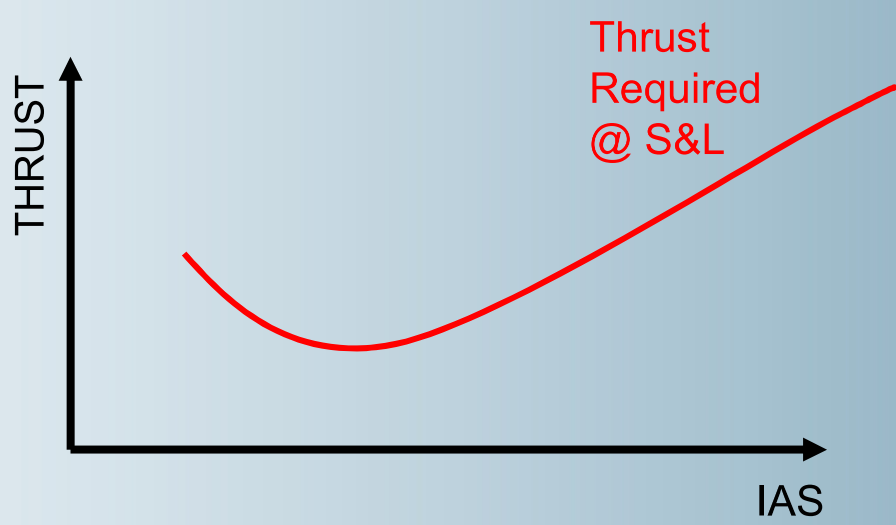
- At TAS = 0kts, the Prop is changing the velocity of the air by 150kts
    - Thrust is high

- At TAS = 150kts, the TAS = the slipstream velocity, so the prop is not changing the velocity of the air
    - Thrust is nil



Thrust Required

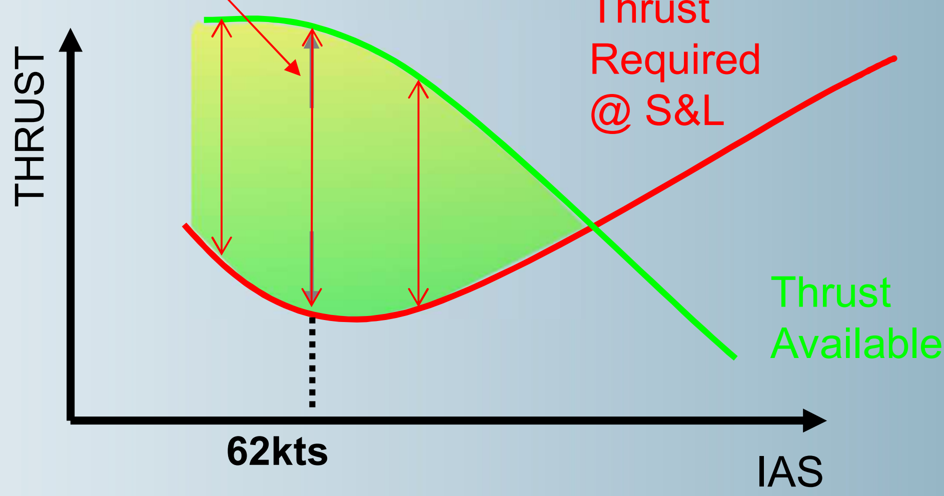
- The thrust required will be dependant on the drag
- At low airspeeds the thrust required in flight will be high because drag is high
- At the minimum drag speed, the thrust required for level flight will be a minimum
- At high airspeeds the thrust required in flight will be high because drag is high
- The difference between the thrust available and the thrust required is called the ***excess thrust***



Excess Thrust

Excess thrust is the difference between the thrust available and the thrust required

- The excess thrust determines how big the performance margin of the aircraft is
- Large excess thrust allows steep climbs or quick acceleration
- The maximum excess thrust will determine the maximum climb *angle*
  - In the C172 this is 62kts



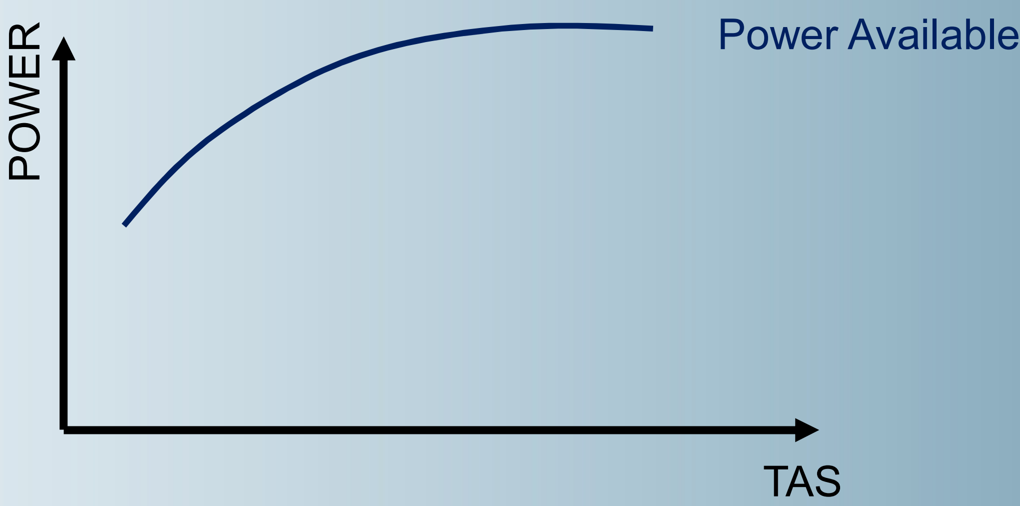
POWER

Power available

Power is a rate at which work is done, it is directly proportional to fuel flow and is defined by he following formula:

Power = Thrust x TAS

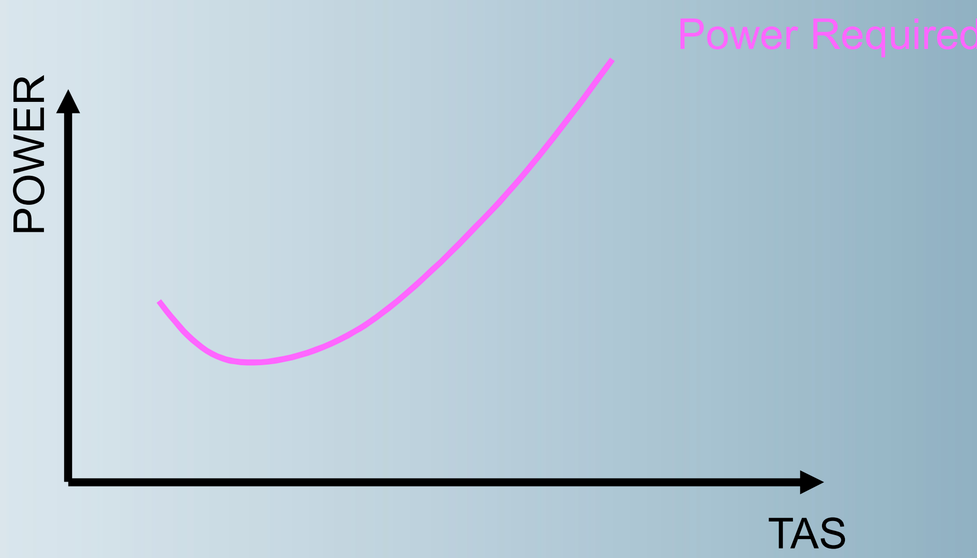
- Power output is related to RPM
- The power available will tend to increase as speed increases
- This is because as the TAS increases the RPM which the engine can achieve will increase, therefor more fuel can be burnt
- Think
  - Stationary: Max RPM ~ 2300
  - At 110kts: Max RPM ~ 2600-2700
    - More power



Power Required

Power required = Drag x TAS

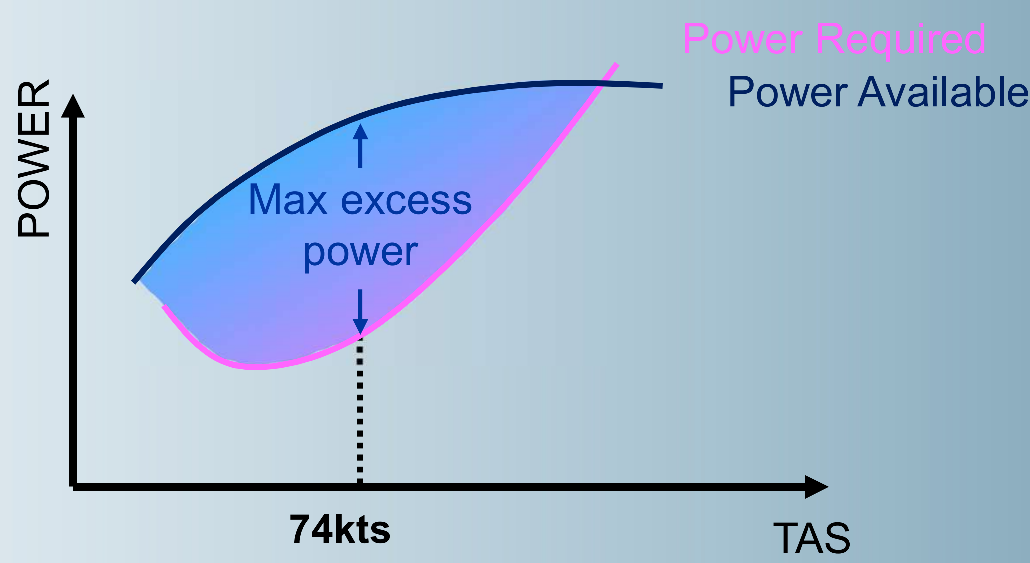
- The power required depends on a combination of Thrust(drag) and TAS
- At low airspeeds, the power required will be quite high, because drag is high
- At intermediate airspeeds the drag will be low, so the power required will be low
- At high airspeeds the drag will be high and the TAS will also be high, so power required will be very high



Excess Power

Excess power is the difference between the power available and the power required

- The excess power determines how big the performance margin of the aircraft is
- Large excess power allows high rates of climb or high S&L airspeeds
- The maximum excess power will determine the maximum climb *rate*
    - In the C172 this is 74kts

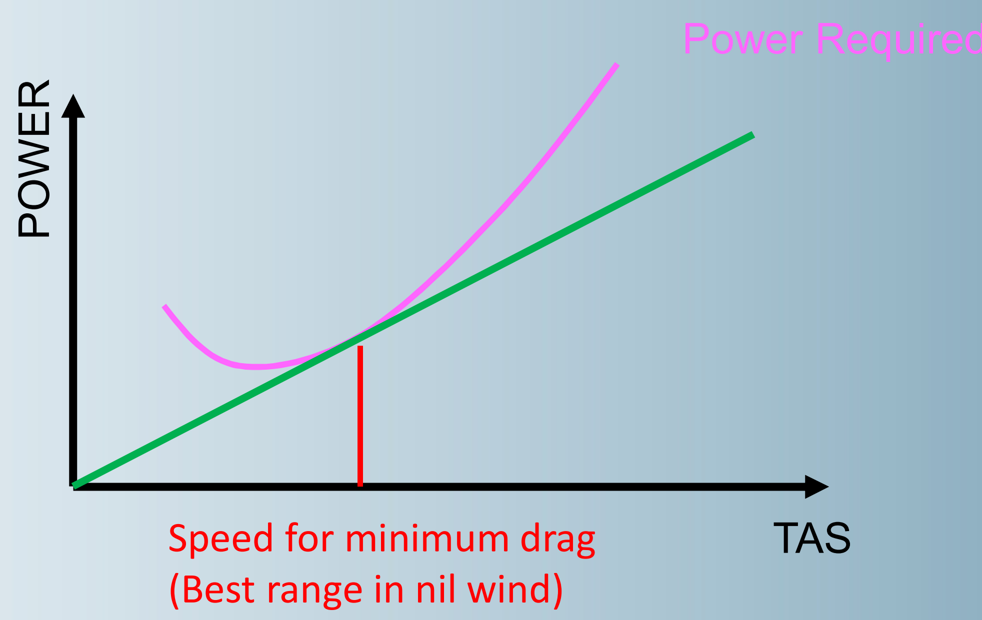


Minimum Drag on the Power Curve

The minimum drag will occur at an airspeed corresponding to the highest ratio of TAS to Power (fuel flow)

- This point is found by drawing a tangent from the origin to the power curve

- This point will also give you the maximum range in nil wind (more on this later)

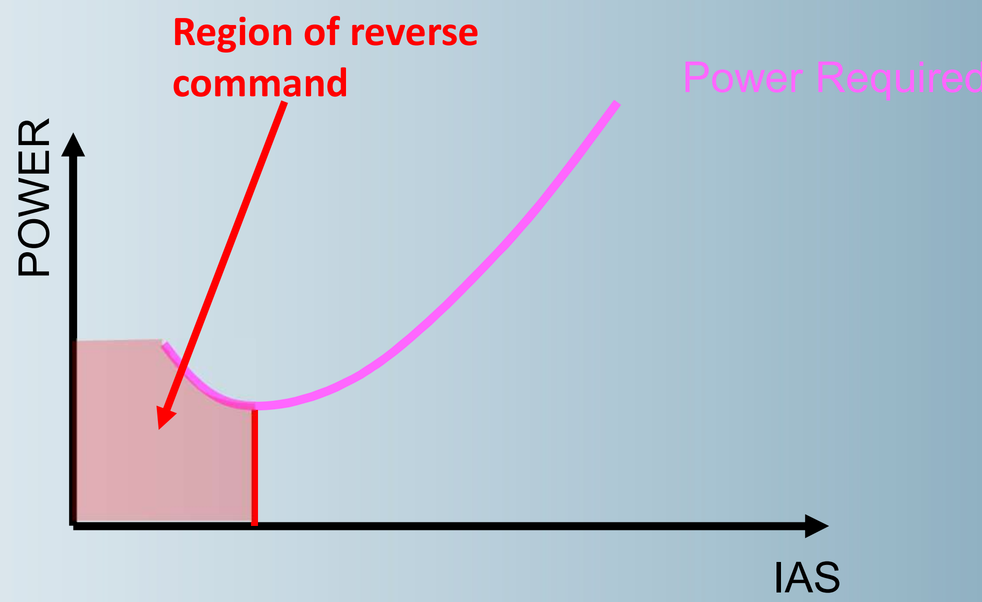


REGION OF REVERSE

Region of Reverse Command

The area of the power curve where the power required increases with decreasing airspeed is known as the **Region of Reverse Command**

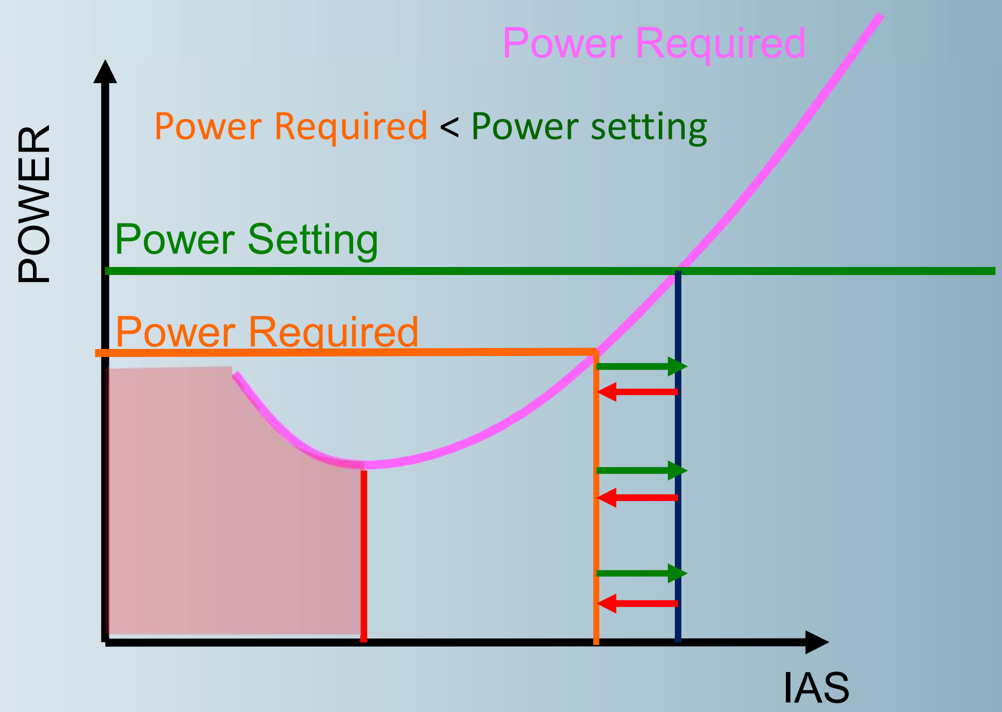
- In the normal operating area, changes of airspeed in level flight will be resisted
  - The aircraft is said to be **speed stable**
- In the region of reverse command, changes in speed will not be resisted and the speed will runaway from the set speed
  - The aircraft is said to be **speed unstable**



Region of Reverse Command

Example of speed stability

- If an aircraft is flying above the min power speed and it slows down due to a gust, the power required reduces
- The power setting is now greater than what is required for level flight
- The excess power will cause the aircraft to accelerate back to its original speed
- The opposite will happen if the speed increase



Region of Reverse Command

Example instability

- If an aircraft is flying below the min power speed and it slows down due to a gust, the power required INCREASES
- The power setting is now less than what is required for level flight (despite not actually changing)
- The lack of power will cause the aircraft to slow down even further
- The pilot must take action to halt speed loss
- The opposite will happen if the speed increase