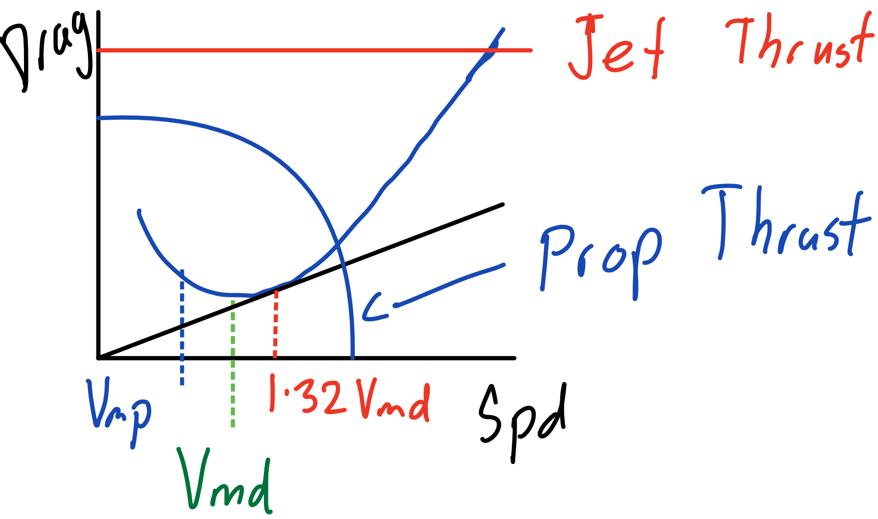
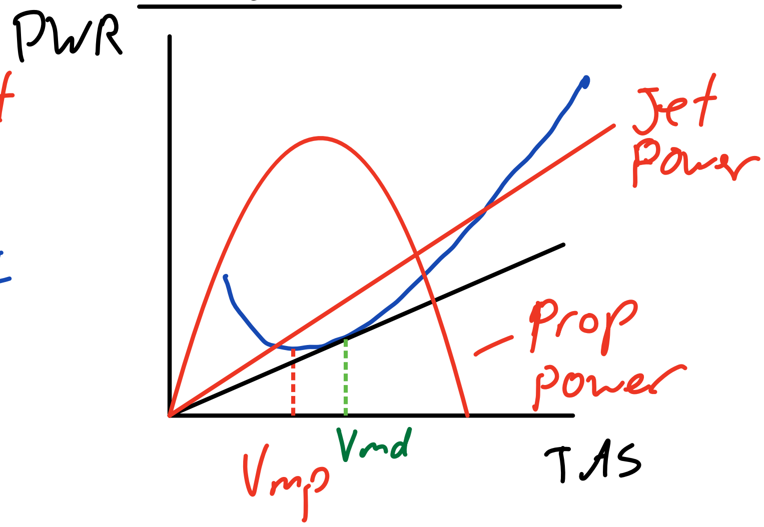
# Tables to pass the exam

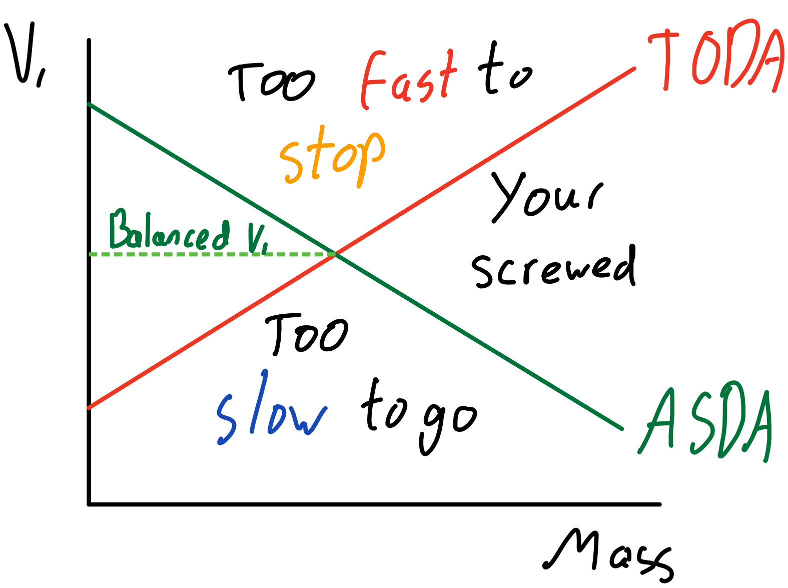
## Spd vs Drag

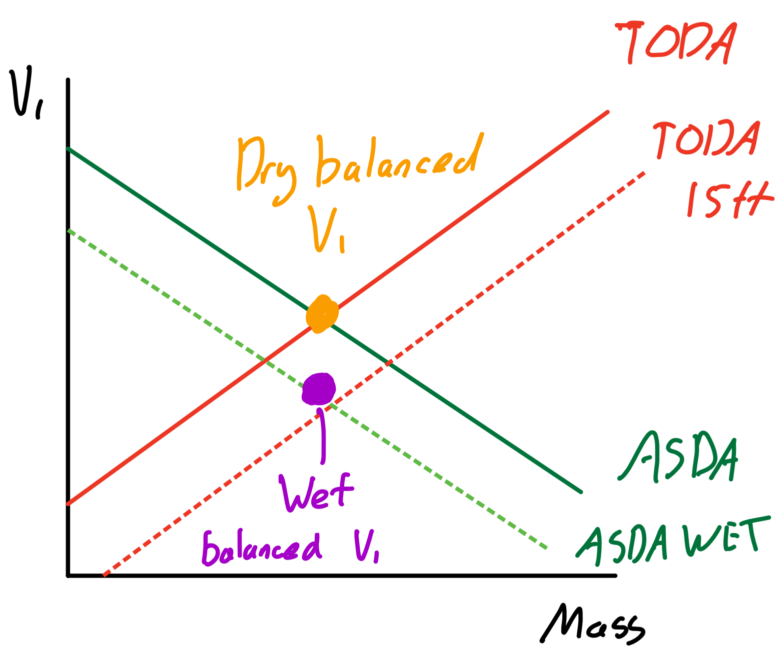



## TAS vs Power

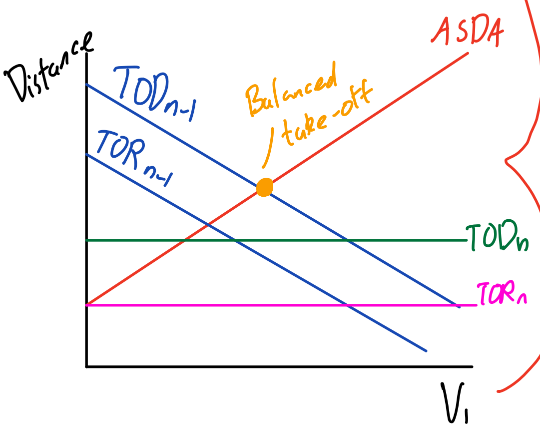



## The take-off



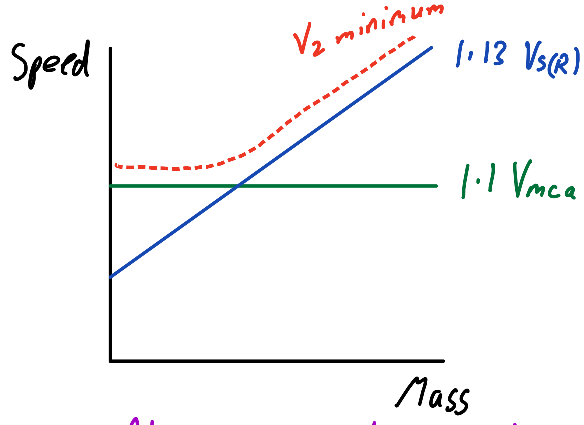




We keep the mass the same as we can't offload fuel during the taxi




Graph given in exam

## When is $V_2$ limited by Factors?




At low masses, $V_2$ is limited by $V_{mca}$.
At high masses, $V_2$ is limited by $V_s$

## Essential Knowledge table:

| | $V_r$ | $V_2$ minimum |
|---|---|---|
| $V_{mca}$ | 1.05 | 1.1 |
| $V_s$<br>$V_{S(R)}$ | 1.1<br>(Class B MEP) | 1.08 4-Engine turbo-prop<br>1.13 Class A<br>1.2 Class B |

SEP $V_s \le V_r$

$V_{S(R)}$ used on Class A a/c (stall reference speed)

## Effects on $V_{mbe}$

| Variable | Effect on $V_{mbe}$ |
|---|---|
| + Mass | Decrease |
| + Density | Increase |
| + Flap | No effect |
| HWC | Increase |
| TWC | Decrease |
| Upslope | Increase |
| Downslope | Decrease |
| Wet | No effect |

## PCN and ACN

PCN: Pavement classification number
ACN: Aircraft classification number

A number then 4 letters
The number + first letter are the only important ones

The ACN cannot exceed PCN
↳ Unless covered under occasional movements
↳ Where ACN can exceed PCN by 10%

If an ACN has the letter R - (Rigid) the PCN must also have R

## Hydroplaning

Viscous:
- Damp or wet pavement
- Med-High speed
- Smooth pavement
- Worn tires
- Film of oil, dust, grease, rubber
- Lower speeds than dynamic hydroplaning

Dynamic hydroplaning:
- Flooded pavement
- High speed
- Bar to PSI = x14.5

Take-off: $9 \times \sqrt{\text{Tyre pressure in psi}}$
Landing: $7.7 \times \sqrt{\text{Tyre pressure in psi}}$

Reverted rubber:
- 'Flat spot on tyre'
- High speed

Friction coefficient
$\geq 0.4$ = Good

Where can you find contaminated runway (limitations, procedures and performance)?
Found in ops manual part B: Specified section

## Take-off Factors used

Paved: ×1
Dry grass: ×1.2
Wet grass: ×1.3
Slope: 5% for every 1%

Perf Factors

Reg Factors

| Type of runway | Distance | Factor |
|---|---|---|
| Balanced | TORR | TOD ×1.25 |
| Unbalanced | TORR | TOD×1 |
| | TODR | TOD ×1.15 |
| | ASDR | TOD ×1.3 |

Graphical distance
Perf Factors
Actual distance
Reg factors
Required/available (TODR, ASDR, LDR)

Gets bigger

Gets smaller

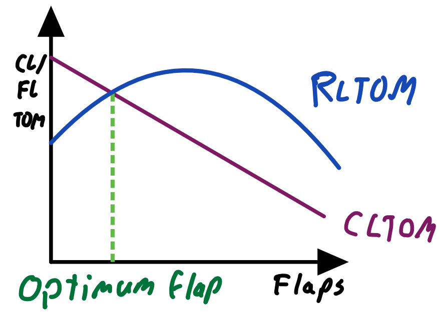
End of runways

## The climb

Not affected by wind:
- Climb°
- Climb %
- Still air climb°

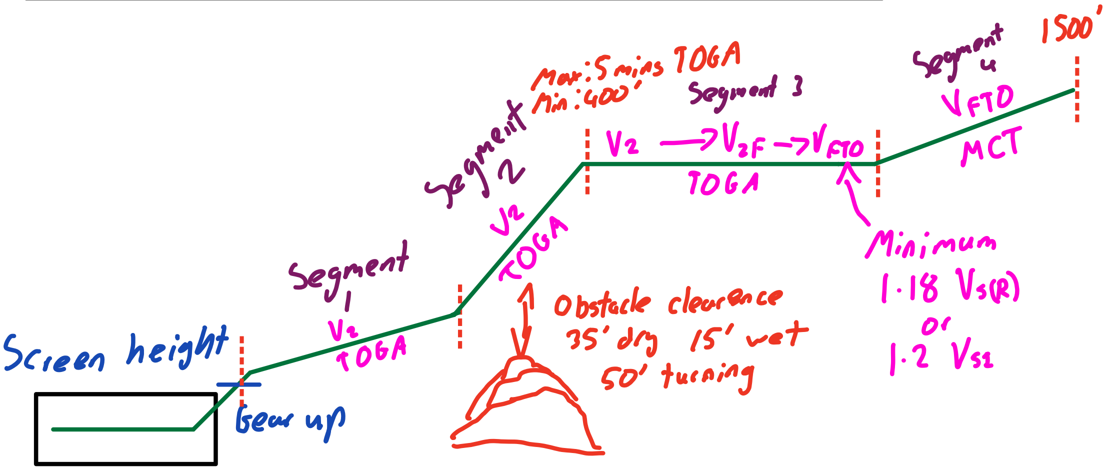
Affected by wind:
- Climb flight path angle
- Climb flight path gradient
- Wind adjusted climb°
- Climb° relative to the ground

## The effect of flaps vs RLTOM / CLTOM




When given numbers, choose the highest of the lowest kgs
Remember wind doesn't affect CLTOM

## The Net take-off flight plan (NTOFP)




## Restrictions on turning (NTOFP)

| Normal | | With special authority | |
|---|---|---|---|
| 0-50' | No turns | 200-400' | 20° |
| 50-400' | 15° | >400 | 30° |
| >400' | 25° | | |

## Minimum gross climb gradients (NTOFP)

| No. of engines | Seg 1 | Seg 2 | Seg 3 | Seg 4 |
|---|---|---|---|---|
| 2 | >0 | ≥2.4 | ≥1.2 | ≥1.2 |
| 3 | ≥0.3 | ≥2.7 | ≥1.5 | ≥1.5 |
| 4 | ≥0.5 | ≥3.0 | ≥1.7 | ≥1.7 |

Even though segment 3 is flown level there are gradients specified to ensure you have sufficient excess thrust

Class B minimum gradient is 4% – AEO

## Climb decrements

| AoB | Additional climb gradient |
|---|---|
| 15° | 1x published decrement |
| 20° | 2x published decrement |
| 25° | 3x published decrement |

## Net to gross in a climb

| No. of engines | Conversion |
|---|---|
| 2 | +0.8% |
| 3 | +0.9% |
| 4 | +1% |

## Noise Abatement departure Procedure (NADP)

NADP1: Reduces noise near the airport

NADP2: Reduces noise for areas further away from the airport

## Obstacle accountability area

To determine if we need to account for obstacles

Half wingspan + 60 (Max of 90)

+

0.125 x distance from end of runway

|  | Straight out | Turning departure |
|---|---|---|
| VMC or accurate nav | 300m | 600m |
| All other conditions | 600m | 900m |

Choose the lower value

## MEP engine failure

- 300 ft

or

- Loss of visual

Whichever is higher

With obstacles to be considered:

Either AEO % factored 0.77

or: AEO horizontal distance x 1.3

## Climbing calculation toolbox

$$SAG = \frac{RoC / RoD}{TAS} \times \frac{6000}{6080}$$

$$WAG \quad \frac{RoC / RoD}{G/S} \times \frac{6000}{6080}$$

$$WAG = SAG \times \frac{TAS}{G/S}$$

$\% = \sin y \times 100$ – Always larger than an angle

$$\% = \frac{T-D}{W} \times 100$$

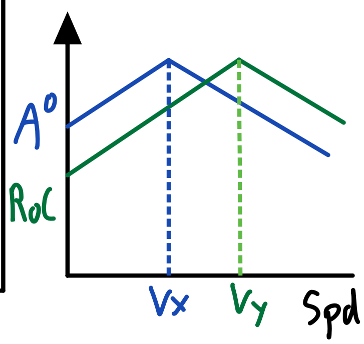
## Vx and Vy

Vx: Speed for best climb°

↳ Based on excess thrust

Vy: Speed for best RoC

↳ Based on excess power




|  | Vx | Vy |
|---|---|---|
| Jet | $V_{md}$ | $1.32\ V_{md}$ |
| Prop | $<V_y$ | $V_{mp} - V_{md}$ |

|  | Vxse | Vyse |
|---|---|---|
| Jet | Slower | Slower |
| Prop | Faster | Slower |

End of the climb

## Start of the cruise

Class A: Enroute phase starts from 1500ft until 1500ft

Class B: Enroute phase starts from 1500ft to 1000ft

Absolute ceiling: 0fpm

Gross ceiling: Class A: 500fpm
Class B: 100 fpm

Net ceiling: Class A: 750fpm
Class B: 150fpm

Aerodynamic ceiling: 1g buffet

Manoeuvre ceiling: 1.3g buffet boundarys

# SFC: Specific fuel consumption

Measure of engine efficiency

Jet: $\frac{\text{Fuel flow}}{\text{Thrust}}$ Prop: $\frac{\text{Fuel flow}}{\text{Power}}$

A lower SFC is better

## Jet SFC:

Temp and SFC are proportional

Lowest SFC at cruise ceiling: 85-95% N1

Altitude has no direct effect

## Endurance: The amount of time you can stay airborne

Endurance $\propto \frac{1}{FF}$

Jet endurance $\propto \frac{1}{SFC \times Drag}$

We want a large number

SFC × Drag:
- Lowest at Vmd
- Lowest at high altitude

Prop endurance $\propto \frac{1}{SFC \times \text{Power req}}$

SFC:
- Lowest at low-medium altitudes

Power req:
- Lowest at Vmp
- Lowest at the lowest possible altitude

Turboprop best endurance is at 15000ft - Vmp

## Effects on Endurance:

| Variable | Effect on Endurance | Effect on endurance speed |
|---|---|---|
| ↑Mass | Decrease | Increase |
| HWC | No effect | No effect |
| TWC | No effect | No effect |

## Range + Endurance

| | Endurance | Range |
|---|---|---|
| Jet | Vmd | 1.32 Vmd |
| Prop | Vmp | Vmd |

## Specific Range (SR): How far we get per unit of fuel (nm/kg)

Specific Air range (SAR) = $\frac{TAS}{FF}$ ~ No wind

Specific ground range (SGR) ~ Wind affected

A high SR is good

## SR Alternative Formulas: Important!!!

Jet: SAR = $\frac{TAS\uparrow}{\downarrow SFC \times Drag}$

We want a high number =
- High Altitude for high TAS
- High Altitude for low SFC

= High altitude is best (Not ceiling)

Prop: SAR = $\frac{1}{\uparrow SFC \times Drag}$

We want this big:
- Low alt for low SFC

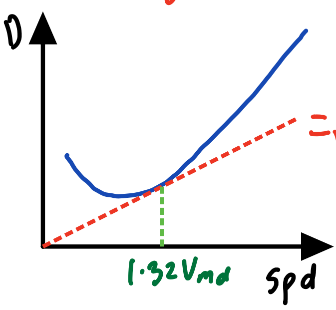
= Low to medium altitude is best

Turbo prop: Optimum alt is ~ 18000ft

## Best speed for SR

Jet range: 1.32 Vmd

Prop range: Vmd




$= \frac{TAS\uparrow}{\downarrow SFC \times Drag\downarrow}$

## Effects on specific Range:

| Variable | Range | Effect on max Range Spd |
|---|---|---|
| ↑Mass | Decrease | Increase |
| HWC (Only effects SGR) | Decrease | Increase |
| TWC (Only effects SGR) | Increase | Decrease |
| 2000ft (Deviation from optimum Alt) | 1% | No effect |
| 4000ft (Deviation from optimum Alt) | 4% | No effect |
| 8000ft (Deviation from optimum Alt) | 10% | No effect |

## Long range cruise (LRC)

- Costs can be saved by reaching destination quickly.
- 1.32 Vmd is too slow.
- LRC is 4% faster for 1% range penalty:
- LRC = 1.37 Vmd
  - Sometimes known as $M_{LRC}$

## Optimum altitude:

The altitude where SR is greatest.

Deviations from optimum altitude

↳ 2000ft = 1 % range penalty

↳ 4000 ft = 4% range penalty

↳ 8000 ft = 10% range penalty

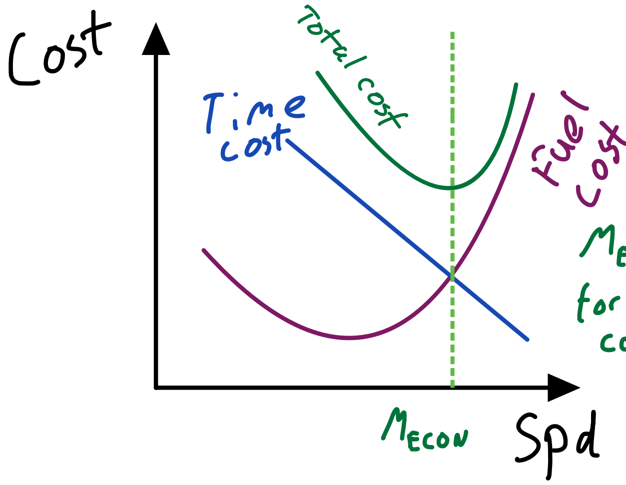
Cruise climb: A constant slow climb to remain at optimum altitude

↳ Not possible due to ATC restrictions

Step Climb: Remain within 2000 ft of optimum altitude. In 4000ft increments

Limited by 1.3g buffet boundarys

## Cost Index




$M_{ECON}$ = Speed for lowest total cost.

Cost Index = $\frac{\text{Cost of Time}}{\text{Cost of fuel}}$

Higher cost index increases all speeds

Aternative to holding - Fly at $V_{md}$

End of the cruise

## Net to gross conversion: (Descent)

| No of Engines | Net to gross conversion |
|---|---|
| 2 | ± 1.1 % |
| 3 | ± 1.4 % |
| 4 | ± 1.6 % |

SEP = ± 0.5 %

## Descent calculation tool box

*These are given in the exam

SAD = $\frac{\text{Height change}}{\text{Net \%}}$ × 100

Ground distance = SAD × $\frac{G/S}{TAS}$

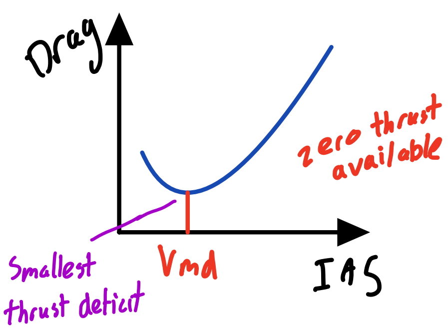
## Start of the descent

Descent variables — Speed controlled using pitch

| Variable | Constant Mach | Constant IAS |
|---|---|---|
| IAS | Increases | Constant |
| $C_L$ + AoA | Decreases | Constant |
| Pitch angle | Decreases | Constant |
| Descent° | Increases | Constant |
| TAS | Increases | Decreases |
| RoD | Increases | Decreases |

## Gliding descent-Range

Mass has no effect on glide range flying at $V_{md}$ in still air




| Variable | Effect on glide range | Effect on glide range speed |
|---|---|---|
| ↑ Mass | No effect | Increases |
| ↓ Mass | No effect | Decreases |
| ↑ Flap | Decreases | Decreases |
| ↓ Flap | Increases | Increases |
| HWC | Decreases | Increases |
| TWC | Increases | Decreases |

## Factors affecting glide endurance

| Variable | Effect on Endurance | Effect on Endurance Speed |
|---|---|---|
| ↑ Mass | Decreases | Increases |
| ↑ Flap | Decreases | Decreases |
| HWC | No effect | Increases |
| TWC | No effect | Decreases |

## Speeds for max range + max endurance

| | Endurance | Range |
|---|---|---|
| Powered descent | Between $V_{MP}$-$V_{MD}$ | $V_{MD}$ |
| Gliding descent | $V_{MP}$ | $V_{MD}$ |

## Gliding in 'real life' ← LoL

- Aviate, navigate + communicate

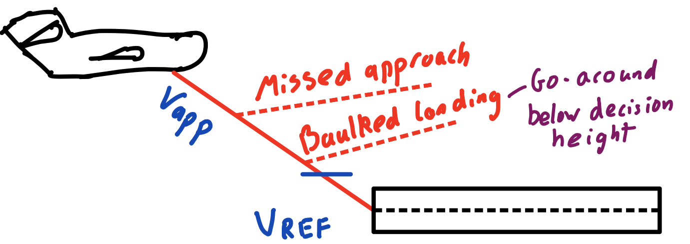
Field Characteristics:
- → Shape : Square
- → Surface : Flat, not ploughed
- → Size : Big!
- → Surroundings : Clear
- → Position abeam the field

## End of the descent

### Start of the landing

Landing calculations begin at screen height and end when a/c is at a full stop

Screen height
Class A : 50' (35' on a approach >4.5°)
Class B : 50'




### Missed Approach % (Class A)

| No of engines | Required missed approach % |
|---|---|
| 2 | 2.1% |
| 3 | 2.4% |
| 4 | 2.7% |

### Baulked landing %

Class A

| No. of engines | Baulked landing % |
|---|---|
| AEO | 3.2% |
| OEI | 2.5% |

$V_{APP}$ : Approach speed: $1.33\ V_S$

$V_{REF}$ : Reference landing speed.

Class A: $1.23\ V_{S(R)0}$

Class B: $1.3\ V_{S0}$

### Missed approach (Class B)

| No. of Engines | Required missed approach % |
|---|---|
| OEI | 0.75% |

### Baulked landing %

Class B

| No. of engines | Required baulked landing % |
|---|---|
| AEO | 2.5% |

### Missed Approach configuration

Flap : Approach
Gear : Up
Thrust : MCT
No. of engines : OEI

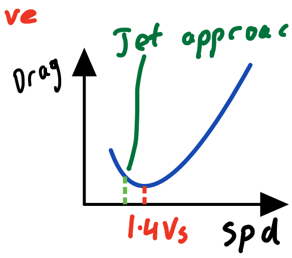
### Baulked Landing configuration

Flaps : Land
Gear : Down
Thrust : TOGA
No. of engines : AEO

### $V_{MD}$ in relation to $V_S$

| | Clean | Dirty |
|---|---|---|
| Jet | $1.6V_S$ | $1.4V_S$ |
| Prop | $1.3V_S$ | $1.2V_S$ |

A jet flies its approach at $1.33V_S - 1.23V_S$ meaning it is at the 'back' of the drag curve




### Landing factors used:

#### Performance

Wet r/w : 1.15
Grass (up to 20cm) : 1.15
Per 1% downslope : 5% increase

#### Regulation

Jets: $LDR = LD \times 1.67$
$LD = LDA \times 0.6$

Props: $LDR = LD \times 1.43$
$LD = LDA \times 0.7$