

Aircraft Performance

Edition 1.0

INTRODUCTION

PERFORMANCE CLASSIFICATIONS

- **CS25** – Large Aircraft Requirements
- **CS23** – Small Aircraft Requirements

EU-OPS CLASSIFICATIONS

- Class **A** – MEJ/Turboprops - >5700kg or >9 Pax
- Class **B** – Turboprops/Pistons - ≤5700kg MCTOM and ≤9 Pax (**CAP MEP 1.2**)
- Class **C** – Pistons - >5700kg or >9 Pax

DEFINITIONS

- **Measured Performance** – Average flown by **test pilots**
- **Gross Performance** – Average of a fleet flown by **line pilots**
- **Net Performance** – Gross performance **degraded** by a **safety factor**
- **MCTOM** – Maximum Certified Take-Off Mass
- **AEO** – All Engines Operative
- **OEI** – One Engine Inoperative

PHASES OF FLIGHT

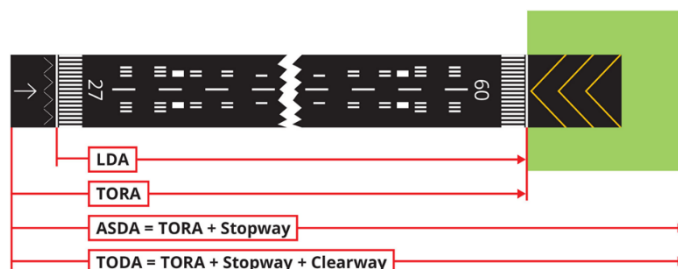
- **Take-Off** – **Brake Release Point** to **Screen Height**
- **T/O Climb** – **Screen Height** to **1500ft AGL**
- **En-Route** – **1500ft AGL** to **1000ft AGL**
- **Approach** – **1000ft AGL** to **Screen Height**
- **Landing** – **Screen Height** to **Full Stop**

SCREEN HEIGHT

- **50ft** for **Class B** or **A** (<15° AoB at **take-off** or **normal landings**)
- **35ft** for **Class A** (**dry take-off** or **steep approach**)
- **15ft** for **Class A** (**wet take-off**)

AERODROMES

DECLARED DISTANCES



- **TORA** – Take-Off Run Available
 - Length suitable for take-off ground run
- **ASDA** – Accelerate Stop Distance Available
 - **TORA + Stopway**
 - **Cannot** permanently withstand aircraft
- **TODA** – Take-Off Distance Available
 - **TORA + Clearway**
- **LDA** – Landing Distance Available
 - Length suitable for landing ground run

STOPWAY

- Area beyond the runway on the **centre-line**
- **At least** as wide as the runway
- Supports an aircraft in an **RTO**
- May be **longer** than the **clearway**

CLEARWAY

- Area beyond the runway that aircraft may fly at **below** the screen height
- **Minimum 75m** either side of the centre-line
- Slope **not exceeding 1.25%**
- **Maximum** of **50% TORA**

BALANCED FIELD

- **TODA = ASDA**
- Occurs when the **stopway** and **clearway** are of **equal length**
- Artificially created by **ignoring** any clearway beyond the stopway

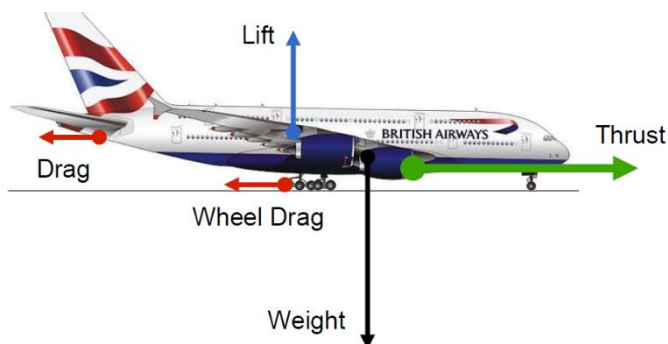
FRANGIBLE OBSTACLES

- Items in the clearway must be **frangible**
- This means they will **break** on impact
- Presents **minimal hazard** to aircraft

BASICS

- **Take-Off Distance Required (TODR)** can be split into **ground roll** and **airborne distance** (to reach screen height)
- TODR is **directly affected** by the aircraft **mass**
- $TODR = v^2 / 2a$

FORCES IN THE TAKE-OFF RUN



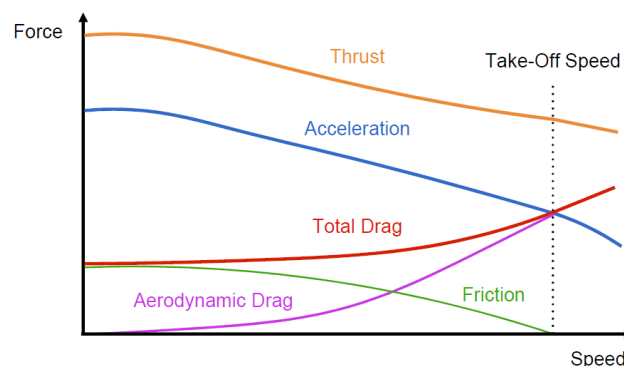
KEY SPEEDS

- V_{MBE} - Maximum Brake Energy Speed
- V_1 - Decision Speed
- V_R - Rotation Speed
- V_{LOF} - Main Gear Leaves the Ground
- V_F - Final Velocity at Screen Height

FACTORS AFFECTING THRUST

- **Speed** $\uparrow$ = **Thrust** $\downarrow$
 - Jet engines using **RAM effect** have an initial thrust **decrease** then **increase**
- **Altitude** $\uparrow$ = **Thrust** $\downarrow$
 - Supercharged piston engines have **constant** thrust whilst **MAP** is **constant**
- **Temperature** $\uparrow$ = **Thrust** $\downarrow$
 - **Flat rated** jet engines give **constant** thrust up to a certain temperature

DRAG AT TAKE-OFF



- **Friction** **reduces** as lift **increases**
- **Runway contamination** **increases** **impingement** and **displacement** drag

FLTOM vs CLTOM

- **FLTOM** - Field Limited Take-Off Mass - **Restricted** by **TODA**
- **CLTOM** - Climb Limited Take-Off Mass - **Restricted** by the **climb performance**
- The **lowest** of **FLTOM** and **CLTOM** gives us **PLTOM** (Performance Limited Take-Off Mass)

FACTORS AFFECTING FLLTOM

FLLTOM is **reduced** when...

- Pressure altitude **increases**
 - Engine Bleeds **on**
 - Runway **upslope**
 - Temperature **increases**
 - Runway surface **contamination**
 - Tailwind **increases**
 - Flaps allow an **increase** in FLLTOM
- These factors **increase** TODR (the limiting factor)*

FACTORS AFFECTING CLTOM

CLTOM is **reduced** when...

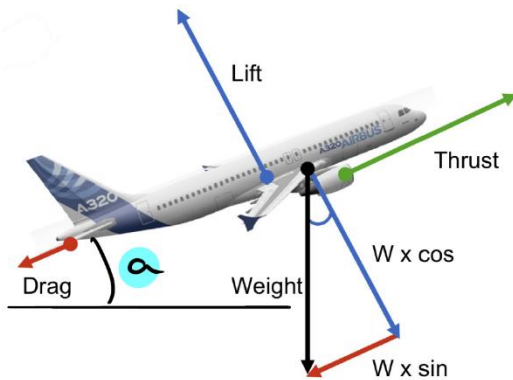
- Temperature is **increased**
 - Pressure altitude **increases**
 - Engine Bleeds are **on**
 - **Any** flap deflection **reduces** CLTOM
 - **Prevailing winds** **do not affect** CLTOM
- These factors **reduce** ROC & CG (limiting factors)*

EFFECTS OF FLAPS

- Flap extension **reduces** the **stalling speed** and therefore **reduces** TORR
- **Any** deflection **increases** drag and therefore **reduces** climb performance
- Used for **distant** obstacles

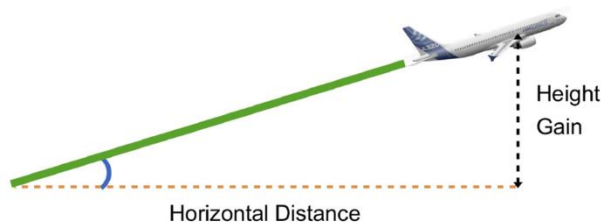
CLIMB

FORCES IN THE CLIMB



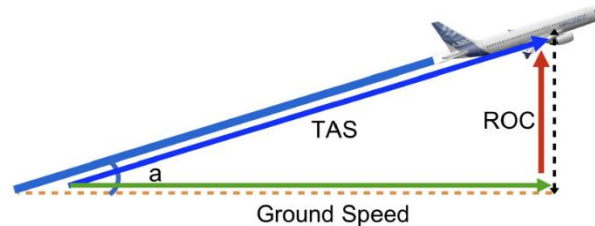
- $a = \text{Climb (Air) or Flight Path (Ground) Angle}$
- $\text{Load Factor} = \frac{\text{Lift}}{\text{Weight}} = \cos(a)$
- $\sin(a) = \frac{\text{Thrust} - \text{Drag}}{\text{Weight}}$
- Load Factor is < 1 as lift is **less** than weight
- This is because **thrust** offsets the difference

CLIMB GRADIENT



- $\text{CG \%} = \frac{\text{Height Gain}}{\text{Distance}} \times 100$
OR
- $\text{CG \%} = \frac{\text{Thrust} - \text{Drag}}{\text{Weight}} \times 100$
- **Maximum Climb Gradient** = V_X
 - Jets = V_{MD}
 - Props $\approx V_{MP}$
- **Highest** when the aircraft is **clean**

RATE OF CLIMB



- $\text{ROC} = \text{TAS} \times \frac{\text{Thrust} - \text{Drag}}{\text{Weight}}$
OR
- $\text{ROC} = \text{TAS} \times \text{CG}$
- **Maximum Rate of Climb** = V_Y
- Dependent on **Excess Power**
 - $P_A - P_R / W$

 V_X AND V_Y

- V_X is **constant** & V_Y **decreases** with **altitude**
- Usually an **IAS**, but **both increase** as a **TAS**
- **Both increase** with **increased mass**
- **Both decrease** with **increased drag**
- V_Y is **always** $\geq V_X$

FACTORS FOR CLIMB PERFORMANCE

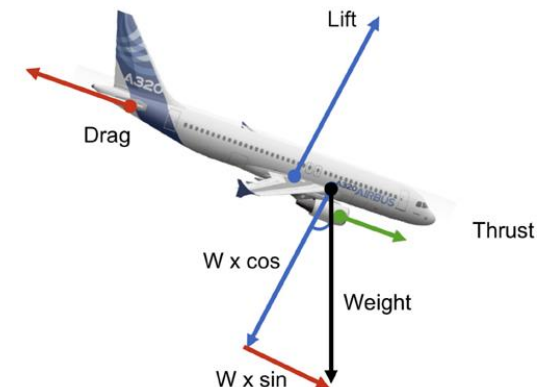
	Weight (increase)	Wind		Configuration	Speed (above or below optimum)	Density (decrease)	Windmilling Prop.	
		Head	Tail				Fine	Coarse
Climb Gradient	V_X ↓ ↑	↑	↓	V_X ↓ ↑	↓	↓	↓	↑
Rate of Climb	V_Y ↓ ↑	=	=	V_Y ↓ ↑	↓	↓	↓	↑

CEILINGS

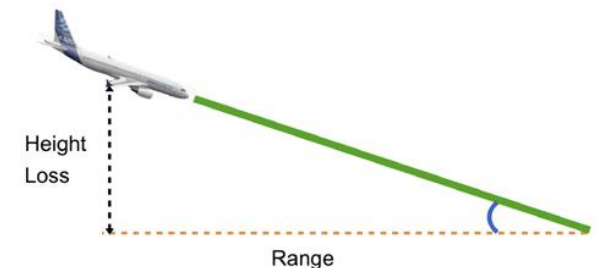
- **Absolute Ceiling** – 0fpm ROC
- **Service Ceiling** – 100fpm ROC
- **Performance Ceiling** – 300fpm ROC AEO
- **Optimum Altitude** – **Highest SR**
 - **Increases** as weight **decreases** (Jets)

DESCENT

FORCES IN THE DESCENT



DESCENT GRADIENT



- $\text{DG \%} = \frac{\text{Height Loss}}{\text{Range}} \times 100$
OR
- $\text{DG \%} = \frac{\text{Drag} - \text{Thrust}}{\text{Weight}} \times 100$

SPECIFIC RANGE

- The **distance travelled** with the **available fuel**
- Can be used as a measure of **efficiency**
- $SR = \text{nm/kg} = \text{TAS} / \text{Fuel Flow} = \text{TAS} / \text{SFC} \times P_R$

ENDURANCE

- The **length of time** an aircraft can fly for
- Found when fuel consumption is **least**

BEST SPEEDS

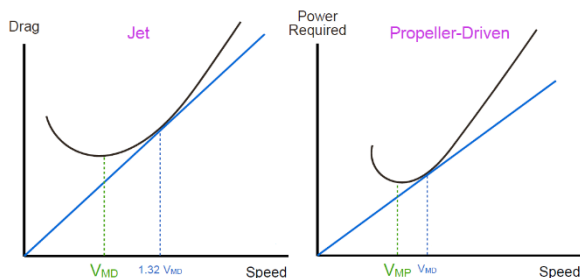
- Best **Endurance** is the **bottom** of the curve, Best **SR** is the **tangent** through the origin
- Best Endurance Speed < Best SR Speed

JETS:

- Best **Endurance** = V_{MD}
- Best **SR** = $1.32 V_{MD}$
 - This is because a much **greater** TAS can be achieved for a **minimal** drag increase
 - Related to the **TAS/Drag Ratio**

PROPS:

- Best **Endurance** = V_{MP}
- Best **SR** = V_{MD}
 - Related to the **TAS/Power Required Ratio**



CRUISE SPEEDS

- Climbing through **low** altitudes, **IAS** is **constant** as V_{MO} is **limiting**
- Through **higher** altitudes, **Mach No.** is **constant** as M_{MO} is **limiting**
- Remember Eat Chicken Tikka Masala
- Long Range Cruise** = **4% Faster** than **Max Range**
 - Closer to Max SR than normal to get as far as possible

ORDER OF SPEEDS

$$V_S < V_{MP} < V_{X(P)} < V_{Y(P)} < V_{MD}/V_{X(J)} < V_{Y(J)} < 1.32 V_{MD}$$

FACTORS AFFECTING RANGE/ENDURANCE

- Temperature** $\uparrow$ = Range/Endurance $\downarrow$
- Weight** $\uparrow$ = Range/Endurance $\downarrow$
 - Because $SFC \propto \text{Mass}$

WINDS

- Tailwind** **increases** range but has **no effect** on **endurance**
- For **maximum ground range**, fly **slower** in a **tailwind** and **faster** in a **headwind**

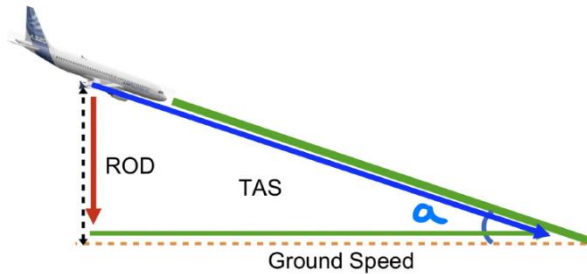
MOVING CG FORWARD (-)

- Increased** Fuel Consumption
- Decreased** Range and Endurance
- Increased** Longitudinal Stability
- Increased** Stall Speed
- Decreased** Absolute Ceiling
- Decreased** Rate of Climb
- Same effects as a **heavier** aircraft

MOVING CG AFT (+)

- Decreased** Longitudinal Stability
- Light** Pitch **Stick Forces** (could overstress)
- Increased** Range and Endurance
- Decreased** Stall Speed
- Same effects as a **lighter** aircraft

RATE OF DESCENT



- $ROD = TAS \times \frac{\text{Drag} - \text{Thrust}}{\text{Weight}}$
- OR
- $ROD = TAS \times \sin(a)$

GLIDE

- **Glide Angle** is **only** affected by **AoA** and **configuration** (minimum at V_{MP})
- **Heavier** aircraft have **higher** IAS and **ROD** but will glide the **same distance**
- A **lighter** aircraft will glide for the **longest time** (endurance)

LANDING

BASICS

- **Landing Distance Required** (LDR) can be split into the **flare** and the **ground run**
- Measured from **Screen Height** to **Full Stop**
- $LDR = \frac{-V_{REF}^2}{2a}$

KEY SPEEDS

- V_{REF} – Speed at **50ft** (Screen Height)
 - **Greater** of V_{MCL} , **1.3** V_{S0} (Class **B**) or **1.23** V_{SR0} (Class **A**)
- V_{MCL} – Minimum Control Speed for Landing
- V_{S0} – Stall Speed (Landing Config)
- V_{SR0} – Stall Ref. Speed (Landing Config)
 - $\approx$ **6% faster** than V_{S0}

FACTORS AFFECTING GROUND ROLL

- Aerodynamic Drag
- Brake Drag (increased with *Anti-Skid*)
- Reverse Thrust

FACTORS AFFECTING LANDING DISTANCE

LDR **increases** when...

- **Mass increases** (V_{REF} **increases**)
- **Air density decreases** (TAS **increases**)
- **Tailwind increases**
- **Runway downslope**
- **Less flaps** are used

FACTORS AFFECTING GO-AROUND PERF.

- *Same factors that affect **CLTOM** (Chapter 3)*

WET RUNWAYS

- Technique is a **positive touchdown**, **full reverse** and **brakes ASAP**

BASICS

- CAP gives us **gross** performance data
- Applying **aerodrome specific** factors gives **gross specific** performance
- Applying **regulatory** factors to this gives **net** performance

TAKE-OFF SPEED REQUIREMENTS

- V_R – Rotation Speed
 - Must be **higher** than V_{S1}
- Speed at **50ft** (V_{REF}) must be:
 - A safe speed under reasonable conditions
 - $\geq 1.2 V_{S1}$

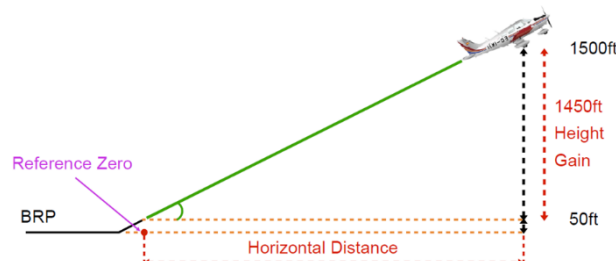
TAKE-OFF REGULATORY FACTORS

- **No** Stopway/Clearway:
 - $TORR = TODR_{(GROSS)} \times 1.25$
- **With** Stopway/Clearway
 - $TORR = TODR_{(GROSS)} \times 1$
 - $ASDR = TODR_{(GROSS)} \times 1.3$
 - $TODR = TODR_{(GROSS)} \times 1.15$
- **FLLTOM** calculated using the **shortest** of these distances
- **Surface/Slope Factors:**
 - Dry Grass – x1.2
 - Wet Grass – x1.3
 - 1% **upslope** – x1.05
- **All these factors in CAP SEP 2.1.1**

	TORA	ASDA	TODA
Given Distances	4250 ft	4470 ft	4600 ft
Slope Factor	1.1	1.1	1.1
Surface/Condition Factor	1.2	1.2	1.2
Regulation Factor	1.0	1.3	1.15
De-factored Distance	3220 ft	2605 ft	3030 ft

TAKE-OFF CLIMB

- **Minimum** 4% climb gradient at take-off power and flaps in the take-off position



OBSTACLE CLEARANCE

- **Minimum** 50ft clearance
- Use **factored** winds (50% headwind, 150% tailwind)

LANDING CLIMB

- **Minimum** 3.3% climb gradient with flaps in landing position at V_{REF}

LANDING SPEED REQUIREMENTS

- $V_{REF} \leq 1.3 V_{S0}$

LANDING REGULATORY FACTORS

- $LDR = LDR_{(GROSS)} \times 1.43$
- **Surface/Slope Factors:**
 - Grass – x1.15
 - Wet – x1.15
 - 1% **downslope** – x1.05
- **All these factors in CAP SEP 2.1.1**

EQUATIONS

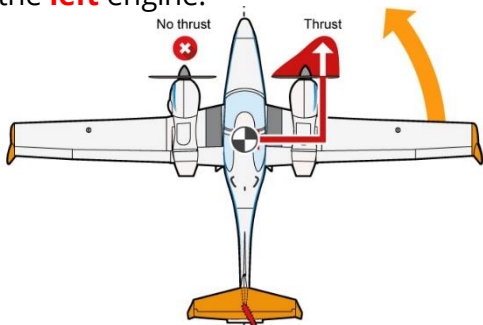
- **Distance** = $GS \times \text{Height Gain} / ROC \times 100$
- **ROC** = $TAS \times CG$
- **For additional equations, see CAP MEP 3.2**

GRAPH QUESTION TIPS

- **Take-off speeds** can be found from the table in **Figure 2.1**
- Climb graph gives **air distance** – use the formula - $NAM / TAS = NGM / GS$
- At **reference zero**, the aircraft is **already** at **50ft** so remember to **subtract/add** 50ft
- Use **formula** instead of the wind graphs - **Wind Speed x cos(difference in angles)**
- Remember to calculate **pressure altitude** if **QNH $\neq$ 1013**
- Do not confuse **TAS** and **IAS**
- If the question asks for a **distance required**, it expects the **net** value

CRITICAL ENGINE

- **Worst** engine to fail (**highest** yaw moment)
- **Into wind** engine for **counteracting** props
- For **clockwise** propellers, the critical engine is the **left** engine:



- A failure **increases** V_X and **decreases** V_Y
- **Increases** power required and total drag

KEY SPEEDS

- V_{MC} – Minimum Control Speed
 - Enough to maintain control with 5° AoB
 - $\leq 1.2 V_{S1}$
- V_{EF} – Speed at which the critical engine is assumed to fail

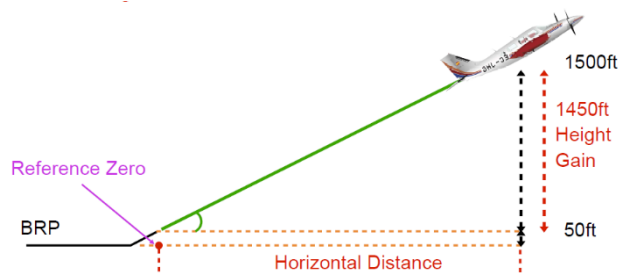
TAKE-OFF SPEED REQUIREMENTS

- V_R – Rotation Speed
 - $\geq 1.05 V_{MC}$
 - $\geq 1.1 V_{S1}$
- Speed at **50ft** (V_{REF}) must be:
 - A safe speed under reasonable conditions
 - $\geq 1.1 V_{MC}$
 - $\geq 1.2 V_{S1}$

TAKE-OFF REGULATORY FACTORS

- *The same as SEP*
- *All these factors in CAP MEP 2.1.1*

TAKE-OFF CLIMB



- **AEO** Climb Gradient Requirements
 - 4% at Screen Height
- **OEI** Climb Gradient Requirements
 - Measurably **Positive** at 400ft
 - 0.75% at 1500ft
- *All requirements in CAP MEP 3.1.2*

OBSTACLE CLEARANCE

- **Minimum** 50ft clearance
- Use **factored** winds (50% headwind, 150% tailwind)
- **AEO** Climb Gradient is **factored** by **0.77**
- Above a **cloud base**, use **OEI CG**
- *For accountability area, see CAP MEP 3.1.1*

DESCENT

- **Net** Gradient = **Gross** Gradient +0.5%

LANDING SPEED REQUIREMENTS

- $V_{REF} \leq 1.3 V_{S0}$

LANDING CLIMB TYPES

- **Approach Climb** – Go-around initiated during the **approach**
 - **Minimum** 2.5% CG
- **Landing Climb** – Go-around initiated just before **touchdown** (“**Balked Landing**”)
 - **Minimum** 0.75% CG
- *All requirements in CAP MEP 5.1.2/5.1.3*

LANDING REGULATORY FACTORS

- *The same as SEP*
- *All factors in CAP MEP 5.1.1*

EQUATIONS

- *The same as SEP*

GRAPH QUESTION TIPS

- *The same as SEP, plus...*
- **ASDA** graph gives **net** performance and assumes **no** stopway or clearway

SPEED DEFINITIONS

- V_{MCG} – Minimum Control Speed (Ground)
 - Determined **without** nose-wheel steering to simulate **wet conditions**
 - Does **not** account for **crosswind**
 - **Engine thrust** and **rudder deflection** the most important parameters
- V_{MCA} – Minimum Control Speed (Air)
 - Must maintain **straight flight**
- V_{SR} – Reference Stall Speed

TAKE-OFF SPEEDS

- V_1 – Decision Speed
 - $\geq V_{MCG}$ (this can be forced by increasing V_1)
 - $\leq V_{MBE}$
 - $\leq V_R$
 - See **CAP MRJT 1.3**
- V_R – Rotation Speed
 - $\geq V_1$
 - $\geq 1.05 V_{MCA}$
 - Allows V_2 at Screen Height
 - Ensures $V_{LOF} \geq 1.1 V_{MU}$ (**AEO**) or $\geq 1.05 V_{MU}$ (**OEI**) - **1.08** and **1.04** if **geometry limited**
- $V_{2(MIN)}$ – Minimum Safety Speed
 - $\geq 1.1 V_{MCA}$
 - $\geq 1.13 V_{SR}$ for **2/3 engine turboprops and turbojets without OEI provisions**
 - $\geq 1.08 V_{SR}$ for **4+ engine turboprops and turbojets with provisions**
- V_2 – Safety Speed
 - $\geq V_{2(MIN)}$
 - $\geq V_R + \text{Speed Attained to Screen Height}$

LIMITING FACTORS FOR V_1

- V_{MCA} is limiting at **high air densities**, **large flap angles** and **low weights**
- V_{MU} is limiting in the **opposite** conditions

FACTORS AFFECTING V SPEEDS

V_1 is **increased** when...

- Pressure altitude **increases**
- Air temperature **increases**
- TOM **increases**
- Flap deflection **decreases**
- Headwind **increases**
- Runway **upslope**

V_R is the same but not affected by wind or slope

V_2 is **decreased** when...

- Pressure altitude **increases**
- Air temperature **increases**
- TOM **decreases**
- Flap deflection **increases**

V_{MCG}/V_{MCA} the same but not affected by mass or flaps

TAKE-OFF DISTANCES

- **Regulatory** take-off distances the **highest** of:
 - **AEO distance x1.15**
 - **OEI distance**

REJECTED TAKE-OFF

- Initiated **at** or **before** V_1
- **Above** V_1 , you **must** take-off
- **2 second delay** between V_{EF} and V_1 for **recognition**
- **First action** is to **reduce thrust**
- Dependent on **ASDA**

UNBALANCED FIELDS

- **Clearway** but **No Stopway**:
 - $TOD > ASD$
 - V_1 must be **lower**
- **Stopway** but **No Clearway**:
 - $TOD < ASD$
 - V_1 will be **higher**
- For **balanced fields**, there's a **single** V_1 value
- See **CAP MRJT 2.5.1**

TAKE-OFF CLIMB

SEGMENT 1 – SCREEN HEIGHT TO GEAR UP

- **2 engines** - $\geq 0\%$ CG
- **3 engines** - $\geq 0.3\%$ CG
- **4 engines** - $\geq 0.5\%$ CG
- Gear **down**, flaps in **T/O config** at V_2
- **No bank** permitted **below 50ft/1/2 wingspan**

SEGMENT 2 – GEAR UP TO 400FT

- **2 engines** - $\geq 2.4\%$ CG
- **3 engines** - $\geq 2.7\%$ CG
- **4 engines** - $\geq 3.0\%$ CG
- Gear **up**, flaps in **T/O config** at $V_2 + 10\text{kts}$
- **Maximum** 15° AoB

SEGMENT 3 - >400FT TO FLAPS UP

- **2 engines** - $\geq 1.2\%$ CG
- **3 engines** - $\geq 1.5\%$ CG
- **4 engines** - $\geq 1.7\%$ CG
- Gear **up**, flaps **retracting**, **accelerating**

SEGMENT 4 – UP TO 1500FT+

- **Same** CG requirements as **Segment 3**
- Gear **up**, flaps **up**, **max continuous thrust** at final segment speed

FLAT RATING

- Thrust **increases** as OAT **decreases**
- **Below** a certain OAT, thrust is **limited**

OBSTACLES

- 35ft clearance in the **net** take-off path
- **Factored winds** used for take-off calcs.
- *For accountability area, see CAP MEP 3.1.1*

ADDITIONAL TAKE-OFF PROCEDURES

CONTAMINATED RUNWAYS

- >0.3mm covering >25% of the runway
- **Increases** all required distances, except **compact snow** and **ice only increase ASDR**
- **Decreases** maximum mass, V_1 and V_R
- Standing water, slush, wet/dry snow increase *impingement drag* so V_1 reduction is **smaller** as contamination gets **thicker**
- Drag **increases** then **decreases** in the **ground roll**
- **Reverse thrust inoperative** will **increase ASDR** if the runway is **wet**
- See *CAP Figure 4.14 to help answer Q's*

INCREASED V_2 SPEEDS

- a.k.a **"Improved Climb Procedure"**
- Used to **improve** climb gradient (obstacle clearance)
- Allows a **higher** take-off mass
- **Limited** by FLLTOM and Tyre Speed Limit

REDUCED THRUST TAKE-OFFS

- **Reduces** operating costs and noise and **increases** engine life
- **Assumed Temperature** Take-Off **may be overridden** by applying TOGA power
- **Derated Thrust cannot be**
- *Restrictions listed in CAP MRJT 2.8.1*
- Also not used if **windshear** reported
- ASDR **decreases** but TODR **increases**

REDUCED THRUST TAKE-OFFS

- **Increases** all required distances
- V_1 will therefore **decrease**
- **Obstacle clearance is reduced**
- Reduces the limiting mass by 7700kg
- V_1 reduction is based on the **new mass** but *must be above V_{MCG}*
- *All details in CAP MRJT 2.9*

ENROUTE

LIMITS ON CRUISE SPEED/ALTITUDE

- Thrust Available
- Buffet Onset (**Low** or **High-Speed Stall**)
 - $V_S = V_{DD}$ - **Aerodynamic Ceiling**
 - **0.3G margin** (**40° AoB**) applied for **maneuvering ceiling**

WIND-ALTITUDE TRADE

- **Optimum altitude** may not have **optimum winds**
- Trade is applied when **tailwind exceeds the losses**

MAXIMUM ECONOMY CRUISE

- **Cost Index** = **Cost of Time** / **Cost of Fuel**
- **Low** Cost Index = **Low Speed** / Max Range
- **High** Cost Index = **High Speed** / Shortest Time

ETOPS

- **Non-ETOPS** - 60 mins at **OEI cruise speed** in **still air, ISA conditions**
- **ETOPS approval** can extend this

OEI CRUISE

- Remaining **thrust < drag**
- **Cannot** maintain **speed/altitude/range**
- **Driftdown** - descent to an altitude that can be maintained

DRIFTDOWN REQUIREMENTS

- **1000ft clearance** **at** level off altitude
- **2000ft clearance** **during** the driftdown
- **Positive gradient** at **1500ft AAL**
- If these requirements can't be met, **jettison fuel** ASAP

DRIFTDOWN SPEED

- Greatest **Clearance** - Fly V_{MD}
 - V_X for jets, V_Y for props
- Greatest **Range**
 - $1.32 V_{MD}$ (V_Y) for jets, V_{MD} for props

LANDING

APPROACH SPEEDS

- $V_{REF} > 1.23 V_{SR0}$
- V_{REF} is **regulatory** and does **not** change based on **turbulence**

LANDING CLIMB TYPES

- **Fuel dumping** may be necessary to meet these requirements
- Landing Climb:**
- Based on **AEO**, **landing flap** and **gear down**
 - **Minimum 3.2% CG** at aerodrome conditions
 - Climb Speed $> 1.23 V_{SR}$ and $> V_{MCL}$
- Discontinued Approach Climb:**
- Based on **OEI**, **approach flap** and **gear up**
 - **Minimum 2.1% CG** (2 Engines)
 - **Minimum 2.4% CG** (3 Engines)
 - **Minimum 2.7% CG** (4 Engines)
 - Normal approach speed $< 1.4 V_{SR}$

LANDING DISTANCES

- **Turbojet** - LDR **x1.67** (**60%** of runway)
- **Turboprop** - LDR **x1.43** (**70%** of runway)
- **Wet** - **x1.15**
- May be **less** if the **Flight Manual** says so
- **Graph** questions give **net** performance data (no need to apply factors)
- Used for destinations **and** alternates

RUNWAY SELECTION

- Landing considered **both** in **still air** and **forecast winds**
- **Most restrictive** used to find **FLLM**
- **a.k.a use 0 wind or the tailwind**
- For **multiple runways**, pick the **least** of the **highest** Still Air and Wind effective masses

QUICK TURNAROUND

- Affected by **temperature, slope, wind, pressure altitude, mass, flap position** and **runway length**
- **Within limits** - **No** waiting time
- **Outside limits** - **Wait 53 mins** and check thermal plugs
- See **CAP MRJT 5.2**