Aircraft Performance

Edition 1.0

Introduction & Aerodromes

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

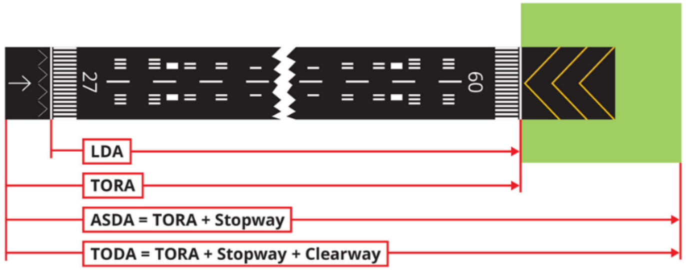
- **Take-Off – Brake Release Point** to **Screen Height**
- **T/O Climb – Screen Height** to **1500ft AGL**
- **En-Route – 1500ft AGL** to **1000ft AGL**
- **Approach – 1000ft AGL** to **Screen Height**
- **Landing – Screen Height** to **Full Stop**

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

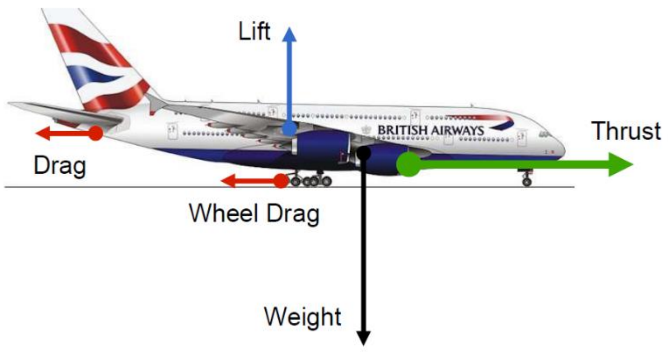
- Items in the clearway must be **frangible**
- This means they will **break** on impact
- Presents **minimal hazard** to aircraft

Take-Off – General Principles

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



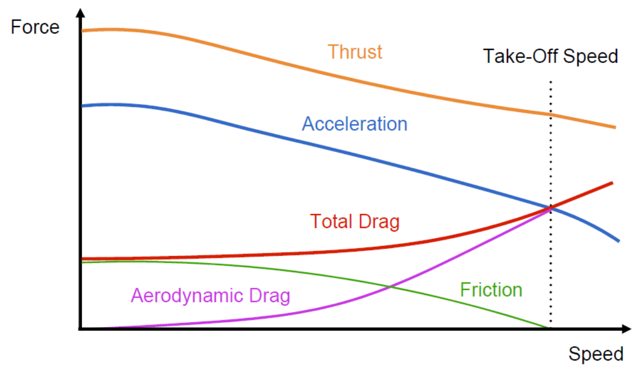
KEY SPEEDS

- **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 ↑ = Thrust ↓**
  - Jet engines using **RAM effect** have an initial thrust **decrease** then **increase**
- **Altitude ↑ = Thrust ↓**
  - Supercharged piston engines have **constant** thrust whilst **MAP** is **constant**
- **Temperature ↑ = Thrust ↓**
  - **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)

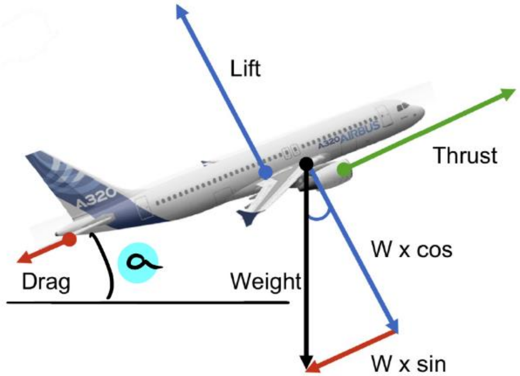
EFFECTS OF FLAPS

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

Climb and Descent – General Principles

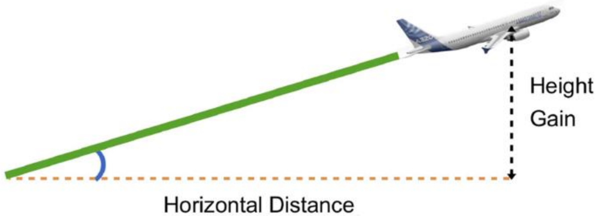
CLIMB

FORCES IN THE CLIMB



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

CLIMB GRADIENT

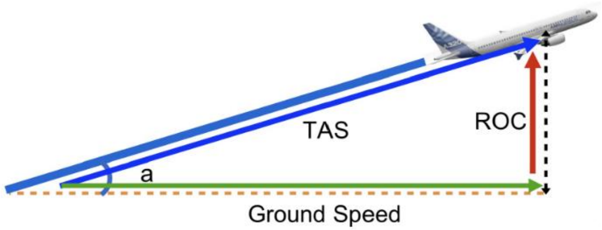


- **CG % =** $\frac{\text{Height Gain}}{\text{Distance}}$ **x 100**

OR

- **CG % =** $\frac{\text{Thrust - Drag}}{\text{Weight}}$ **x 100**
- **Maximum Climb Gradient** = V_X
  - Jets = V_{MD}
  - Props ≈ V_{MP}
- **Highest** when the aircraft is **clean**

RATE OF CLIMB



- **ROC = TAS x** $\frac{\text{Thrust - Drag}}{\text{Weight}}$

OR

- **ROC = TAS x CG**
- **Maximum Rate of Climb** = V_Y
- Dependent on **Excess Power**
  - $\frac{P_A - P_R}{W}$

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** ≥ V_X

FACTORS FOR CLIMB PERFORMANCE

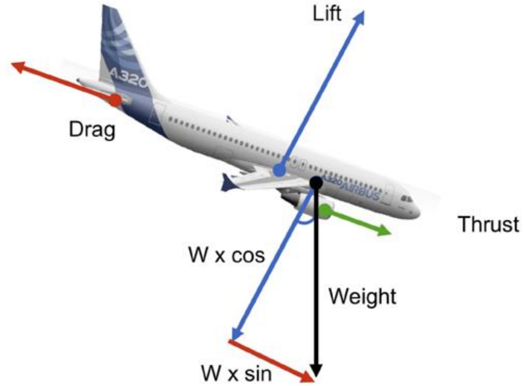
	Weight (increase)	Wind		Configuration	Speed (above or below optimum)	Density (decrease)	Windmilling Prop.	
		Head	Tail				Fine	Coarse
Climb Gradient	↓ V_X ↑	↑	↓	↓ V_X ↓	↓	↓	↓	↑
Rate of Climb	↓ V_Y ↑	=	=	↓ V_Y ↓	↓	↓	↓	↑

CEILINGS

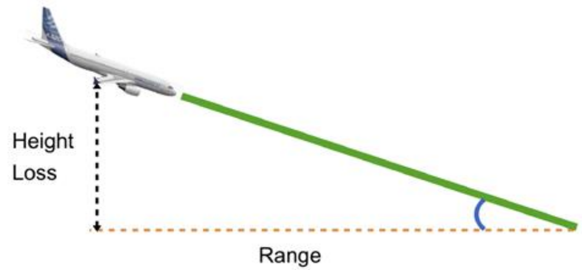
- **Absolute Ceiling – 0fpm** ROC
- **Service Ceiling – 100fpm** ROC
- **Performance Ceiling – 300fpm** ROC AEO
- **Optimum Altitude – Highest SR**
  - **Increases** as **weight decreases** (Jets)

DESCENT

FORCES IN THE DESCENT



DESCENT GRADIENT



- **DG % =** $\frac{\text{Height Loss}}{\text{Range}}$ **x 100**

OR

- **DG % =** $\frac{\text{Drag - Thrust}}{\text{Weight}}$ **x 100**

Straight and Level – General Principles

SPECIFIC RANGE

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

ENDURANCE

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

BEST SPEEDS

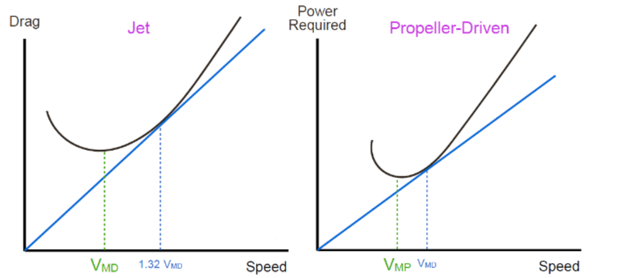
- Best **Endurance** is the **bottom** of the curve, Best **SR** is the **tangent** through the origin
- Best Endurance Speed < Best SR Speed

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 ↑ = Range/Endurance ↓**
- **Weight ↑ = Range/Endurance ↓**
  - Because SFC ∝ 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 (-)

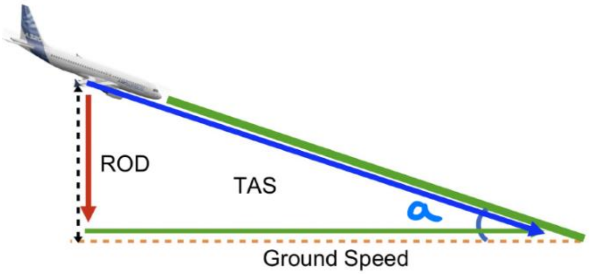
- **Increased Fuel Consumption**
- **Decreased Range** and **Endurance**
- **Increased Longitudinal Stability**
- **Increased Stall Speed**
- **Decreased Absolute Ceiling**
- **Decreased Rate of Climb**
- *Same effects as a* ***heavier*** *aircraft*

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*

Descent and Landing – General Principles

RATE OF DESCENT



- **ROD = TAS x** $\frac{\textbf{Drag - Thrust}}{\textbf{Weight}}$

OR

- **ROD = TAS x 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 =** $-V_{REF}^2/2a$

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)
  - ≈ **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
  - **≥ 1.2 V_{S1}**

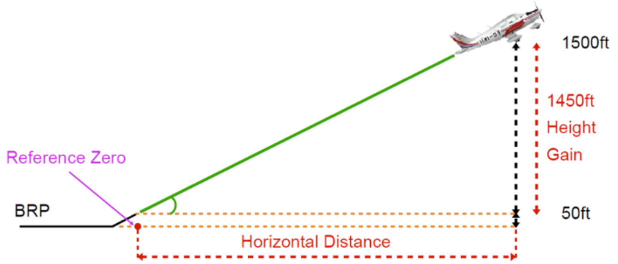
TAKE-OFF REGULATORY FACTORS

- **No Stopway/Clearway**:
  - **TORR** = TODR(GROSS) **x 1.25**
- **With Stopway/Clearway**
  - **TORR** = TODR(GROSS) **x 1**
  - **ASDR** = TODR(GROSS) **x 1.3**
  - **TODR** = TODR(GROSS) **x 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} ≤ 1.3 V_{S0}**

LANDING REGULATORY FACTORS

- **LDR** = LDR(GROSS) **x1.43**
- **Surface/Slope Factors:**
  - **Grass – x1.15**
  - **Wet – x1.15**
  - **1% downslope – x1.05**
- ***All these factors in CAP SEP 2.1.1***

EQUATIONS

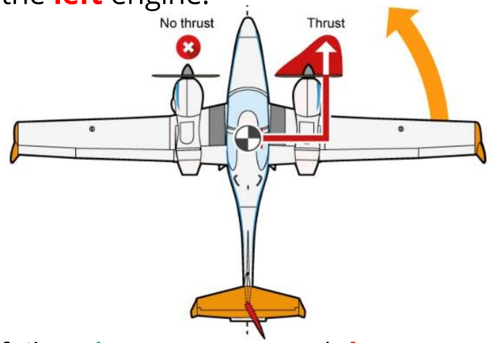
- **Distance = $\frac{\text{GS x Height Gain}}{\text{ROC}}$ x 100**
- **ROC = TAS x CG**
- ***For additional equations, see CAP MEP 3.2***

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 ≠ 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**
  - **≤ 1.2 V_{S1}**
- V_{EF} – Speed at which the critical engine is assumed to fail

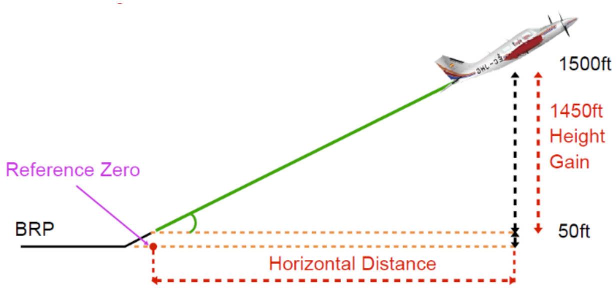
TAKE-OFF SPEED REQUIREMENTS

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

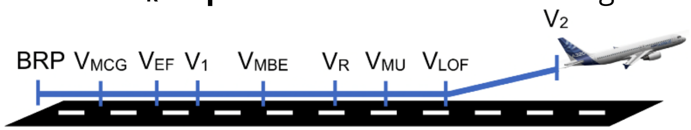
Class A Take-Off

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
  - **≥ V_{MCG}** *(this can be forced by increasing V_1)*
  - **≤ V_{MBE}**
  - **≤ V_R**
  - ***See CAP MRJT 1.3***
- **V_R –** Rotation Speed
  - **≥ V_1**
  - **≥ 1.05 V_{MCA}**
  - Allows **V_2** at Screen Height
  - Ensures **V_{LOF} ≥ 1.1 V_{MU} (AEO)** or **≥ 1.05 V_{MU} (OEI)** - ***1.08** and **1.04** if **geometry limited***
- **$V_{2\,(MIN)}$ –** Minimum Safety Speed
  - **≥ 1.1 V_{MCA}**
  - **≥ 1.13 V_{SR}** for **2/3 engine turboprops** and **turbojets without OEI provisions**
  - **≥ 1.08 V_{SR}** for **4+ engine turboprops** and **turbojets with provisions**
- **V_2 –** Safety Speed
  - **≥ $V_{2\,(MIN)}$**
  - **≥ V_R** + **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 - ≥0% CG**
- **3 engines – ≥0.3% CG**
- **4 engines - ≥0.5% CG**
- Gear **down**, flaps in **T/O config** at **V_2**
- **No bank** permitted **below 50ft/½ wingspan**

SEGMENT 2 – GEAR UP TO 400FT

- **2 engines - ≥2.4% CG**
- **3 engines – ≥2.7% CG**
- **4 engines - ≥3.0% CG**
- Gear **up**, flaps in **T/O config** at **V_2 + 10kts**
- **Maximum 15° AoB**

SEGMENT 3 - >400FT TO FLAPS UP

- **2 engines - ≥1.2% CG**
- **3 engines – ≥1.5% CG**
- **4 engines - ≥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**

Class A Take-Off & Additional Take-Off Procedures

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***

Class A Enroute & Landing

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 **FLLLM**
- ***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***