Performance legislation

27 de março de 2023 10:53

	Multi-engine Jet	Propeller driven	
		Multi-engine Turboprop	Piston
Mass: > 5700 kg or Passenger Seats: > 9	A	A	C
Mass: ≤ 5700 kg and Passengers Seats: ≤9	A	B	B

(93) ‘performance class A aeroplanes’ means multi-engined aeroplanes powered by turbo-propeller engines with an MOPSC of more than nine or a maximum take-off mass exceeding 5 700 kg, and **all multi-engined turbo-jet powered aeroplanes**;

(94) ‘performance class B aeroplanes’ means aeroplanes powered by propeller engines with an MOPSC of nine or less and a maximum take-off mass of 5 700 kg or less;

(95) ‘performance class C aeroplanes’ means aeroplanes powered by reciprocating engines with an MOPSC of more than nine or a maximum take-off mass exceeding 5 700 kg;

Engine Ratings:
Certified = compulsory
Not certified = recommended
Classes

- class A aircraft all jets and turboprops with more than 9 pax. seats or MTOM >5700kg (B-737). JAR 25
- class B aircraft small prop. driven aircraft, piston or turbo with < 9 pax. seats and MTOM <5700kg. JAR 23
- class C aircraft large piston aircraft > 9 pax. seats or MTOM > 5700kg (not many still flying commercially).

According to the AMC CS 25.125(c) - Landing:

1. *During measured landings, if the brakes can be consistently applied **in a manner permitting the nose gear to touch down safely, the brakes may be applied with only the main wheels firmly on the ground**. Otherwise, the brakes should not be applied until all wheels are firmly on the ground.*
2. *This is not intended to prevent operation in the normal way of automatic braking systems which, for instance, permit brakes to be selected on before touchdown.*

The majority of the autobrake systems are activated just after the main landing gear touches down. The Airbus' AFM instructions, regarding the manual braking, says: *"apply just after touchdown"* with not any reference to the nosewheel.

The difference between the net and gross flight paths/performance is as follows:

- The gross performance is the average performance that a fleet of aircraft should achieve if maintained satisfactorily and flown in accordance with the techniques established during flight certification and subsequently described in the aircraft performance manual. Gross performance therefore defines a level of performance that any aircraft of the same type has a 50 percent chance of exceeding at any time.
- **The net performance is the gross performance diminished to allow for various contingencies that cannot be accounted for operationally**, e.g., variations in piloting technique, temporarily below-average performance, etc. It is improbable that the net performancel flight path will not be achieved in operation, provided the aircraft is flown in accordance with the recommended techniques, i.e., power, attitude, and speed.

EASA AIR OPS
CAT.POL.A.310 Take-off obstacle clearance – multi-engined aeroplanes

3) failure of the critical engine occurs at the point on the all engine take-off flight path where visual reference for the purpose of avoiding obstacles is expected to be lost;
(4) the gradient of the take-off flight path from 50 ft to the assumed engine failure height is equal to the average all-engines gradient during climb and transition to the en-route configuration, multiplied by a factor of 0,77; and
(5) the gradient of the take-off flight path from the height reached in accordance with (a)(4) to the end of the take-off flight path is equal to the OEI en-route climb gradient shown in the AFM.

The all-engine gradient is used up to the cloudbase and the OEI gradient is used thereafter.

- For the all-engine gradient, there is a large safety margin between gross and net gradient: Net = Gross x 0.77 => 13% x 0.77 = **10.01 %**
- No safety margin is applied to the OEI gradient: Net = Gross => **5.2 %**

For a Class A aircraft, following an engine failure during take-off, what is the net take-off flight path?

- It is the actual flight path reduced by a safety margin.

Which statement regarding gross performance is true?

- Actual flight performance with NO safety factor.

The **net climb gradient** is the **gross climb gradient minus a safety margin**.

CS-23 and CS-25 use the term “net take off flight path” to describe certain performance elements. The **net take off flight path (Gradient)** is the …

- Actual flight path of the aeroplane reduced by a safety margin.

compacted snow:

- **Snow compressed into a solid mass such that aeroplane tyres will run on it without further compaction of the surface.**

wet ice:

- **Ice with a layer of water (any depth) on top of it or ice that is melting.**

General performance theory

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TOD:
Upsolpe -> 5% per degree -> 1 degree -> 1.05

V_X – BEST ANGLE OF CLIMB

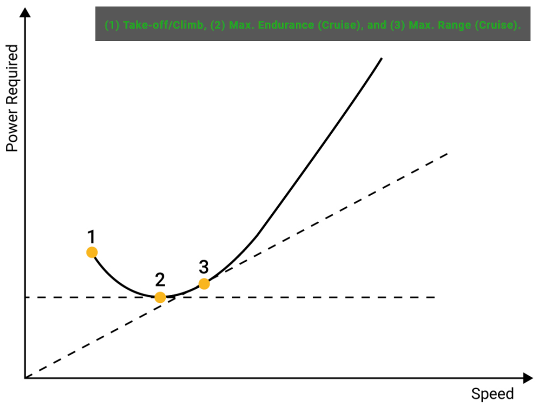
Dependant on Excess Thrust Available -> Vmd IN JET

greatest Excess POWER = best RATE of climb
greatest Excess THRUST = best ANGLE of climb

Runway Factor Class B
Landing:
- x1.15 (grass)
- x1.15(wet paved)

Take Off:
- x1.2 (dry grass)
- x1.3 (wet grass)
- x1.0 (wet paved)

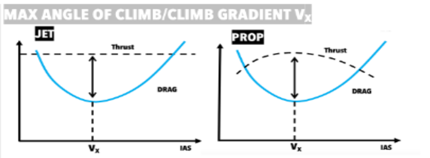
Piston/Propeller/Class B



(1) Take-off/Climb
(2) Max. Endurance (Cruise) V_{MP}, V_X, Max endurance
(3) Max. Range (Cruise) V_{MD}, V_Y, Max range

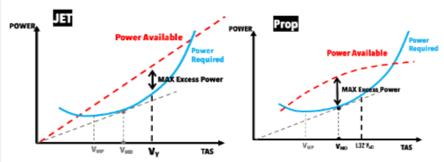
SUMMARY:
Glide Distance (Varies with wind)
=> Tailwind increases glide distance
=> Headwind decreases glide distance
Glide Duration (Varies with mass)
=> Low mass increases glide duration
=> High mass decreases glide duration

MAX ANGLE OF CLIMB/CLIMB GRADIENT V_X



Best Angle of climb speed (V_X) is found at the maximum excess of Thrust – in other words, where the gap between the "Thrust" available and Thrust Required "Drag" curves is the greatest.
- **For Jet** – V_X is the same IAS as V_{MD}
- **For PROP** - V_X is slower than V_{MD}

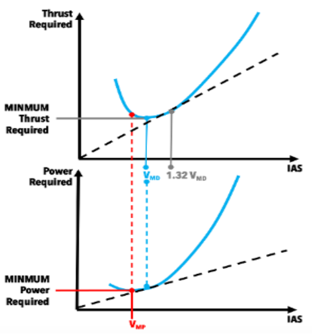
EXCESS OF POWER CURVES



Excess of Power Curve
- **Lowest Point of curve** – Speed for Minimum Power V_{MP}
- **Tangent from origin to Power Required Curve** - Speed for Minimum Drag V_{MD}
- **Point of Maximum Excess of Power** – Best Rate of Climb Speed V_Y

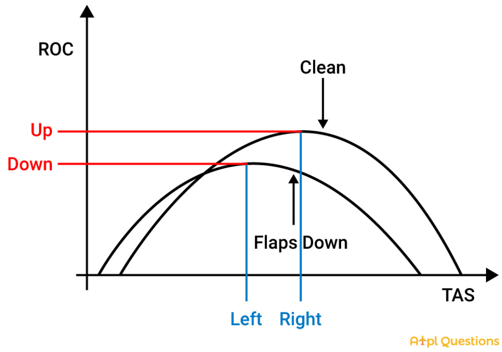
⇒ **For JET:** This speed occurs at faster speeds than V_{MD} (approx. at 1.32 V_{MD} - corresponds to the Best Range Speed.
⇒ **For PROP:** This speed occurs at a faster speed than V_{MP} (Close to V_{MD})

POWER REQUIRED = DRAG x TAS
When comparing the shape of the Power Required Curve and Thrust Required, we notice that these are very similar. The difference being that the Power Required curve is displaced to the left – Which results in the Minimum Power Required Speed V_{MP} being slower than the Minimum Thrust Required V_{MD}.



DRAG/THRUST REQUIRED CURVE
- **Lowest Point of curve** – V_{MD}, Best L/D Ratio and best glide.
  ⇒ **For JET:** V_X = Maximum Endurance Speed
  ⇒ **For PROP:** Maximum Range Speed.
- **Tangent** – 1.32 V_{MD}
  ⇒ **For JET:** Best Range Speed, V_Y

POWER REQUIRED CURVE
- **Lowest Point of curve** – V_{MP}
  ⇒ **For PROP:** Best Endurance Speed.
- **Tangent** – V_{MD}, Best L/D Ratio
  ⇒ **For PROP:** Maximum Range
  ⇒ **For JET:** V_X = Maximum Endurance

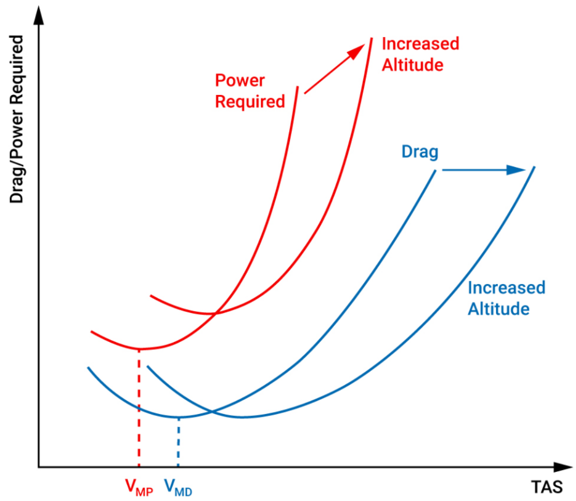


Specific Range is the **nautical air miles flown per unit mass of fuel.**

Specific Range = TAS / Fuel Flow

Increase in Mass the curve moves Up and Right
Decrease in Mass the curves moves Down and Left

Increasing ALT power (required) increases
And TAS increases



Effect of flaps on climb
With a higher flap angle setting, the profile of the wing is changed and the wing's capability to provide lift at low speed increases. The actual generated lift though remains the same, considering the lower speed. For the same amount of Lift, induced drags don't change. With the change of wing shape the parasite drag increases, consequently Total Drag curve moves left and upwards. This reduces V_{MD}, V_X, V_Y and the rate of climb achieved.

Increasing	ROC	V_Y V_X PROP	V_Y V_X JET
Altitude	Reduces	Same	Lower
Temperature	Reduces	Same	Lower
Mass	Reduces	Higher	Higher
Flap Angle	Reduces	Lower	Lower

Min Clearway -> 500ft

The "Density altitude" is:
- the altitude in the standard atmosphere at which the prevailing density occurs.
- pressure altitude corrected for "non standard" temperature.

VNE -> Limited by aerodynamic and Structural

Prop
max range: vmd
max endurance: vmp

JET
max range: vmd 1.32
max endurance: vmd

A frangible obstacle is classed as:
- An obstruction in the take off path that is a minimum hazard to an aircraft

The intersections of the thrust available and the drag curve are the operating points of the aeroplane
- in unaccelerated level flight.

This exercise can be solved using trigonometry.

- *Climb Gradient = (Change in Height / Distance Travelled) x 100; and*
- *TAN Ø = Opposite side / Adjacent Side*
  (Where, in this case, the opposite side corresponds to the Change in Height and the adjacent side is the Distance Travelled)

Based on the above formulas, Climb Gradient can be rewritten as follows:

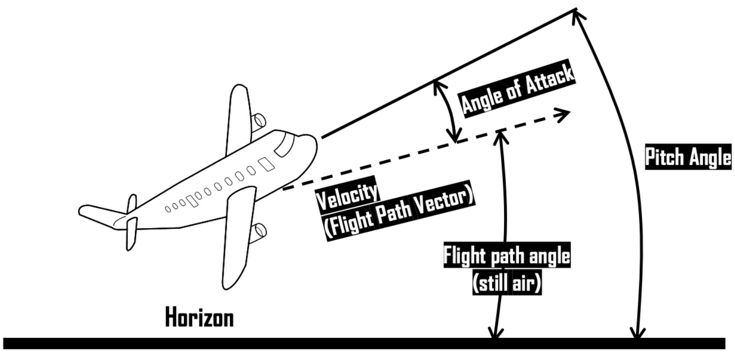
Climb Gradient = TAN Ø x 100
Climb Gradient = TAN 5.5° x 100
Climb Gradient = 9.6%

FLIGHT PATH ANGLE: **angle between the flight path vector and the horizon**. It is assumed to be ground-related and is, therefore, wind dependent.

- For example, in a headwind, the flight path angle relative to the ground will be less than in still air.

CLIMB/DESCENT ANGLE: angle between the local horizon and TAS vector. It is assumed to be air-related and independent on wind.

AOA, Flight Path Angle and Pitch Angle



Screen Height

- **The height at the end of the take-off distance required and at the beginning of the landing distance required.**

What is the ratio of Nautical Air Miles (NAM) of flying distance versus the amount of fuel consumed?

- **specific range**

When to use the formula 9*square root of the tyre pressure in PSI?

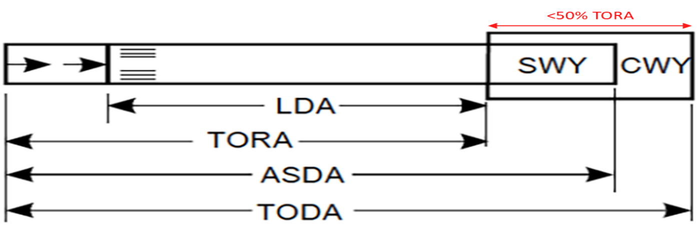
- **For dynamic aqua-planning speed**

The Specific Fuel Consumption (SFC) for a propeller engine is…

- **Fuel flow per unit of power.**

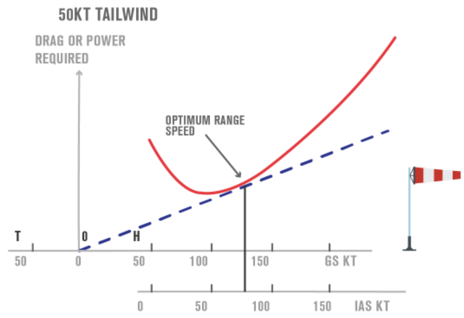
According to OPS regulations, the runway condition complying with the definition of a "wet runway" is:

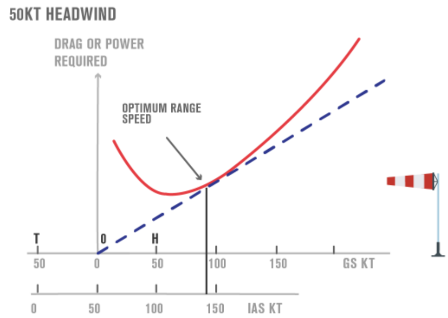
- **There is sufficient moisture on the runway surface to cause it to appear reflective, but without significant areas of standing water.**



Compared with still air, the effect a headwind has on the values of the maximum range speed and the maximum gradient climb speed respectively is that:

- the maximum range speed increases and the maximum gradient climb speed is not affected.





+ ALTITUDE:

- LESS ROC
- LESS CLIMB ANGLE

1kt = 1.15 MPH

TODA has to be the lower of:

1.5 TORA
TORA + clearway

F: Force	**V: Speed**
D: Drag curve	**↑ : Direction of movement**

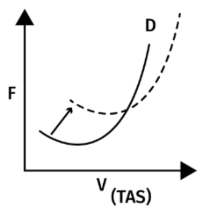


Figure 1

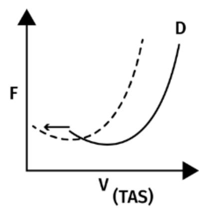


Figure 2

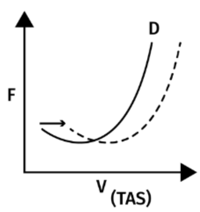


Figure 3

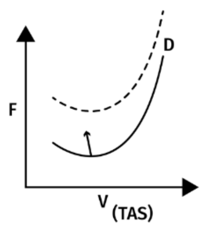


Figure 4

Figure 1: When mass increases (Drag+ also think of Vmd in the graph)
Figure 2: Density altiude decreases (TAS decreases)
Figure 3: Density altitude increases (TAS increases)
Figure 4: Landing Gear extended (Parasite drag ++)

Humidity -> Both piston and turbine engine will suffer similar degradation in performance

Level flight, range and endurance

27 de março de 2023 10:57

Where on the power-required/power-available graph can you find the speed for best endurance for a Propeller Aircraft?

- At the lowest point on the power-required curve.

Where on the power-required/power-available graph can you find the speed for best range?

- By drawing a tangent from the origin of the graph up to the power-required curve.

How are fuel flow and TAS connected to each other in horizontal flight?

- An increase in TAS will lead to a decrease in fuel flow up to the maximum endurance speed and increase thereafter.

A jet aeroplane is cruising at a constant flight level and at its maximum range speed. We can say that the IAS will (1)_____ and the drag will (2)_____.

- (1) decrease; (2) decrease (along the flight you will burn fuel -> drag will reduce -> ias for max range = 1.3VMD reduced)

What speed can be found on both intersections of the thrust required curve with the thrust available curve?

- Vs and Vmax

Specific Range -> TAS / Fuel Flow OR Distance / Fuel Burned

For a jet transport aeroplane, which of the following is the reason for the use of 'maximum range speed'?

- Minimum specific fuel consumption.
- Specific Range = TAS ÷ (SFC x Drag)
  - **Therefore, maximum range will be achieved at the minimum specific fuel consumption.**

Maximum endurance:

- is achieved in **unaccelerated** level flight with minimum fuel flow.

HWC

- **increases the Speed for Maximum Range and leaves the Speed for Maximum Angle of Climb unchanged.**

A jet aeroplane is flying at the speed for maximum range, below the optimum altitude. How does the specific range change when altitude increases? The specific range…

- first increases then decreases.
- SPECIFIC RANGE (SR) = TAS ÷ FUEL FLOW

Increase in HW DOES NOT AFFECT MAX Endurance Speed (Time to fly will be the same you only reach less ground NM)

Wind influence on Range and Endurance

RANGE

Wind speed is an important practical influence on gliding distance over the surface.

- With a tailwind, the glide distance achieved will be increased as a result of the increased groundspeed. Whereas with a headwind, it will be reduced because of the consequently slower groundspeed.

ENDURANCE

- **The wind has no effect on endurance.** Endurance is about time in the air, not distance covered. Maximum endurance is concerned with minimizing fuel flow and wind does not affect the fuel flow into the engine. As long as it has usable fuel in its tanks, an aircraft will still remain airborne.

SUMMARY:

RANGE Glide Distance (Varies with wind)

=> Tailwind increases glide distance

=> Headwind decreases glide distance

ENDURANCE Glide Duration (Varies with mass)

=> Low mass increases glide duration

=> High mass decreases glide duration

Consider the curve for the thrust required versus speed, for a jet aeroplane. What speed can be obtained from the minimum of this curve? The speed for:

- Max Endurance, because fuel flow is proportional to thrust at the minimum.

Specific Fuel Consumption(SFC)

- **is the fuel flow per unit of thrust. (JET)**
- **fuel flow per unit of Power (PROP)**

SPECIFIC FUEL CONSUMPTION

Specific fuel consumption (SFC) in a jet is the fuel flow per unit of thrust, while SFC for a propeller is the fuel flow per unit of power.

The SFC is only an engine consideration and is not affected by drag, which is an airframe consideration.
In a turbojet engine, SFC is lowest when the air temperature is low and the engine is running at its design rpm of approximately 90 to 95% rpm.

This means that SFC is proportional to temperature.
It also means that the engine is most efficient at high altitude where the thrust required to overcome drag is approximately 90 to 95% of the thrust available.

JET	V_X (Best Angle of Climb) = V_{MD} (Minimum Drag Speed) = Maximum/Best Endurance Speed = Maximum L/D	V_Y (Best Rate of Climb) = 1.32 V_{MD} = Maximum/Best Range Speed
PROP	V_{MP} (Minimum Power Speed) = Best Endurance	V_Y (Best Rate of Climb) = V_{MD} (Minimum Drag Speed) = Maximum/Best Range Speed = Maximum L/D

POWER REQUIRED CURVE

- **Lowest Point of curve – V_{MP}**

  => **For PROP:** Best Endurance Speed.

- Tangent – V_{MD}, Best L/D Ratio

  => For PROP: Maximum Range

  => For JET: V_X = Maximum Endurance

Specific endurance is defined as:
- 1/fuel flow

What happens to jet endurance with altitude?
- Endurance is maximum at a high level, low OAT, and design RPM.

Which of the following statements defines the power required?
- The power that is needed to maintain unaccelerated level flight for a set of conditions.

Specific Range decreases with increasing temperature
Max SR of a Jet -> 1.32 Vmd
SFC increase with increasing temperature
SFC decreases at higher altitudes and colder ambient temperatures.
Any Deviation for Optimum ALTITUDE -> - SR

Jet Hold -> Endurance -> Vmd

+ Alt -> Low Speed Buffet INCREASE & High Speed Buffet DECREASES

Prop SRG (Ground) -> It increases until the increase in the Ground speed is offset by the increase in power required.

JET SRG -> the ground distance that the aircraft would fly per kilogram of fuel.

Vs1g - > The 1-g stall speed at which the aeroplane can develop lift equal to its weight.

How does the Specific Range (SR) vary, in a propeller-driven aeroplane?
- **SR increases slowly with altitude up to full throttle height.**

Climbing

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climb, the maximum angle is achieved when flying with the minimum thrust required.

CLIMB Gradient ALWAYS Higher than Climb Angle

+ALT -> + TAS -> + Vx & Vy

Wind does not Affect Time to climb in (ROC) only Mass & Density

Wind does AFFECT distance to climb

Vy -> Best Rate of Climb
Vx -> best angle of climb -> greatest excess of thrust

Consider a graph showing the rate of climb on the vertical axis and the speed on the horizontal axis.

- A **tangent** which is drawn from the **origin** will intercept the graph on a specific location which shows **Vx** and the **peak** of the graph show **Vy**

The speed for minimum thrust required is used to climb with the best angle of climb.

decrease in air density -> decrease in performance -> reduce rate of climb

In a Climb Lift is lower than in Straight and Level -> Thrust is helping

1 EINOP -> Vy decreases (ROD DOWN)

Climb at MAX ratio between Thrust available and required -> Vx == Max Angle of climb

What is the best combination of slats and flaps for climb performance?

- Small slat angle, small flap angle.

The WORST performance will occur with a combination of high outside air temperature and high pressure altitude.

Less Flaps -> + ROD -> + CLIMB Gradient

- **Weight -> excess thrust is increased(Vx) -> + climb angle to mantain the same speed**

Factors affecting Take-Off and Climb

	Take-Off Performance	Climb Performance
Density ↓	↓	↓
Airport Elevation ↑	↓	↓
Pressure Altitude ↑	↓	↓
Temperature ↑	↓	↓
Relative Hum. ↑	↓	↓
Mass ↑	↓	↓
Uphill slope	↓	-
Downhill slope	↑ *V1 decreases*	-
Headwind *(50%)*	↑	No effect
Tailwind *(150%)*	↓	No effect
Engine failure	↓	↓
More flap	↑	↓
Lesser flap	↓	↑ *(faster V2)*
Wet runway	↓	-
Clearway	↑	-
	field length limited takeoff mass	*climb limited take-off mass*

Descending

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Effect of weight on a Glide Descent

SIN (θ) = (D - T) ÷ W

T = Idle +-= 0

Sin (a) = D / W

Descending Drag increases but thrust idle performance increases

Sin (a) = CONSTANT

-> ROD = Sin(a) * TAS(decreasing while descending) --> - ROD

1 EINOP -> search for TW(carry us in distance) and Vmd(less drag)

If we look at a change in Weight while descending:

- + Mass -> + Vmd (need a higher speed to reach Vx in a JET)
- Angle of descent in this higher speed will be the same
- ROD will decrease as TAS decreases with ALT with the same Angle of Descent at a Higher Speed

DESCEND WITH Constant Mach:

- limited by VMO

Mmo - Climb (to the Mmoon),
Vmo - Descent (V is like an arrow pointing down)

In A DESCENT to LAND:

- + hw -> + Lift -> + AIRSPEED -> - GS -> Below glide slope
- - hw -> - Lift -> - AIRSPEED -> + GS -> above glide slope

Airworthiness requirements

27 de março de 2023 10:54

Easy Access Rules for Normal, Utility, Aerobatic and Commuter Category Aeroplanes (CS-23) (Initial issue)
CS 23.51 Take-off speeds ED Decision 2003/14/RM

(a) For normal utility and aerobatic category aeroplanes, the rotation speed V_R, is the speed at which the pilot makes a control input with the intention of lifting the aeroplane out of contact with the runway or water surface.

(1) For twin-engined landplanes, V_R must not be less than the greater of 1·05 V_{MC} or 1·10 V_{S1};

(2) For single engined landplanes, V_R, must not be less than V_{S1}; and

(3) For seaplanes and amphibians taking off from water, V_R, must be a speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete failure of the critical engine.

SEP:

- **Vr >= Vs1**
- **V2 = 1.20 Vs1**
- **Vref >= 1.30 Vs0**

MEP:

- **V r = 1.05 Vmc & >= 1.1 VS1**
- **V2 = 1.2 VS1 & >= 1.1 Vmc**
- **V ref = 1.3 VSO & >= Vmc**

V_{REF} is the Landing Reference Speed at a point 50 feet above the landing threshold. It is not less than 1.3 times the stall speed in the normal landing configuration. In simple terms: your final approach speed.

Engine Failure **Thrust Required INCREASE** and **excess Thurst Decrease by MORE THAN 50 %**

Take-off and landing

22 de abril de 2023 11:13

If the runway surface is other than dry and paved the following factors must be used when determining the take-off distance:

Surface type	Condition	Factor
Grass (on firm soil) up to 20 cm. Long	Dry	x 1.2
	Wet	x 1.3
Paved	Wet	x 1.0

TakeOff -> clear all obstacles by a vertical margin of:

- 35 ft for Class A
- 50 ft for Class B

Landing Distance Requirements EU-OPS

The landing distance required on a dry runway for destination and alternate aerodromes, from 50 ft for class A aircraft and 35 ft for class B aircraft to a full stop must not exceed:

- 60% (0.6) of the landing distance available for turbojet airplanes
- 70% (0.7) of the landing distance available for turboprop airplanes

Takeoff Flight Path

- Class A : begin 35ft.. ends 1500ft
- Class B : begin 50ft..ends 1500ft

Obstacle accountability area:

- The area **beyond** the **TODA** within which obstacles are considered for the purposes of **takeoff climb performance**.

HORIZONTAL DISTANCE

- wing span is **more** than **60m**:
  - **then (D x 0.125) + 90m**

- wing span is **less** than **60**:
  - then of at least **1/2 x wingspan plus 60 m, plus D x0.125**.

CAP 698 MEP1 - Balked Landing Requirements

The minimum acceptable gross gradient of climb after a balked landing is 2.5%. This must be achieved with:

a) The power developed 8 seconds after moving the power controls to the take-off position.
b) The landing gear (undercarriage) extended.
c) Flaps at the landing setting.
d) Climb speed equal to V_{REF}.

Regulation (EU) No 965/2012
CHAPTER 3 – PERFORMANCE CLASS B
CAT.POL.A.305 Take-off

(a) The take-off mass shall not exceed the maximum take-off mass specified in the AFM for the pressure altitude and the ambient temperature at the aerodrome of departure.
(b) The unfactored take-off distance, specified in the AFM, shall not exceed:
(1) when multiplied by a factor of **1,25**, the take-off run available (TORA); or
(2) when stop way and/or clearway is available, the following:
(i) the TORA;
(ii) when multiplied by a factor of 1,15, the take-off distance available (TODA); or
(iii) when multiplied by a factor of 1,3, the ASDA.

EASA AIR OPS
Regulation (EU) No 379/2014
CHAPTER 3 – PERFORMANCE CLASS B
CAT.POL.A.310 Take-off obstacle clearance – multi-engined aeroplanes

(a) The take-off flight path of aeroplanes with two or more engines shall be determined in such a way that the aeroplane clears all obstacles by a vertical distance of at least **50 ft**, or by a horizontal distance of at least 90 m plus 0,125 × D, where D is the horizontal distance travelled by the aeroplane from the end of the TODA or the end of the take-off distance if a turn is scheduled before the end of the TODA, except as provided in (b) and (c). For aeroplanes with a wingspan of less than 60 m, a horizontal obstacle clearance of half the aeroplane wingspan plus 60 m plus 0,125 × D may be used. It shall be assumed that:
(1) the take-off flight path begins at a height of **50 ft** above the surface at the end of the takeoff distance required by CAT.POL.A.305(b) and ends at a height of **1 500 ft** above the surface;
(2) the aeroplane is not banked before the aeroplane has reached a height of 50 ft above the surface, and thereafter the angle of bank does not exceed 15°;
(3) failure of the critical engine occurs at the point on the all engine take-off flight path where visual reference for the purpose of avoiding obstacles is expected to be lost;
(4) the gradient of the take-off flight path from 50 ft to the assumed engine failure height is equal to the average all-engines gradient during climb and transition to the en-route configuration, multiplied by a factor of 0,77; and
(5) the gradient of the take-off flight path from the height reached in accordance with (a)(4) to the end of the take-off flight path is equal to the OEI en-route climb gradient shown in the AFM.

Climb, cruise and descent

22 de abril de 2023 11:13

Climb -> less density -> less fuel flow(if on the same power setting) -> but more power output must be generated

On a twin engined piston aircraft with variable pitch propellers, for a given mass and altitude, the minimum drag speed is 125 kt and the holding speed (minimum fuel burn per hour) is 95 kt. The best rate of climb speed will be obtained for a speed

- between 95kt and 125kt

CAP 698

4 En-Route

4.1 Requirements

The aeroplane may not be assumed to be flying above the altitude at which a rate of climb of 300 ft/min is attained.

The net gradient of descent, in the event of engine failure, shall be the gross gradient of descent increased by a gradient of 0.5%

Gradient Engine INOP = 4.8 + 0.5 = 5.3 %

Climb/Descend gradient = (Change in Height / Horizontal distance) x 100%

Horizontal distance = (2000 / (5.3 x 6080)) x 100 % = 6.2 NM

NOTE: Altitude and horizontal distance must be in the same unit of measurement, 1NM = 6080 ft approximately.

An aeroplane with reciprocating engines is flying at a constant angle of attack, mass and configuration. With increasing altitude the drag...

- remains unchanged but the TAS increases.

Net glide Gradient = Gross Glide Gradient + 0.5%

The glide gradient may be given as a Lift/Drag ratio at Vmd

- **example: A L/D ratio of 9.1:1 implies a glide gradient of: 1/9.1 = 0.11 or 11%**

Use of aeroplane performance data

27 de março de 2023 10:54

CAP 698 – Landing MEP1

Field Length Requirements

a) The landing distance, from a screen height of 50 ft, must not exceed 70% of the landing distance available, i.e. a factor of 1.43.

b) If the landing surface is grass up to 20 cm long on firm soil, the landing distance should be multiplied by a factor of 1.15.

c) If the METAR or TAF or combination of both indicate that the runway may be wet at the estimated time of arrival, the landing distance should be multiplied by a factor of 1.15.

d) The landing distance should be increased by 5% for each 1% downslope. No allowance is permitted for upslope.

e) The despatch rules for scheduled (planned) landing calculations are in JAR-OPS 1.550 (c)

CAP 698 – Take-Off
Field Length Requirements

a) When no stop way or clearway is available the take-off distance when multiplied by 1.25 must not exceed TORA.
b) When a stopway and/or clearway is available the take-off distance must:

I. not exceed TORA

II. when multiplied by 1.3, not exceed ASDA

III. when multiplied by 1.15, not exceed TODA

c) If the runway surface is other than dry and paved the following factors must be used when determining the take-off distance in a) or b) above:

Surface type	Condition	Factor
Grass (on firm soil) up to 20 cm. Long	Dry	x 1.2
	Wet	x 1.3
Paved	Wet	x 1.0

When it comes to available distances -> the most limiting is the shortest
When it comes to required distance -> the most limiting is the longest. (add regulatory factors)

When it asks ground roll distance you go straight (in takeoff)

LDA :1.43
LDR x1.43

Mixture leaned = short line
Mixture full rich = long line

@Captain you don't apply upslope for landing, that's only for T.O.

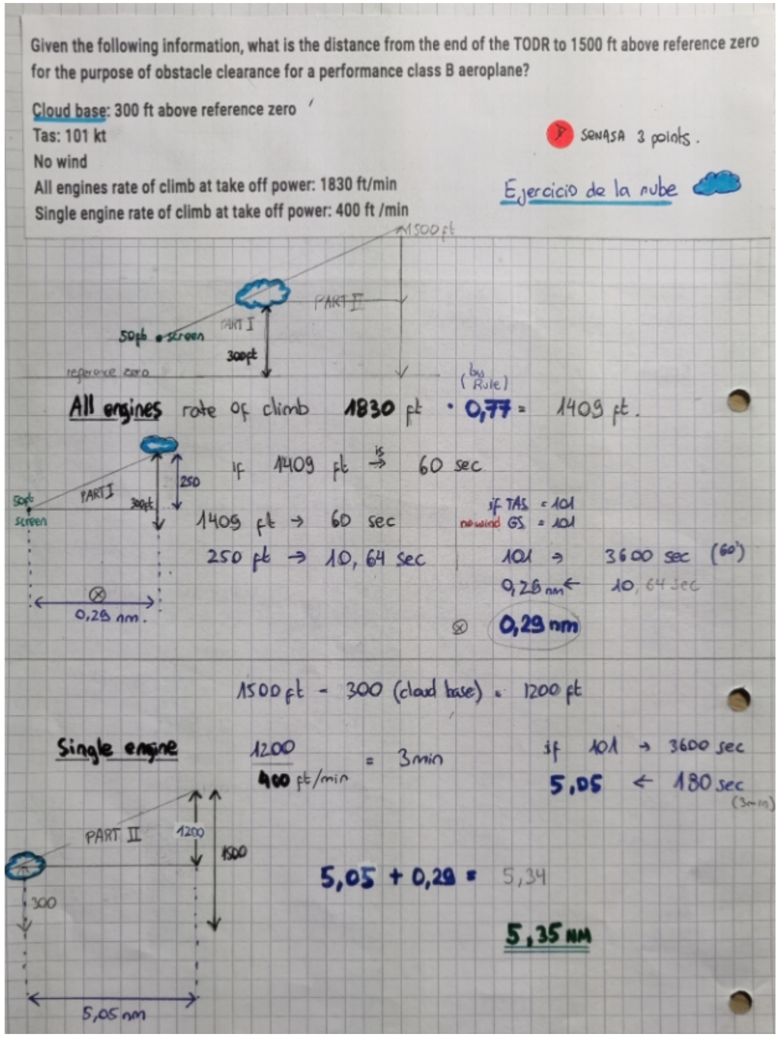
Min Gradient after take-off for Performance class B = 4% -> with all engines operating

Cap 698 section 3 page 1:
Take off distance must not exceed
- TORA
- ASDA/1.3
- TODA/1.15

ASDA = 1270 + 215 = 1485
=> ASDA/1.3 = 1142 ft

1.3% upslope => 5% x 1.3 = 6.5%
1142/1.065 = 1072 ft

No factor for paved and wet



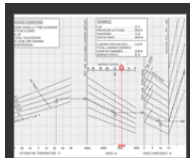
Hi @Youness, the graph gives you landing distance (not landing distance available). When you're asked for landing distance required, the factor 1.43 must be applied.
When discussing landing distance, two categories must be considered:
- Actual landing distance is the distance used in landing and braking to a complete stop (on a dry runway) after crossing the runway threshold at 50 feet; and
- Required landing distance is the distance derived by applying a factor to the actual landing distance.

Actual landing distances are determined during certification flight tests without the use of reverse thrust. Required landing distances are used for dispatch purposes (ie for selecting the destination and alternate airports).

Hope this helps!

Take - off SEP or MEP
Dry grass x1.20
Wet grass x1.30

Landing for SEP or MEP
Dry grass x1.15
Metar Wet x1.15



Refer to figure.
The speed across the threshold is described as V_{REF} (reference landing speed), but for Class B aircraft also in some manufacturer's graphs as the "barrier speed".

From the Figure 3.9, the barrier speed can be extracted as:

- Enter with mass of *3450 lb.*
- Move vertically upwards and read the barrier speed of *80 kt.*

According to CS 23.73, the barrier speed for a Class B reciprocating engine-powered aeroplane must not be less than the higher of:

- *V_{MC} with take-off flap configuration, or*
- *1.3 V_{S1} (stall speed or the minimum steady flight speed in a configuration appropriate to the case under consideration).*

Thus, the stall speed in the landing configuration (V_{S0}) is: *barrier speed / 1.3 = 80 kt / 1.3 =* **62 kt**.

- This is asking you for ROC just for climbing purposes (which is independent of wind) so take into account TAS.
- Other questions ask you for ROC relating to obstacle clearance (however now you must take into account GS, wind) so GS
- When ask Flight path or obstacle related we must use GS.

CLASS B - Barrier speed Vref = 1.3 Vs0 for SEP and MEP
CLASS A - Barrier speed Vref = 1.23 Vs0

Min Gradient after take-off for Performance class B = 4%

V's

25 de abril de 2023 17:12

Definitions and abbreviations used in Certification Specifications for products, parts and appliances

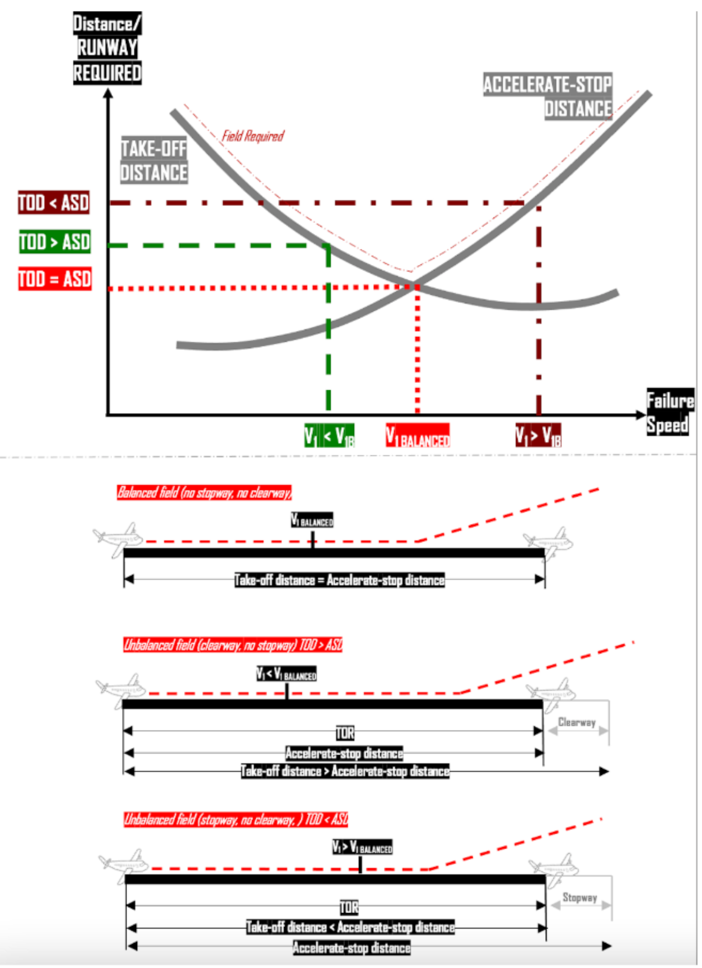
CS-Definitions

'V_A' means design manoeuvring speed.
'V_B' means design speed for maximum gust intensity.
'V_C' means design cruising speed.
'$V_{D/MD}$' means design diving speed.
'$V_{DF/MDF}$' means demonstrated flight diving speed.
'V_{EF}' means the speed at which the critical engine is assumed to fail during take-off.
'V_F' means design flap speed.
'V_{F1}' means the design flap speed for procedure flight conditions.
'$V_{FC/MFC}$' means maximum speed for stability characteristics.
'V_{FE}' means maximum flap extended speed.
'V_{FTO}' means final take-off speed.
'V_{FR}' means visual flight rules.
'V_H' means maximum speed in level flight with maximum continuous power.
'V_{HF}' means very high frequency.
'V_{LE}' means maximum landing gear extended speed.
'V_{LO}' means maximum landing gear operating speed.
'V_{LOF}' means lift-off speed.
'V_{MC}' means minimum control speed with the critical engine inoperative.
'V_{MCA}' means the minimum control speed, take-off climb.
'V_{MCG}' means the minimum control speed, on or near ground.
'V_{MCL}' means the minimum control speed, approach and landing.
'$V_{MO/MMO}$' means maximum operating limit speed.
'V_{MU}' means minimum unstick speed.
'V_{NE}' means never-exceed speed.
'V_R' means rotation speed.
'V_{RA}' means rough airspeed.
'V_{REF}' means reference landing speed.
'V_S' means the stall speed or the minimum steady flight speed at which the aeroplane is controllable.
'V_{SO}' means the stall speed or the minimum steady flight speed in the landing configuration.
'V_{SR}' means reference stall speed.
'V_{SR0}' means reference stall speed in the landing configuration.
'V_{SR1}' means reference stall speed in a specific configuration.
'V_{SW}' means speed at which onset of natural or artificial stall warning occurs.
'V_{S1}' means the stall speed or the minimum steady flight speed obtained in a specified configuration.
'V_{S1g}' means the one-g stall speed at which the aeroplane can develop a lift force (normal to the flight path) equal to its weight.
'V_T' means threshold speed.
'V_{Tmax}' means maximum threshold speed.
'V_{TOSS}' means take-off safety speed for Category A rotorcraft.
'V_Y' means speed for best rate of climb.

Vfto - (final takeoff speed) - may not be less than 1.18 Vrs and
must provide at least the minimum climb gradient

Balacing Fields

25 de abril de 2023 14:07



Field length is balanced when…one engine inoperative take-off distance equals one engine inoperative accelerate stop distance.

BALANCED FIELD LENGTH

When the Accelerate-stop Distance Available (ASDA) is equal to the Take-off Distance Available (TODA), this is known as a Balanced Field Length. Likewise, when the ASDA and TODA are different lengths, this is known as an Unbalanced Field Length.

BALANCED FIELD TAKE-OFF

A balanced field take-off is performance based and is a condition where the Accelerate-stop Distance Required (ASDR) is equal to the Take-off Distance Required (TODR) for the aircraft weight, engine thrust, aircraft configuration and runway condition.
The balanced field length is the shortest field length at which a balanced field take-off can be performed.

- *A Balanced field length is used to simplify the field-length take-off mass. When applying this concept, TOD = ASD and V_1 = $V_{1\ Balanced}$. And this means that we are using the minimum requirements in case of engine failure, thus increasing safety margins. When using stopway or clearway, extra distance will be available and V_1 will vary.*

BALANCED V_1

The first graph on the attached figure, helps understanding the impact of increasing or decreasing V_1.
Analyzing it, we can conclude the following:

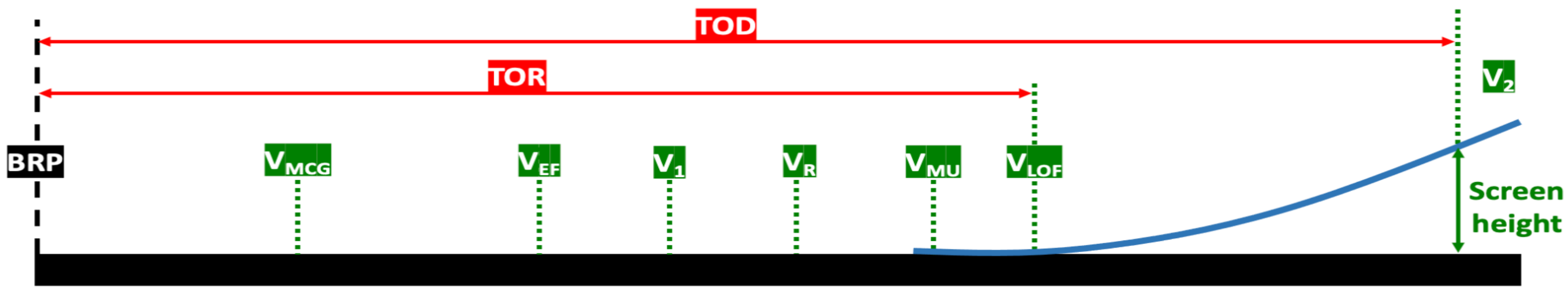
- A Balanced V_1 is a V_1 speed which results in TODR equal to ASDR. Often called the "Ideal V_1" as it gives the minimum field length required for a given weight and optimum performance.
- **Any lower V_1 ($V_1 < V_{1B}$) would increase TODR, as it would take longer for the aircraft to accelerate to V_2 with OEI. As a result, the total field required increases.**
- Any higher V_1 ($V_1 > V_{1B}$) would increase ASDR due to a higher energy absorption by the brakes. As a result, the total field required would also increase.

=> In essence, Balanced V_1 improves field length limited take-off performance.
=> Unbalanced V_1 allows for higher take-off weights by taking advantage of any runway and clearway or stopway available in excess of balanced field length.

Summary and extra info:

- *If TOD = ASD, V_1 = BALANCED, Balanced condition.*
- ***If TOD > ASD, $V_1 < V_{1\ BALANCED}$, Unbalanced condition. Clearway, no stopway = higher mass and lower V_1 speed***
- *If TOD < ASD, $V_1 > V_{1\ BALANCED}$, Unbalanced condition. Stopway, no clearway = higher mass and higher V_1 speed.*

TORA (Take-Off Run Distance Available) => RUNWAY only (no STOPWAY or CLEARWAY)
TODA (Take-Off Distance Available) => TORA + CLEARWAY
ASDA (Accelarate-Stop Distance Available) => TORA + STOPWAY



Take-off

27 de março de 2023 10:54

Aircraft Classification Number(ACN) < = Paved Classification Number(PCN)

Aircraft Classification Number (ACN) is a value assigned to an airplane to show its load force. Operation on the pavement is permissible if the **ACN** is less than or equal to the **pavement classification number (PCN)** of an aerodrome. Because the PCN includes a safety factor, a 10% increase of ACN over PCN is generally acceptable for pavements that are in good condition and occasional use by aircraft with ACNs up to 50% greater than the PCN may be permitted. In such circumstances the movement of the aircraft must be very closely monitored for damage to the aircraft and pavement.

The **first** part is the **PCN numerical value**, indicating the load-carrying capacity of the pavement. This is always reported as a whole number, rounded from the determined capacity.

The only letter that you need to interpret is the first letter of the second part:

The **second** part is a **letter**: either an **R** or an **F**, depending on whether the pavement itself is of a rigid (most typically concrete) or a flexible (most typically asphalt) design.

Solution:

The exercise is asking the minimum usable PCN, considering an allowable 10% increase;

47 x 1.1 = 51.7 > ACN 50

If sufficient excess runway is available, the climb limited take-off mass and the climb gradient can be increased by increasing V2

What is the primary advantage of using the increased V2 (improved climb) procedure on take-off?

- **The obstacle-limited take-off mass is increased.**

Class A Net Take-off Distance Required

The take-off distance required is the greatest of the following three distances:

- All engines operating. The horizontal distance travelled, with all engines operating, to reach a screen height of 35 ft multiplied by 1.15
- One engine inoperative (dry runway). The horizontal distance from BRP to the point at which the airplane attains 35 ft, assuming the critical power unit fails at V_{EF} on a dry, hard surface.

One engine inoperative (wet runway). The horizontal distance from BRP to the point at which the airplane attains 15 ft, assuming the critical power unit fails at V_{EF} on a wet or contaminated hard surface, achieved in a manner consistent with the achievement of V_2 by 35 ft.

Class A

- **take off wet/1EngInop => 15 ft**
- **take off dry => 35 ft**
- **landing dry/wet => 50 ft**

Class B

- **take off dry/wet => 50 ft**
- **landing dry/wet => 50 ft**

V1 is lower or equal to Vr

V_{2MIN}

The minimum take-off safety speed, or the speed at the screen height, with the critical engine inoperative.

Class A aircraft V_{2MIN} may not be less than:

- $1.13V_{SR}$ for 2 and 3 engine turboprops and all turbojets without provision for obtaining a significant reduction in the one engine inoperative power-on stalling speed
- $1.08V_{SR}$ for turboprops with more than 3 engines and turbojets with provision for obtaining a significant reduction in the one engine inoperative power-on stalling speed.
- $1.1V_{MC}$

<u>Class A uses V_{sr}, the stall reference speed, instead of V_{S1} which is basically the same.</u>

<u>Class B aircraft V_{2MIN} may not be less than:</u>

- V_{MC} for single engine
- 1.1 V_{MC} for twin
- V_{S1}

vMCG -> primary aerodynamic control only (rudder)

net take-off flight path must clear all obstacles by:

Vertical

- **35 ft for Class A airplanes**
- **50 ft for Class B airplanes.**

-horizontal

- wingspan more than 60 -> **at least 90 m + 0.125D where D is the distance from the end of the TODA**
- with wingspan **less than 60 m -> 60 + half the wingspan + 0.125D**

When V1 has to be reduced because of a wet runway the one engine out obstacle clearance / climb performance:

- **decreases / remains constant.**

For a take-off from a contaminated runway, which of the following statements is correct?

- **The take-off performance data is generally determined by the manufacturers by calculation, only a few values are verified by flight tests.**

The one engine out take-off run is the distance between the brake release point and:

- **the middle of the segment between VLOF point and 35 ft point.**

CAP 698
Section 4 Data for Medium-Range Jet Transport (MRJT1)
2 Take-Off

2.1.2 The Field Length requirements specified in CS 25 are:

a) If the take-off distance includes a clearway, the take-off run is the greatest of:

i) All power units operating (dry and wet runway). The total of the gross distance from the start of the take-off run to the point at which V_{LOF} is reached, plus one half of the gross distance from V_{LOF} to the point at which the aeroplane reaches 35 ft, all factorised by 1.15 to obtain the net TORR.

ii) <u>One power unit inoperative (dry runway)</u>. **The horizontal distance from the brakes release point (BRP) to a point equidistant between V_{LOF} and the point at which the aeroplane reaches 35 ft with the critical power unit inoperative.**

iii) One power unit inoperative (wet runway). The horizontal distance from the brake release point (BRP) to the point at which the aeroplane is 15ft above the take-off surface, achieved in a manner consistent with the attainment of V_2 by 35ft, assuming the critical power unit inoperative at V_{EF}

Segments of the Take-off Climb

For a class A aircraft, one engine inoperative, the T/O climb is divided into 4 segments:

1. The take-off flight path starts once the take-off is complete, at 35 ft with the airplane at V_2 with one engine inoperative. On a wet runway, the screen height is reduced to 15'. Operating engines are at takeoff thrust, the flaps/slats are in takeoff configuration and landing gear retraction is initiated once safely airborne with positive climb. The first segment ends when the landing gear is fully retracted.
2. Begins when the landing gear is fully retracted. Engines are at takeoff thrust and the flaps/slats are in the takeoff configuration. This segment ends at the higher of 400'.
3. Begins at 400' or higher specified acceleration altitude. Engines are at takeoff thrust and the aircraft is accelerated in level flight. Slats/flaps are retracted on speed. The segment ends when aircraft is in clean configuration and the final take-off speed has been achieved. Once this has happened, thrust can be reduced from maximum take-off thrust, TOGA, to maximum continuous thrust, MCT.
4. Starts when the flaps are retracted, the final segment speed is achieved, and the thrust is set to maximum continuous thrust. From this point the airplane is climbed to above 1500 ft where the take-off flight path ends. The climb gradient for this last stage must not be less than 1.2%.

	1° Segment	2° Segment	3° Segment	4° Segment
Starts	35 ft	Gear Up	> 400 - AGL	Flaps Up VFTO MCT
Action	Select Gear Up	Climb to > 400 - AGL	Retract Flaps Accelerate to VFTO Set MCT	Climb to 1500 - AGL
Gradient for 2 Engines	> 0%	> 2.4%	> 1.2%	> 1.2%
Gradient for 3 Engines	> 0.3%	> 2.7%	> 1.5%	> 1.5%
Gradient for 4 Engines	> 0.5%	> 3.0%	> 1.7%	> 1.7%

Note: While third segment is usually flown in level flight, the available gradient must be at least equal to that required in final segment (1.2%). During third segment the high lift devices are retracted.

2.1.2 The **Field Length requirements specified in CS 25** are:

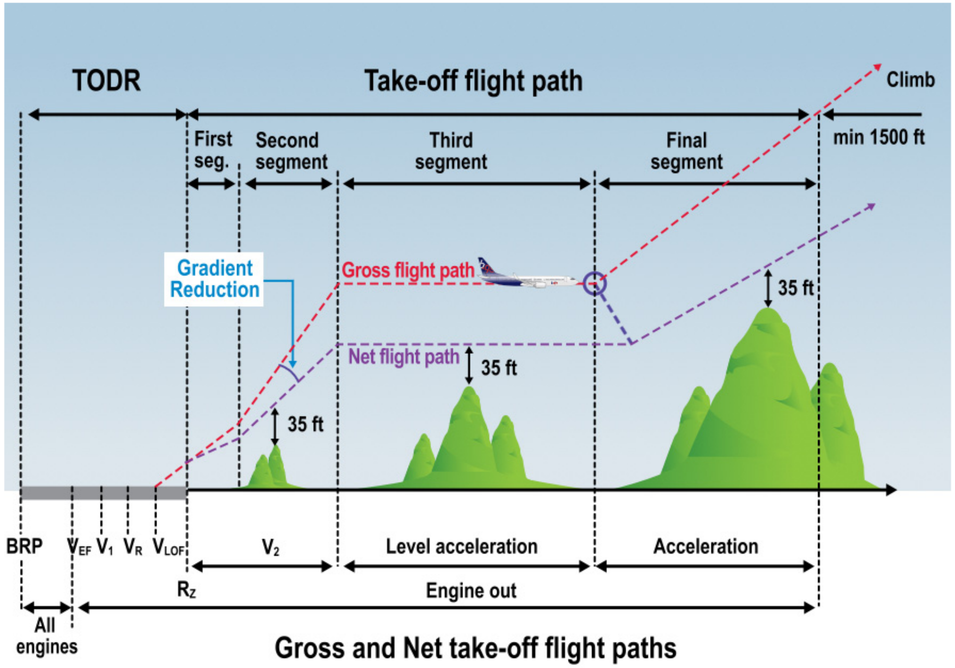
- all engines operating: 1.15 take off distance
- one engine inoperative (dry): from breaks released point till have way between lift off point to 35 ft screen hight
- one engine inoperative (wet): from breaks released point till reaching screen hight of 15 ft at appropriate v2 speed.

A balanced field takeoff is a condition where the accelerate-stop distance required is equal to the takeoff distance required

Summary and extra info:

- *If TOD = ASD, V_1 = BALANCED, Balanced condition.*
- *If TOD > ASD, $V_1 < V_{1\ BALANCED}$, Unbalanced condition.*
  Clearway, no stopway = higher mass and lower V_1 speed
- *If TOD < ASD, $V_1 > V_{1\ BALANCED}$, Unbalanced condition.*
  Stopway, no clearway = higher mass and higher V_1 speed.

TORA (Take-Off Run Distance Available) => RUNWAY only (no STOPWAY or CLEARWAY)
TODA (Take-Off Distance Available) => TORA + CLEARWAY
ASDA (Accelarate-Stop Distance Available) => TORA + STOPWAY



Gross and Net take-off flight paths

V_{2MIN}
The minimum take-off safety speed, or the speed at the screen height, with the critical engine inoperative.

Class A aircraft V_{2MIN} may not be less than:

- $1.13V_{SR}$ for 2 and 3 engine turboprops and all turbojets without provision for obtaining a significant reduction in the one engine inoperative power-on stalling speed
- $1.08V_{SR}$ for turboprops with more than 3 engines and turbojets with provision for obtaining a significant reduction in the one engine inoperative power-on stalling speed.
- $1.1V_{MC}$

Class A uses V_{SR}, the stall reference speed, instead of V_{S1} which is basically the same.

The runway is contaminated by compacted snow. How does it affect the Take-Off Distance (TOD) / Accelerate-Stop Distance (ASD)?

- **TOD is not affected / ASD increases.**

4.6.4. Compacted Snow/Icy take off Performance
Performance data for take off on slippery runways, i.e. those with no measurable depth of contaminant, including compacted snow and ice covered runways include accountability for:

=> ACCELERATION - normal acceleration, no additional drag due to the runway state
=> DECELERATION - reduced aeroplane tyre to ground friction at predetermined levels

Performance Class A, Take-Off. The selected V1 is the balanced V1. As a consequence of this the:

- **Accelerate stop distance is equal to the engine failure take-off distance.**

Performance Class A, Take-Off. In comparison to a conventional take-off, the improved climb take-off results in a:

- **Higher V1 and more take-off distance required.**

The time interval between VEF and V1 is called the recognition time and is approximately 2 seconds.

Upslope

- **TODR INCREASES**
- **ASDR INCREASES**

Which of the following statements is correct regarding the obstacle limited take-off mass for a Performance Class A aeroplane?

- **It should be determined on the basis of a 35 ft obstacle clearance with respect to the net take-off flight path.**

Tyre Speed Limit -> Rotation Rate of the tyre and temperature

Take-off climb - **Turns on the Flight Path.**

- **Turns** are **not allowed below** a **height of half the wingspan or 50 ft whichever is greater.**

Second Climb segment -> USE AS 1 ENG INOP

The maximum depth of wet snow that the CAA recommends does not cover any part of the runway for flying operations to continue should not exceed is:

- **13 mm or 1/2 inch**

Dry snow is 102mm or 4 inches

Effect On Distances :

--

TOD :

. Wet : No effect

. Contaminated : Increased

. Compacted Snow : No effect

--

ASD :

. Wet : Increased

. Contaminated : Increased

. Compacted Snow : Increased

--

LD :

. Wet : Increased

. Contaminated : Increased

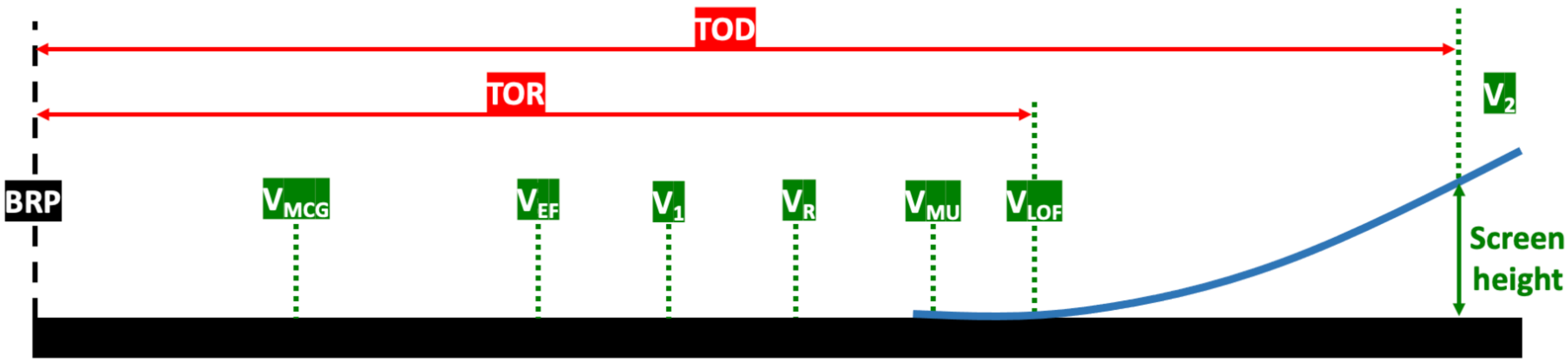
. Compacted Snow : Increased

--

Hope this helped .

EU-OPS states that the climb gradient to use for the purpose of calculating obstacle clearance must be the net climb gradient. Net gradient is the gross gradient reduced by a safety factor:

- 0.8% for 2-engine aircraft
- 0.9% for 3-engine aircraft
- 1.0% for 4-engine aircraft



V_S Stall speed is less than V_{MCA}.
V_2 is the Take-off Safety Speed, and minimum speed to be used during initial climb out. V_2 shall be at least 1.1 times V_{MCA}, and no less than 1.2 times V_S => Therefore, we know that **V_2 speed is > than both V_S and V_{MCA}.**

- $V_S < V_{MCA} < V_{2\ min}$.

Note: V_R is at least 1.05 V_{MCA}. V_{MU} is higher than V_R.

A **FLAT RATED** jet engine will give:
- **a constant thrust for temperatures below a cut-off value**

Reduced thrust take-off must not be used in the following cases:

- Icy or very slippery runways
- Contaminated runways
- **Anti-skid inop**
- Reverse thrust inop
- Increased V_2 procedure (improved climb)
- Engine Power Management Computer inop
- Not recommended in Windshear conditions

- more than 3mm is contaminated, less than 3 including 3 is wet.
- damp - not dry, but not a shiny appearance
- contaminated - more than 3mm or 25%

HYDROPLANING SPEED CALCULATIONS:

- *Rotating Tyres formula (applies to rejected take-offs): **V = 9 √ P***
- *NON-Rotating Tyres formula (applies to touchdown): **V = 7.7 √ P***
  Where V stands for velocity (kt) and P is tyre pressure (PSI)

In this case, the aircraft is taking off: V = 9 √ 200 = approx. **127 kt**

The environment limit is +55 degree.We cannot increase temp above it.

majority of things you need to know about slopes : (please note these down if it helps you)

- asdr :
. uphill slope : increases
. downhill slope : decreases

- todr :
. uphill slope : increases
. downhill slope : decreases

- tod:
. uphill slope : increase
. downhill slope : decrease

- stopping distance :
. uphill slope : decrease
. downhill slope : increase

- take-off run :
. uphill slope : increases
. downhill slope : decreases

- take-off mass :
. uphill slope : decreases , ((not the case if tyre speed limited))
. downhill slope : increases , ((not the case if tyre speed limited))

- v1 :
. uphill slope : increase
. downhill slope : decreases
. stopway : increases v1
. clearway : decreases v1

- uphill slope :
increases the tod more than the asd

Fluid contaminants contribute to stopping force by:

- Resisting forward movement of the wheels (i.e., causing displacement drag); and,
- Creating spray that strikes the landing gear and airframe (i.e., causing impingement drag).

EASA AIR OPS
Annex I to VIII
"Contaminated runway". A runway is considered to be contaminated when more than 25 % of the runway surface area (whether in isolated areas or not) within the required length and width being used is covered by the following:
(a) surface water more than 3 mm (0,125 in) deep, or by slush, or loose snow, equivalent to more than 3 mm (0,125 in) of water;
(b) snow which has been compressed into a solid mass which resists further compression and will hold together or break into lumps if picked up (compacted snow); or
(c) ice, **including wet ice.**

According to Part CAT, what is correct regarding the declared runway distances?

Thus wet V1 is a lower value than dry V1

EASA AIR OPS
CAT.POL.A.210 Take-off obstacle clearance

(2) Track changes shall not be allowed up to the point at which the net take-off flight path has achieved a height equal to one half the wingspan but not less than 50 ft above the elevation of the end of the TORA. Thereafter, up to a height of 400 ft it is assumed that the aeroplane is banked by no more than 15°. Above 400 ft height bank angles greater than 15°, but not more than 25° may be scheduled.

(3) Any part of the net take-off flight path in which the aeroplane is banked by more than 15° shall clear all obstacles within the horizontal distances specified in (a), (b)(6) and (b)(7) by a vertical distance of at least 50 ft.

(4) Operations that apply increased bank angles of not more than 20º between 200 ft and 400 ft, or not more than 30º above 400 ft, shall be carried out in accordance with CAT.POL.A.240.

- These do not account for runway line-up, and are usually adjusted in case of a 90° entry or 180° turnaround.

Refer to figure.

CAP 698, Section 3, Page 9

3.1.1 The Obstacle Accountability

Area The dimensions of the obstacle accountability area are as follows:

a) Starting semi-width at the end of TODA of 90 m, if the wing span is less than 60 m, then (60 m + ½ wing span) is the semi-width to be used.

b) The area expands from the appropriate semi-width, at the rate of 0.125 x D, to the maximum semi-width where D is the horizontal distance travelled from the end of TODA or TOD if a turn is scheduled before the end of TODA.

c) Maximum Semi-width *(refer to attached figure)*

- The maximum semi-width for an aircraft that can maintain navigational accuracy and is not turning more than 15º: **300 m**.

Learning Objectives reference 032.04.01.11.05: Explain the benefits and implications of using a derated take-off on a contaminated runway.

The derated take-off enables to improve the take-off performance if the TOW is limited by V_{MCG}.

V_{MCG} limitation usually occurs on short and/or contaminated runways. The principle is to impose a lower engine rating to benefit from lower minimum control speeds.

In the case of derated take-off, the minimum control speeds (V_{MCG} and V_{MCA}) are decreased because:

- The derated thrust is lower than the maximum take-off thrust.
- The effect of temperature on maximum available thrust is taken into account.

A Performance Class A turbojet aeroplane is planned to be operated on contaminated runways and on **wet** runways with suitable performance accountability for the increased stopping distance. For planning purposes, the use of:

- **derated take-off thrust is allowed on both types of runways**.

WET ICE

- Ice with water on top of it or ice that is melting

Reverse Thrust is the thrust rejected to the opposite direction to the normal one, to decelerate an aircraft after landing, to reject a take-off or in-flight (like C-17 Globemaster). Also, some aircraft use reverse to move back under their own power.

Reverse thrust is not included as an additional means of deceleration, when determining the accelerate-stop distance **on a dry runway** and may be **included** as an additional means of deceleration using recommended reverse thrust procedures, when determining the accelerate-stop distance **on a wet runway**.

An unserviceable thrust reverser will incur a weight reduction penalty.

NET TAKE-OFF FLIGHT PATH Class A:

- 35ft to 1500ft

EASA AIR OPS

CAT.POL.A.210 Take-off obstacle clearance

(3) Any part of the net take-off flight path in which the aeroplane is banked by more than 15° shall clear all obstacles within the horizontal distances specified in (a), (b)(6) and (b)(7) by a vertical distance of at least 50 ft.

Condition	Maximum Semi-width	
Change of Track Direction	**0° to 15°**	**Over 15°**
Able to Maintain Visual Guidance or same Accuracy	300m.	600 m.
All Other Conditions	600 m	900 m.

ICAO Annex 14

6. Assessing the surface friction characteristics of snow-, slush-, ice- and frost-covered paved surfaces

Measured Coefficient	Estimated Surface Friction	Code
0.40 and above	Good	5
0.39 to 0.36	Medium to good	4
0.35 to 0.30	Medium	3
0.29 to 0.26	Medium to poor	2
0.25 and below	Poor	1

V_{2MIN} means minimum take-off safety speed.

V_2 is defined as the take-off safety speed, the take-off climb speed or the speed at 35 ft.

Generally, for Class B aircraft, it is the highest of:

- *V_{MC}*
- *V_{S1}*
- *1.1 V_{MC} for twin engine.*

And for Class A airctaft it is the highest of:

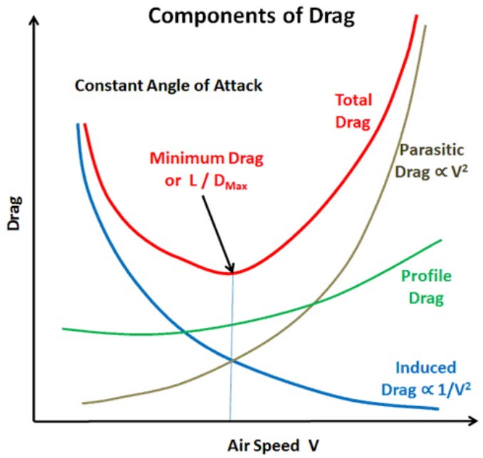
- *1.13 V_{SR}*
- *1.10 V_{MCA}*
- *V_R plus the speed increment before reaching at 35 ft.*

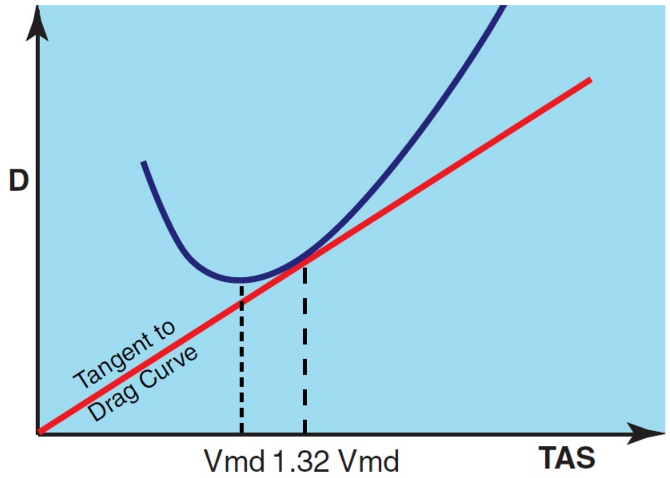
The contaminants listed in a SNOWTAM are:

- 1 — **DAMP**
- 2 — **WET** or water patches
- 3 — **RIME** OR FROST **COVERED** (depth normally less than 1 mm)
- 4 — **DRY SNOW**
- 5 — **WET SNOW**
- 6 — SLUSH
- 7 — **ICE**
- 8 — COMPACTED OR ROLLED SNOW
- 9 — **FROZEN RUTS OR RIDGES**

Climb

1 de maio de 2023 12:12





Cruise

2 de maio de 2023 18:18

Long range cruise is a flight procedure which gives:

- a specific range which is approximately 99% of maximum specific range and a higher cruise speed.

Minimum Fuel Consuption -> Max Range Speed

What does the aircraft manual “corrected” performance factor as entered into the FMS depend on?

- The age of the aircraft.

En-route one-engine-inoperative

2 de maio de 2023 18:48

- Engine failure / Drift down = 2000 ft clearance
- Enroute/level-off altitude = 1000 ft
- Above destination = 1500 ft

In order to descend at the lowest rate possible, after an engine failure, the aircraft must be flown at the speed of minimum drag:

- **For Jet** – Best Angle of Climb (V_X) is the same IAS as V_{MD}.
- **For Prop** – Best Rate of Climb (V_Y) is the same IAS as V_{MD}.

This question is somewhat ambiguous because it does not specify the aircraft type but offers both options. All we can say is that we have received consistent feedback confirming that the current correct option in exams is: best single engine angle of climb speed.

Guys maybe I'm wrong but here is the conclusion after checking AVEX too. There are three questions;
1) Twin engine Jet above OEI = best speed to descent is Vx (best angle speed)
2) Twin engine Prop above OEI = best speed to descent is Vy (best rate speed)
3) Twin engine aircraft (non classified) = "least rate of sink" is Vx

(1) Convert OAT°C into TAT°C *(note that table is based on TAT°C and not OAT°C):*

- *TAT = SAT (1 + 0.2 x M^2), using OAT instead of SAT in °K.*
  TAT = (273 – 45) (1 + 0.2 x (0.74^2))
  TAT = 252.97 K

Now, convert back to °C:
TAT = 252.97 K – 273 K = **-20°C**

(2) Using the provided table, find the Initial Maximum Continuous % N_1:
Enter the table at a pressure altitude of 35 000 ft, continue horizontally to the right until you intersect a temperature of – 20°C. **Read the result of 98.4 % N_1.**

App and Landing

2 de maio de 2023 22:07

For dispatching the aircraft, the maximum allowable landing mass at destination must be determined on the most limiting runway, in still air conditions, and on the runway most likely to be assigned to the aircraft on arrival.

When making these calculations, Class A jet aircraft must be assumed to land and stop within **60%** of the Landing Distance Available (LDA). This is in addition to any factors for wet runways. This percentage factor can also be expressed as multiplication and division factor:

- *Actual Landing Distance <= 60% of LDA* or,
- *Actual Landing Distance x 1.67 <= LDA* or,
- *Actual Landing Distance <= LDA / 1.67*

*NOTE: The corresponding regulatory factor for a **turboprop** is **70%**.*

SUMMARY:

Class A - take off dry => 35 ft

Class A – take off wet => 15 ft

Class B – take off dry/wet => 50 ft

Class A – landing dry/wet => 50 ft

Class B – landing dry/wet => 50 ft

Flooded runway -> Positive Landing (Firm touch to break the water layer)

The speed across the threshold is described as V_{REF}, but also in some manufacturer's graph as the *"barrier speed"*.

More specifically, V_{REF} the speed of the aeroplane, in a specified landing configuration, at the point where it descends through the landing screen height in the determination of the landing distance for manual landings.

V_{SR0} means the reference stall speed in the landing configuration.

The touchdown speed ultimately results from the threshold speed. This is based on a function of the stall speed of the aircraft, **1.23 V_{SR0} for Class A** or **23% above V_{SR0}** and not less than the minimum control speed in the landing configuration, V_{MCL}.

According to CS 25.125 - Landing: *"VREF may not be less than1.23 V_{SR0}"*.

The Quick Turnaround Limit Weight (QTLW) is the maximum landing weight for which:

- there is no minimum ground time required, with respect to possible fuse plug melting, before executing a subsequent takeoff.

Landing above Max Quick Turnaround Mass -> pilot must wait for a specified time before the next take-off

The maximum mass for landing could be limited by...

- the climb requirements with one engine inoperative in the approach configuration.

Class A - Landing Climb Requirements

LANDING CLIMB (All engines operating CS-25.119)

A gradient of not less than 3.2% with:

- All engines operating at the power available 8 seconds after initiation of movement of the thrust control fron the minimum flight idle to the take-off position
- Landing configuration
- Aerodrome altitude
- Ambient temperature expected at the time of landing
- A climb speed of VREF
- VREF:
  i. not less than V_{MCL}
  ii. not less than 1.23VSR0
  iii. provides the maneuvering capability specified in CS-25.143 (h)

DISCONTINUED APPROACH CLIMB (One engine inoperative CS-25.121 (d))

A climb gradient not less than:

- 2.1% for 2 engine aircraft
- 2.4% for 3 engine aircraft
- 2.7% for 4 engine aircraft

With:

- The critical engine inoperative and the remaining engines at go-around thrust
- Landing gear retracted
- Flaps in the approach configuration, provided that the approach flap V_{SR} does not exceed 110% of landing flap V_{SR}
- Aerodrome altitude
- Ambient temperature
- Speed: Normal approach speed but not greater than $1.4V_{SR}$.

Maximum landing weight

EASA CS 25.119 - Landing climb: all-engines operating
In the landing configuration, the steady gradient of climb may not be less than 3.2%, with the engines at the power or thrust that is available 8 seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the go-around power or thrust setting. [...]

EASA CS 25.121 - Climb: one-engine inoperative [...]
(d) Approach:
In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110% of the V_{SR} for the related all-engines-operating landing configuration:
(1) **The steady gradient of climb may not be less than 2.1% for two-engined aeroplanes, 2.4% for three-engined aeroplanes and 2.7% for four-engined aeroplanes, with:**
(i) The critical engine inoperative, the remaining engines at the go-around power or thrust setting;
(ii) The maximum landing weight;
(iii) A climb speed established in connection with normal landing procedures, but not more than 1.4 V_{SR}; and
(iv) Landing gear retracted.

- Approach Climb Requirement: Flaps APPROACH, Gear UP and OEI.
- Landing Climb Requirement: Flaps LANDING, Gear DOWN and AEO.

Hydroplaning is caused by a thin layer of standing water that separates the tires from the runway. It causes substantial reduction in friction between the airplane tires and the runway surface and results in poor or nil braking action at high speeds. High aircraft speed, standing water, slush, and a smooth runway texture are factors conductive to hydroplaning.

HYDROPLANING SPEED CALCULATIONS:

- *Rotating Tyres formula (applies to rejected take-offs):* ***V = 9 √ P***
- *NON-Rotating Tyres formula (applies to touchdown):* ***V = 7.7 √ P***
  Where V stands for velocity (kt) and P is tyre pressure (PSI)

In this case, the aircraft is landing: V = 7.7 √ 200 = approx. **109 kt**

=> Any flap setting results in a speed above the hydroplaning threshold. Therefore, it does not matter which flap setting you select, you will most likely face the risk of hydroplaning anyway.

Dynamic hydroplaning (Rotating wheel - aborted take-off)occurs when there is standing water or slush on the runway deeper than the tread depth of the tyres. A wedge of water builds up, lifting the tires away from the runway surface. The speed of the airplane, the depth of the water, and the air pressure in the tires are some of the factors that affect dynamic hydroplaning.

- **9 x √ tyre pressure (psi)**

Viscous hydroplaning (Stopped wheel - initial spin-up on touchdown) can occur when oil or accumulated rubber combines with water on a runway, it forms an impenetrable layer of liquid your tires can't break through. This is especially problematic on smooth runways, and it can occur on just a thin film of water. Viscous hydroplaning typically occurs in the touchdown zone of the runway, where you get a build-up of black rubber deposit

- 7.7 x √ tyre pressure (psi)

Learning Objective 032.04.06.02.04: Define and explain the following speeds in accordance with CS-25 or CS-Definitions: reference stall speed in the landing configuration (VSR0); reference landing speed (VREF); - minimum control speed, approach and landing (VMCL).
V_{SR} is the reference stall speed of an aircraft. It is a figure provided by the manufacturer that can be used to work out speeds such as V_{REF}, V_R, V_2, etc. **It cannot be less than the V_{S1G} speed.** It can be split into V_{SR1} and V_{SR0}. V_{SR1} is the reference stall speed in a particular configuration (so can have many different values, depending on configuration), whereas **V_{SR0} is the reference stall speed in the landing configuration.**

V_{S1G} is the speed at which the aircraft reaches the C_{LMAX} with the lift equal to the aircraft weight (load factor of 1).

Even though the reference stall speed is not formally defined by a particular condition, we can see from the information above that **V_{SR0} is a speed at or above the speed an aircraft reaches C_{LMAX} in the landing configuration with a load factor equal to 1** (or greater than 1 even, but that would be an unusual case).

The other options are cleverly written to draw you in, but are either not real speeds, or talking about speeds such as V_{MCL} or V_S.

CS 25
AMC 25.125(c)
Landing

1 During measured landings, if the brakes can be consistently applied in a manner permitting the nose gear to touch down safely, the brakes may be applied with only the main wheels firmly on the ground. Otherwise, the brakes should not be applied until all wheels are firmly on the ground.

2 This is not intended to prevent operation in the normal way of automatic braking systems which, for instance, permit brakes to be selected on before touchdown.

AUTOBRAKE -> ONLY IF ANTI-SKID IS AVAILABLE

In the landing roll, when can the pilot apply the brakes?

- 3) When both main gears are on the ground and provided that the nose gear can be lowered in a controlled manner permitting it to touch down safely.
- 4) When all wheels are on the ground.

Take-off

27 de março de 2023 10:54

The Climb limited Take-off Mass is independent of wind, which means that whether the aircraft is climbing in a headwind or tailwind situation, the air gradient achieved will be the same. It is an air gradient requirement under the certification specifications.
Furthermore, you can also see that there is no "Wind" section on the graph provided.

Note: However, the climb angle relative to the ground will be affected by wind.

Climb gradient (rate of climb)-> Air distance
Climb angle-> Ground distance

CAP 698 – MRJT1 Obstacle Clearance
"Obstacle height must be calculated from the lowest point of the runway to conservatively account for runway slope"

Obstacle Height = Obstacle Elevation - [Aerodrome PA - (TODR x Runway Slope)]

Obstacle Height = 3785 - [3420 – ((2760 x 3.28) x (1.3/100))] = **482.8 ft**

Note: BRP = brake release point.

Take the Most conservative!
Higher tailwind
Lesser Headwind

The Obstacle Limited Take-Off Mass (OLTOM) is one of the performance limited take-off masses that dictates or allowed take-off mass for a particular scenario.

It is based on the ability of an aircraft to clear all the obstacles on the net take-off flight path by the required obstacle clearance margin after having an engine failure at V_{EF}, the worst possible point during the take-off roll. It is therefore based on single engine climb performance.

Therefore, **the OLTOM will be increased** when climb performance is good, due to high air density (low density altitude), caused by low temperatures and **high atmospheric pressure.** This is mostly due to **higher thrust output** in denser air.

The OLTOM is also improved by the presence of a headwind, which will increase the actual climb angle for the same rate of climb, due to the lower groundspeed, although only 50% of the headwind can be accounted for during planning.

High temperatures would decrease the OLTOM due to reduced thrust, and contaminated runways would affect the FLLTOM (Field Length Limited Take-Off Mass), not the OLTOM.

Drift-wodn and stabilising altitude

5 de maio de 2023 12:09

The actual gross mass is corrected for ISA deviation, whenever ISA +10°C, to account for thurst loss due to temperature. The "equivalent gross mass" is extracted from the upper-right corner section of the table. The obtained result is then used to enter the chart.

For example, if the actual mass equal 60 000 kg and actual temperature is ISA +20°C, then we will enter the chart with an "equivalent gross mass" of 65 000 kg, based on the top-right small table.