III) CLASS B: SINGLE ENGINE

Propeller driven aeroplanes with a maximum approved passenger seating configuration of 9 or less, and a maximum take-off mass of 5700 kg. or less.

General Requirements

If a Class B single engine aeroplane is operating for commercial air transport purposes

- this aeroplane shall not be operated at night.
- the aeroplane must not be operated in Instrument Meteorological Conditions (IMC) except under special visual flight rules (SVFR).
- it must not be operated unless suitable surfaces are available en-route which permit a safe forced landing to be made should the engine failure occur at any point on the route.
- The aeroplane must not be operated above a cloud layer that extends below the relevant minimum safe altitude.

A) Take Off

TAKE-OFF DISTANCE

The gross take-off distance for Class B aeroplanes is the distance from the start of take-off to a screen height of 50 ft above the take-off surface, with take-off power set, rotating at V_R and achieving the specified speed at the screen.

a. The rotation speed V_R, must not be less than V_{S1}
b. The take-off safety speed (screen height speed) must be not less than the greater of:

- a speed that is safe under all reasonably expected conditions

or

- 1.2 V_{S1}

TAKE-OFF REQUIREMENTS/ FIELD LENGTH REQUIREMENTS

The mass of the aeroplane must be such that the take-off can be completed within the field length available. This requirement is called the “Field Length Requirement”.

The Field Length Requirements:

- When **no** stopway or clearway is available, the take-off distance when multiplied by 1.25 must not exceed TORA

→ **Gross TOD x 1.25 ≤ TORA**

- When a stopway and/or clearway is available the take-off distance must:

• not exceed TORA

→ **Gross TOD ≤ TORA**

• when multiplied by 1.3, not exceed ASDA

→ **Gross TOD x 1.3 ≤ ASDA**

• when multiplied by 1.15, not exceed TODA

→ **Gross TOD x 1.15 ≤ TODA**

FACTORS TO BE ACCOUNTED ACCORDING TO CS-23

The gross take-off distance required shall take account of:

- the mass of the aeroplane at the start of the take-off run
- the pressure altitude at the aerodrome
- the ambient temperature at the aerodrome
- the runway surface conditions and the type of runway surface
- the runway slope (Increase 5% the TOD for each 1% upslope)
- not more than 50% of the reported headwind component or not less than 150% of the reported tailwind component

SURFACE CONDITION FACTORS

Surface Type	Condition	Factor
Grass (firm soil) up to 20 cm	Dry	x 1,2
	Wet	x 1,3
Paved	Wet	x 1,0

PRESENTATION OF DATA

In the chart data for the take-off distance calculation, the wind factors are already factorised (50% for HW and 150% for TW)

Example:

What is the TOD at 3400 lbs, if take off is made from a wet grass runway, at a given airfield 4000ft above mean sea level, with 15°C OAT and 10 kt headwind?

B) Climb

CLIMB PERFORMANCE

There is no requirement for a single engine class B aeroplane to demonstrate that it can clear an obstacle within the take-off flight path, since the pilot of a Class B single engine aeroplane must, always, have visual contact with the ground. Consequently, the pilot will always be able to identify the obstacle within the take-off path and, therefore, avoid it.

Even though there is no operational requirement for a minimum climb performance, it would not be safe to operate the aeroplane in such a manner that its performance is so poor it is barely able to climb. Therefore, it is important as a pilot operating this class and type of aeroplane to know what climb performance would be achieved so that the aeroplane will at least be able to climb sufficiently.

PRESENTATION OF DATA

Example

Given:

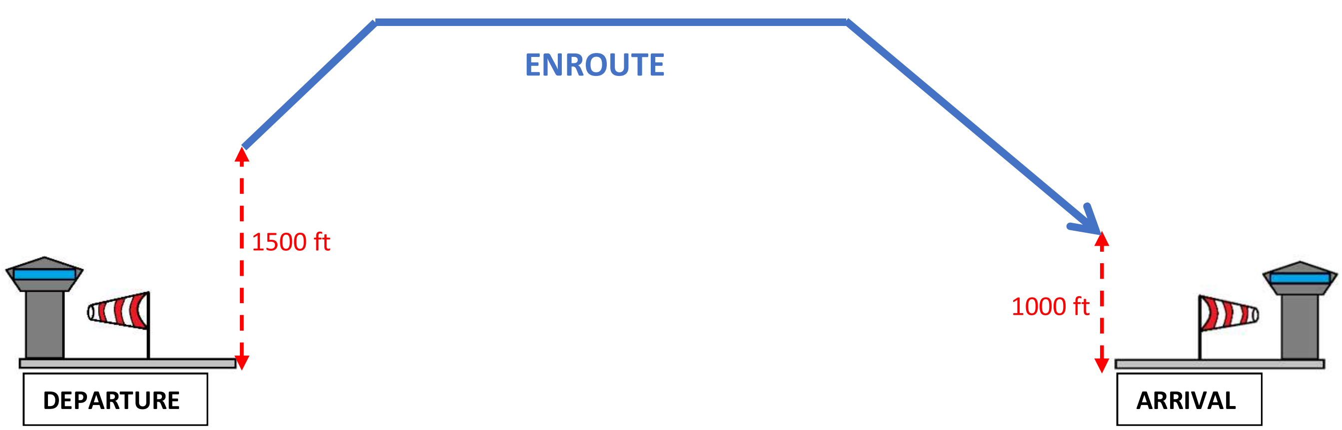
O.A.T at Take-off: ISA
Airport pressure altitude: 3,000 ft
Aeroplane mass: 3,450 lbs
Speed: 100 KIAS

a. 1,310 ft/min and 11.3%
b. 1,130 ft/min and 10.6%
c. 1,030 ft/min and 8.4%
d. 1,140 ft/min and 11.1%

C) En-route & Descent

EN-ROUTE SECTION

The en-route part of the flight is considered to be from 1500 ft above the airfield from which the aeroplane has taken off to 1000 ft above the destination airfield.



EN-ROUTE AND DESCENT REQUIREMENTS

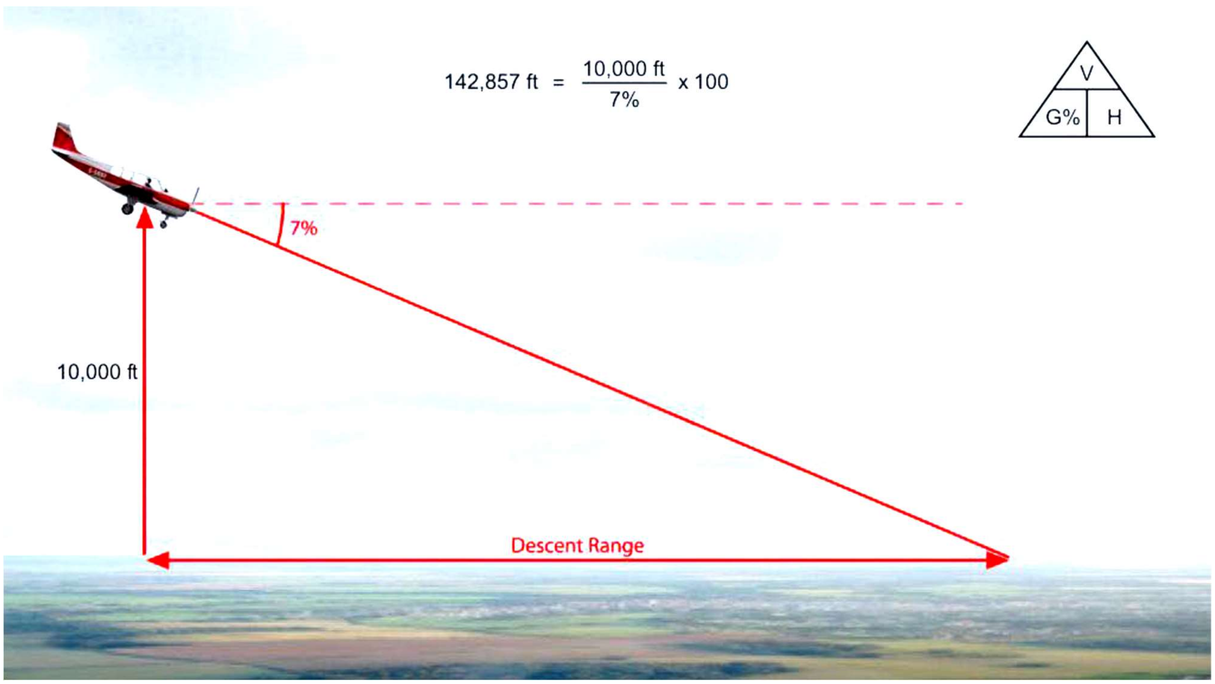
An operator must ensure that the aeroplane, in the meteorological conditions expected for the flight, and in the event of engine failure, is capable of reaching a place at which a safe forced landing can be made." To be able to comply with the rule, operator must know:

1) for any given route, an operator must know the safe forced landing areas
2) whether his aeroplane will be able to reach these areas if the engine were to fail while en-route, depending on the
   - the altitude chosen for the flight
   - the descent gradient of the aeroplane following engine failure.

Example.

Let us assume a cruise altitude of 10,000 feet and a gradient of descent of 7% following an engine failure. What is the descent range?

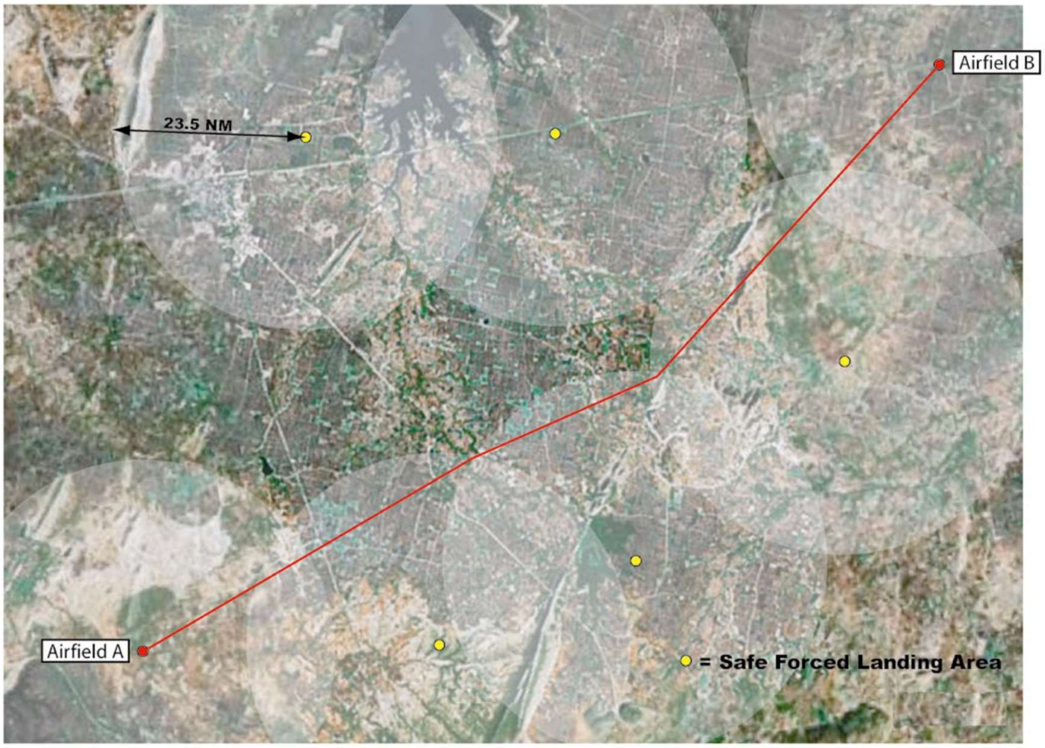
- ➔ Gradient = (Height/Distance) x 100
- ➔ Distance = Height/(Gradient/100)
- ➔ Distance = 10000 / 0,07
- ➔ Distance = 142857 ft ≈ 23,5 nm
- ➔ Following an engine failure, in this case the aircraft will be able to glide 23,5 nm



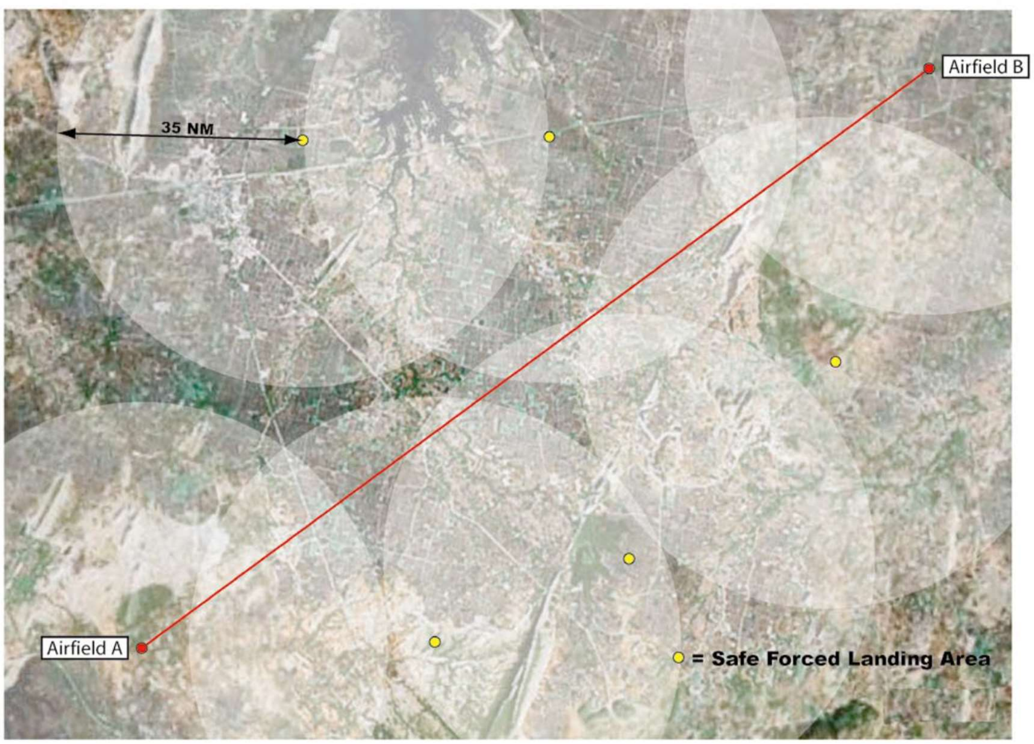
This means that the aeroplane must not pass further away than 23.5 nm from any safe forced landing locations.

1) So then draw a circle of 23.5 nm radius, around each of the safe forced landing locations
2) Then draw a track line from Airfield A to Airfield B that is within each circle.

If the flight track falls outside of the circles then, following engine failure the aeroplane will not make it to a safe forced landing area.



If the aeroplane operates at a higher altitude, then it would be able to cover a greater distance in the glide following an engine failure.
For example, operating at 15,000 ft instead of 10,000ft would increase the aeroplanes still air glide range to 35 nautical miles. Therefore, the circles around each forced landing location will grow.



Notice that now that the aeroplane can fly along a straight track to airfield B, because during the entire flight, the aeroplane could glide to a suitable forced landing location.
Consequently, small piston engine aeroplanes should be flown at their maximum altitudes so that direct routes can be achieved.

However, when complying with the safe forced landing rule, the regulation states that

1) the aeroplane must not be assumed to be flying, with the engine operating at maximum continuous power at an altitude exceeding that at which the aeroplane's rate of climb equals 300 feet per minute.

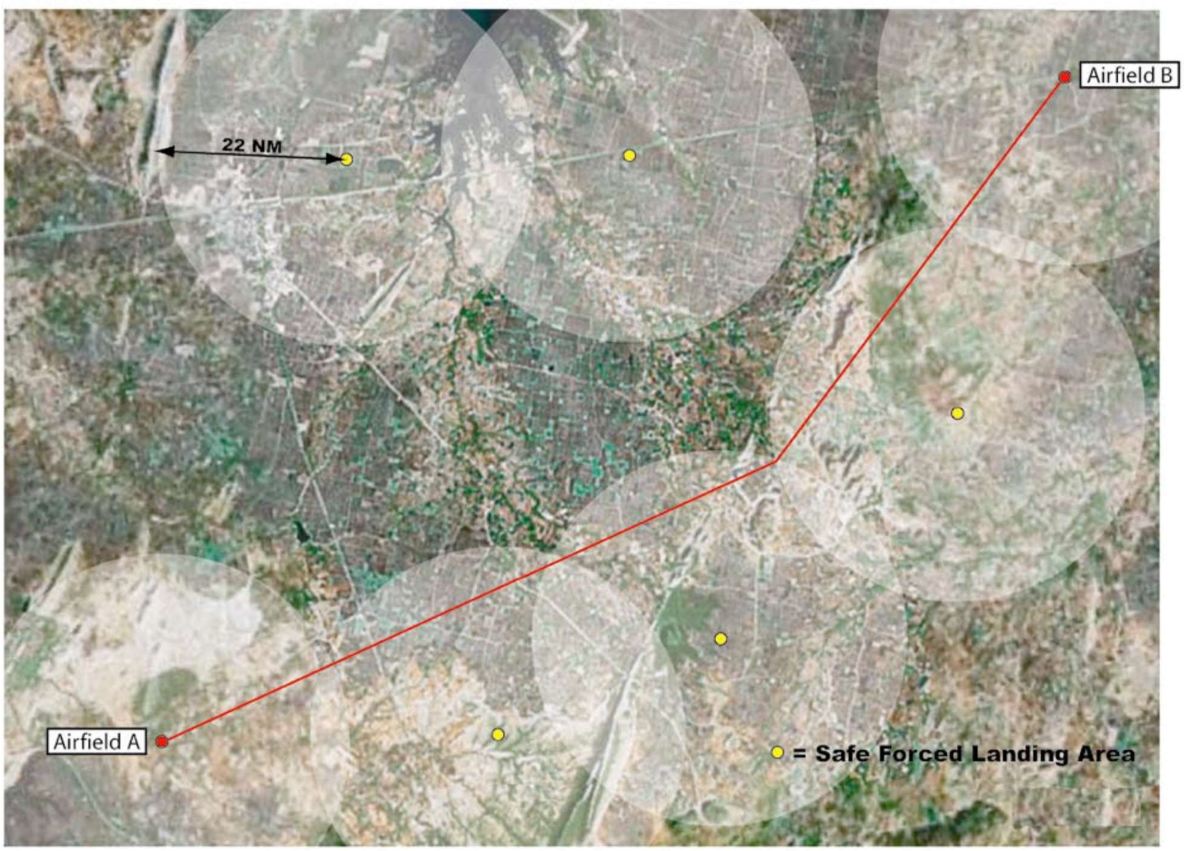
An aeroplane may operate at higher altitude than this regulation prescribes but the operator may not use the higher altitude in his calculation of glide range to a safe landing area.

2) the gross gradient of descent shall be increased by a gradient of 0.5%.

So, in the previous example, 7% become 7,5%

- ➔ Distance = 10000 / 0,075
- ➔ Distance = 133333 ft ≈ 22 nm
- ➔ Following an engine failure, in this case the aircraft will be able to glide 22 nm

This means that the circles around each safe landing area must reduce to a radius of 22 nm. Thus, the planned track will have to change slightly so that at all points along the route the aeroplane is no further than 22 nm from a safe forced landing area.



PRESENTATION OF DATA

Refer to ENDURANCE DATA CHART and RANGE DATA CHART for SEP

D) Landing

LANDING REQUIREMENT

A single engined class B aeroplane must ensure that the landing mass of the aeroplane, for the estimated time of arrival, allows a full stop landing from 50 ft above the threshold within **70% of the landing distance available.** *(By way of derogation 80 % of the LDA)*

$$LD \leq 0.7\,LDA \qquad or \qquad 1{,}43\,LD \leq LDA$$

FACTORS TO BE ACCOUNTED ACCORDING TO CS-23

- the pressure altitude at the aerodrome
- standard temperature
- the runway surface conditions and the type of runway surface
- the runway slope
- not more than 50% of the reported headwind component or not less than 150% of the reported tailwind component

CORRECTION FACTORS

Runway conditions	Correcting factors
Grass up to 20 cm high	x 1,15
Wet	x 1,15
Slope	Increase LD by 5% per each 1% downslope

REFERENCE LANDING SPEED (V_{REF})

The speed at the landing screen height (V_{REF}) for a Class B single engine aeroplane must be no less than 1.3 times the stall speed in the landing configuration (V_{SO}).

$$V_{REF} \geq 1.3\ V_{SO}$$

PRESENTATION OF DATA

Example

Given:

O.A.T: 27 °C

Aeroplane Mass: 2,900 lbs

Tailwind component: 5 kt

Flaps: Landing position (down)

Runway: grass and Dry

Pressure Altitude: 3,000 ft

a. approximately: 1,120 feet

b. approximately: 1580 feet

c. approximately: 1,370 feet

d. approximately : 1,850 feet

DESPTACH RULES

The despatch rules, state that for despatching an aeroplane, it must be assumed that:

- The aeroplane will land on the most favourable runway at the destination airfield in still air,

and,

- The aeroplane will land on the runway most likely to be assigned considering the probable wind speed and direction.

If this second assumption cannot be met, the aeroplane may be despatched only if an alternate aerodrome is designated which full compliance of the regulatory despatch requirements can be met.

IV) CLASS B: MULTI ENGINE

A) Take Off

TAKE-OFF REQUIREMENTS

The take-off requirements for multi-engined Class B aircraft are the same as for single engined aircraft except that multi engine class B aeroplanes must additionally demonstrate a minimum climb gradient performance and an obstacle clearance capability.

GRADIENT REQUIREMENTS

- **ALL ENGINE OPERATING**

A minimum climb gradient of 4% is required with:

- Take-off power on each engine
- Landing gear extended, except that if the landing gear can be retracted in not more than 7 seconds, it may be assumed to be retracted
- The wing flaps in the take-off position
- Climb speed of not less than the greater of 1.1V_{MC} and 1.2V_{SI}

- **ONE ENGINE INOPERATIVE**

1) The climb gradient at an altitude of 400ft above the take-off surface must be measurably positive with:
- The critical engine inoperative and its propeller in the minimum drag position.
- The remaining engine at take-off power
- The landing gear retracted
- The wing flaps in the take-off position
- A climb speed equal to that achieved at 50 ft and

2) The climb gradient must not be less than 0.75% at an altitude of 1500 ft above the take-off surface, with:
- The critical engine inoperative and its propeller in the minimum drag position
- The remaining engine at not more than maximum continuous power
- The landing gear retracted
- The wing flaps retracted
- A climb speed not less than 1.2 V_{SI}

TAKE-OFF REQUIREMENTS/ FIELD LENGTH REQUIREMENTS

Same as single engined aeroplane

The Field Length Requirements:

- When **no** stopway or clearway is available, the take-off distance when multiplied by 1.25 must not exceed TORA

→ **Gross TOD x 1.25 ≤ TORA**

- When a stopway and/or clearway is available the take-off distance must:

• not exceed TORA

→ **Gross TOD ≤ TORA**

• when multiplied by 1.3, not exceed ASDA

→ **Gross TOD x 1.3 ≤ ASDA**

• when multiplied by 1.15, not exceed TODA

→ **Gross TOD x 1.15 ≤ TODA**

FACTORS TO BE ACCOUNTED ACCORDING TO CS-23

The gross take-off distance required shall take account of:

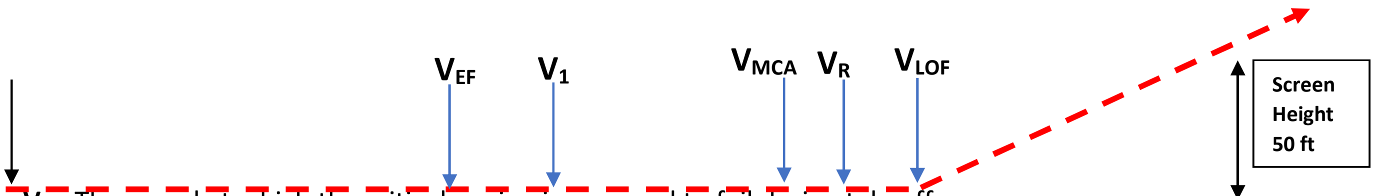
- the mass of the aeroplane at the start of the take-off run
- the pressure altitude at the aerodrome
- the ambient temperature at the aerodrome
- the runway surface conditions and the type of runway surface
- the runway slope (Increase 5% the TOD for each 1% upslope)
- not more than 50% of the reported headwind component or not less than 150% of the reported tailwind component

SURFACE CONDITION FACTORS

Surface Type	Condition	Factor
Grass (firm soil) up to 20 cm	Dry	x 1,2
	Wet	x 1,3
Paved	Wet	x 1,0

TAKE OFF SPEEDS

Brake Release Point



V_{EF}: The speed at which the critical engine is assumed to fail during takeoff

V_1: The takeoff decision speed or the critical engine failure recognition speed. It is the speed above which the takeoff will continue even if an engine fails or another problem occurs.

V_{MCA}: Minimum control speed air. The minimum speed that the aircraft is still controllable with the critical engine inoperative while the aircraft is airborne. V_{MCA} is sometimes simply referred to as V_{MC}

V_R: Rotation speed. The speed at which the pilot begins to apply control inputs to cause the aircraft nose to pitch up, after which it will leave the ground

V_{LOF}: Lift-off speed

TAKE OFF SPEEDS REQUIREMENTS

The gross take-off distance required is the distance from the start of take-off to a point 50 ft. above the take-off surface, with take-off power on each engine, rotating at V_R and achieving the specified speed at the screen.

V_R The rotation speed, must not be less than:

- 1.05 V_{MC}
- 1.1 V_{S1}

The speed at 50 ft. must not be less than (the take-off safety speed):

- a speed that is safe under all reasonably expected conditions
- 1.1 V_{MC}
- 1.2 V_{S1}

V_{MC} for take-off must not exceed 1.2 V_{S1}

ACCELERATE-STOP DISTANCE REQUIREMENTS

The accelerate-stop distance is the sum of:

- Accelerate the aircraft to V_{EF} with all engines operating.
- Accelerate from V_{EF} to V_1 assuming the critical engine fails at V_{EF}
- Come to a full stop from the point at which V_1 is reached.

OBSTACLE CLEARANCE REQUIREMENTS

Multi-engined Class B aircraft must demonstrate clearance of obstacles after take-off up to a height of 1500ft.
Obstacles must be cleared by:

- a vertical margin of at least 50ft , or

- a horizontal distance of at least 90m + 0.125 D where D is the distance from the end of the TODA, or the end of the TOD if a turn is scheduled before the end of the TODA. For aeroplanes with a wingspan of less that 60m the horizontal distance may be taken as 60m + half the wingspan + 0.125D

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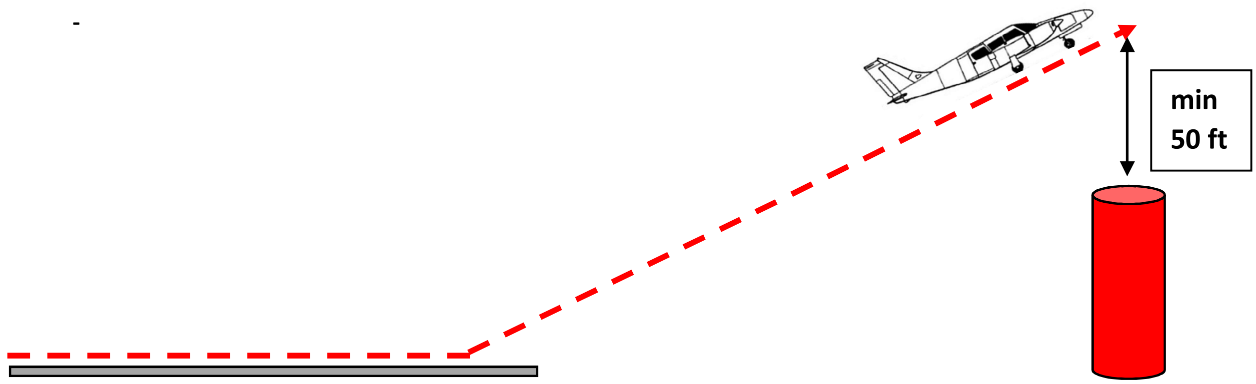
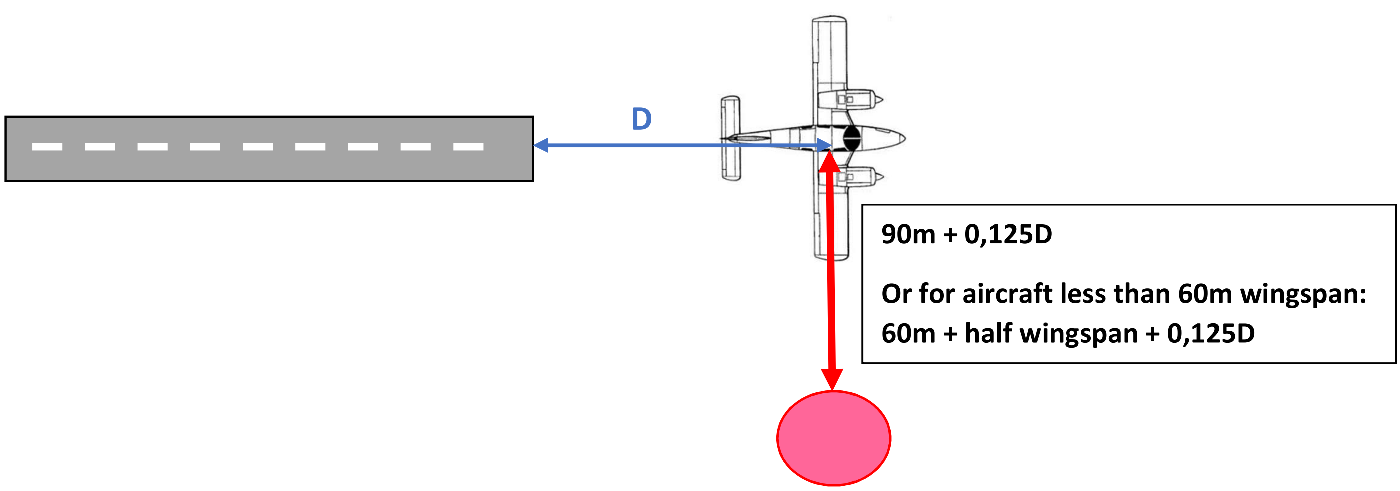
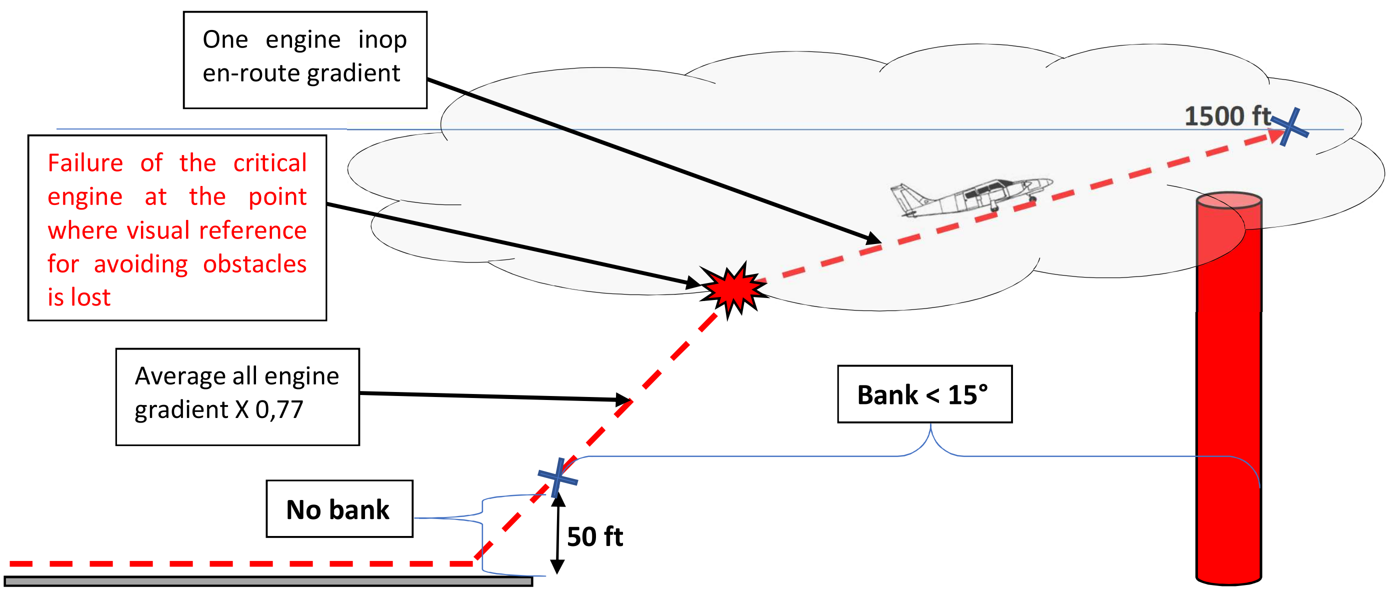


OR

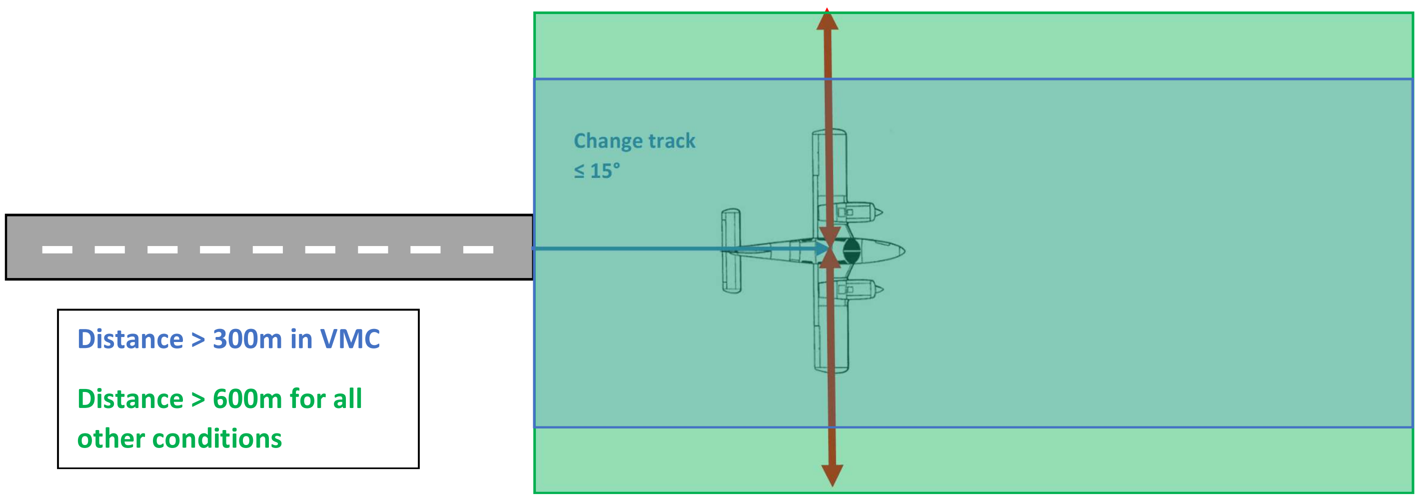


The following conditions must be assumed:

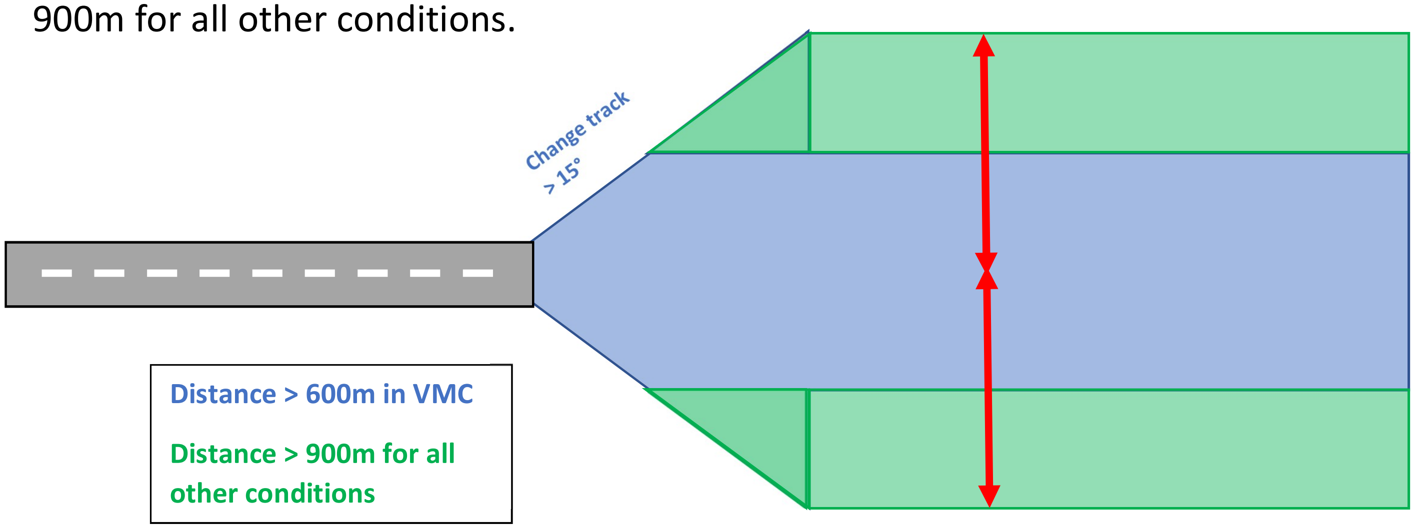
- The flight path begins at a height of 50 ft above the surface at the end of the TOD required and ends at a height of 1500 ft above the surface.
- The aeroplane is not banked before it has reached the height of 50ft, and thereafter that the angle of bank does not exceed 15°.
- Failure of the critical 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.
- The gradient to be assumed from 50 ft to the point of engine failure is equal to the average all engine gradient during climb and transition to the en-route configuration, multiplied by a factor of 0.77
- The gradient from the point of engine failure to 1500 ft. is equal to the one engine inoperative en-route gradient.



If the flight path does not require track changes of more than 15°, obstacles do not need to be considered if the lateral distance is greater than 300m if in VMC or 600m for all other conditions.



If the flight path requires track changes of more than 15°, obstacles need not be considered if the lateral distance is greater than 600m in VMC or 900m for all other conditions.



TAKE-OFF FLIGHT PATH

The flight path profile performance should take account of:

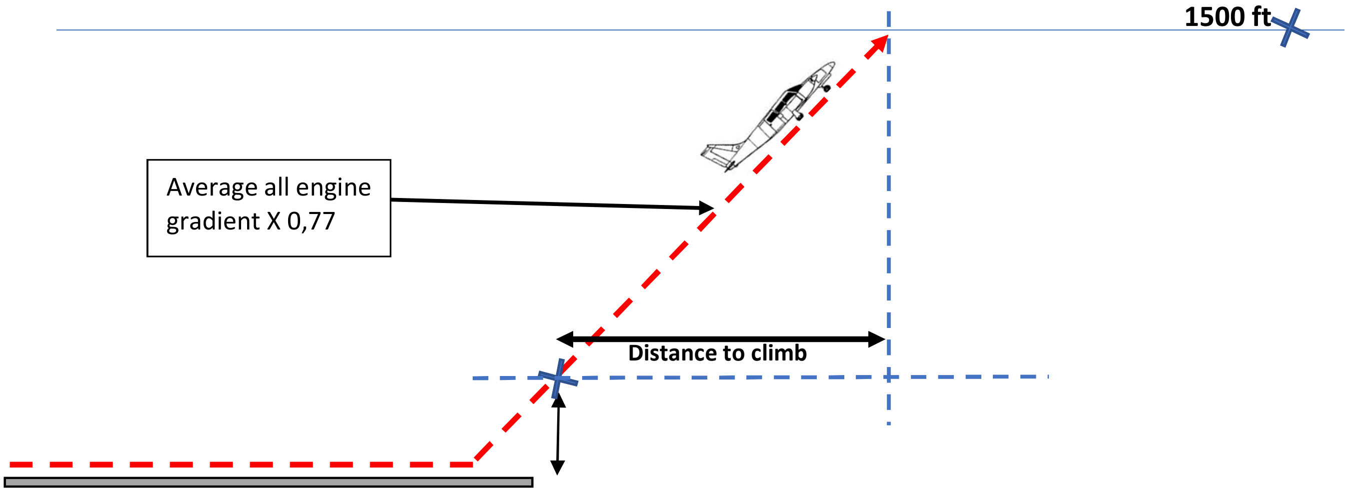
- The mass of the aeroplane at the commencement of the take-off run
- The pressure altitude at the aerodrome
- The ambient temperature
- Not more than 50% of the reported headwind component and not less than 150% of the reported tailwind component.

CONSTRUCTION OF THE FLIGHT PATH

The flight path profile is to find the distance covered to reach 1500 ft above the airfield from 50 ft. It will depend on whether or not visual reference is lost before reaching 1500 ft.

1) VISIBILITY CLEAR TO 1500 ft

- Determine the TOD required for the take-off mass
- Determine the all engines net gradient (gross gradient x 0.77) to 1500 ft from 50 ft



2) CLOUD BASE BELOW 1500 ft

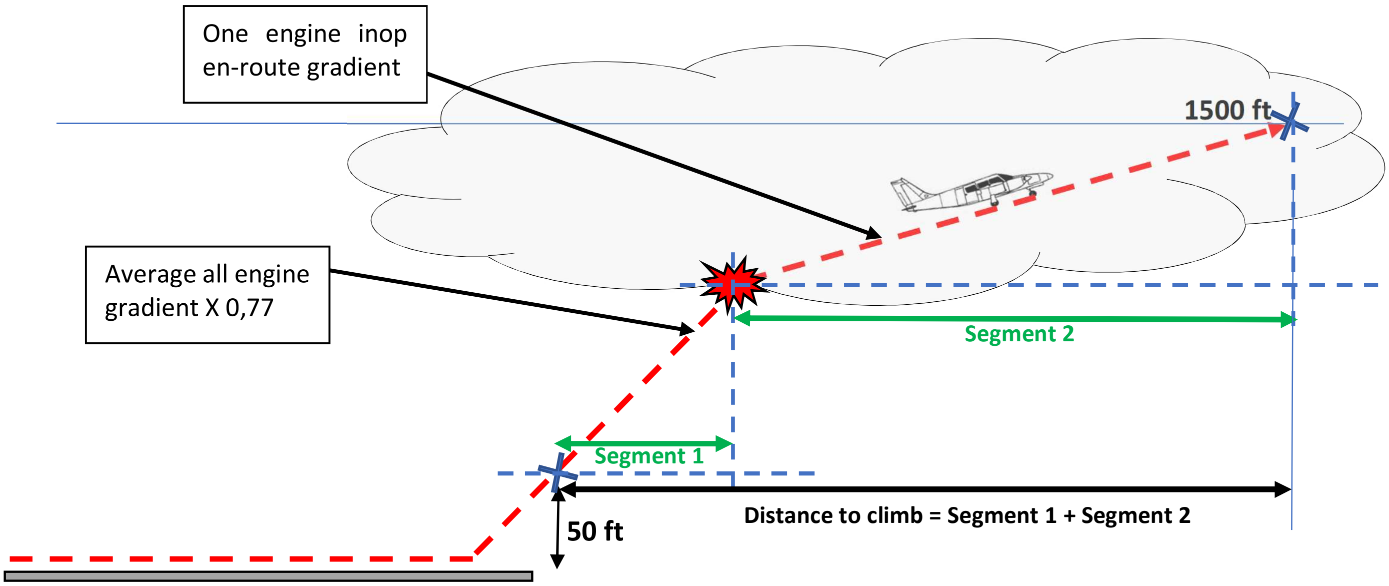
If visual reference is lost before 1500 ft, the flight path will consist of two segments.

- **Segment 1** (From 50 ft to cloud base)

• Determine the TOD required for the take-off mass
• Determine the all engines net gradient (gross gradient x 0.77) from 50 to cloud base

- **Segment 2** (From cloud base to 1500 ft)

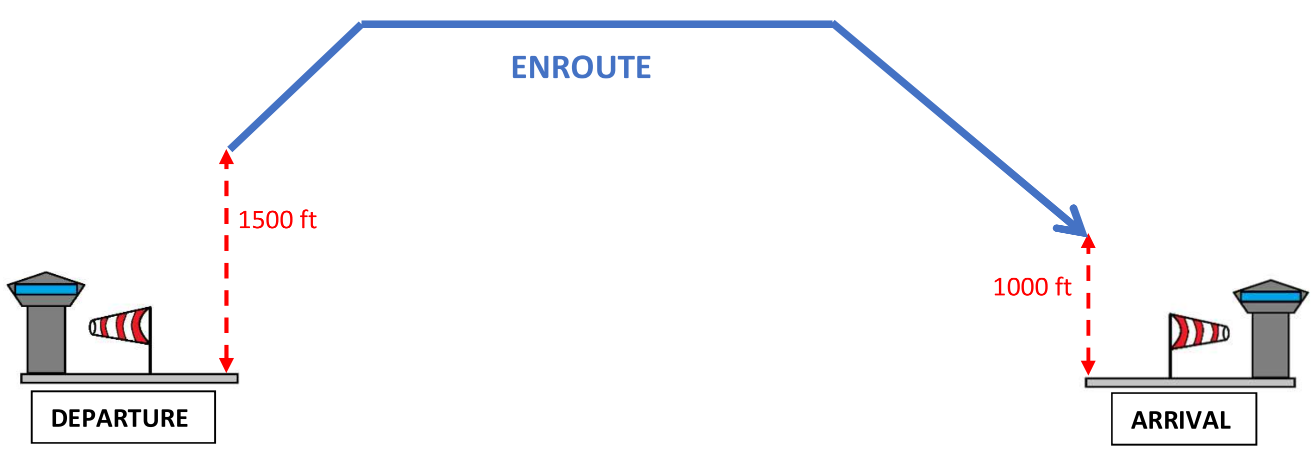
• Determine the One engine inop en-route gradient from cloud base to 1500 ft



B) En-route & Descent

EN-ROUTE REQUIREMENTS

The en-route part of the flight is considered to be from 1500 ft above the airfield from which the aeroplane has taken off to 1000 ft above the destination airfield.

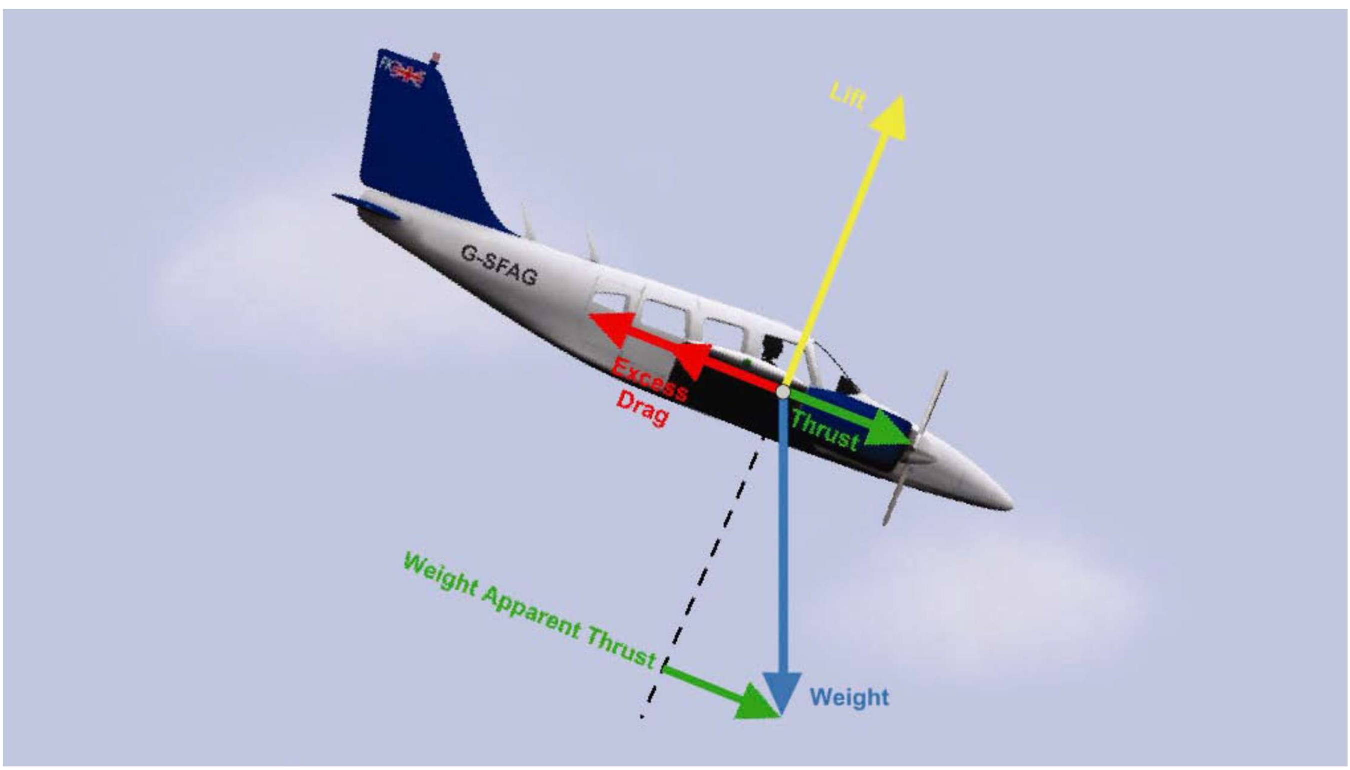


Compared to the single engine aeroplane, the multi engine aeroplane must be capable of a higher performance level and therefore, in the event of an engine failure, continue flight and land at a suitable airfield.

THE DRIFT DOWN

In straight and level flight the forward force of thrust balances the rearward force of drag. When the engine fails, there is more rearward force than forward force, and, as a result of the excess drag the aeroplane will slow down if level flight is maintained. To maintain the speed, which should be kept at V_{MD}, the thrust force generated by the remaining live engine must be augmented so that the forces can once again be balanced.

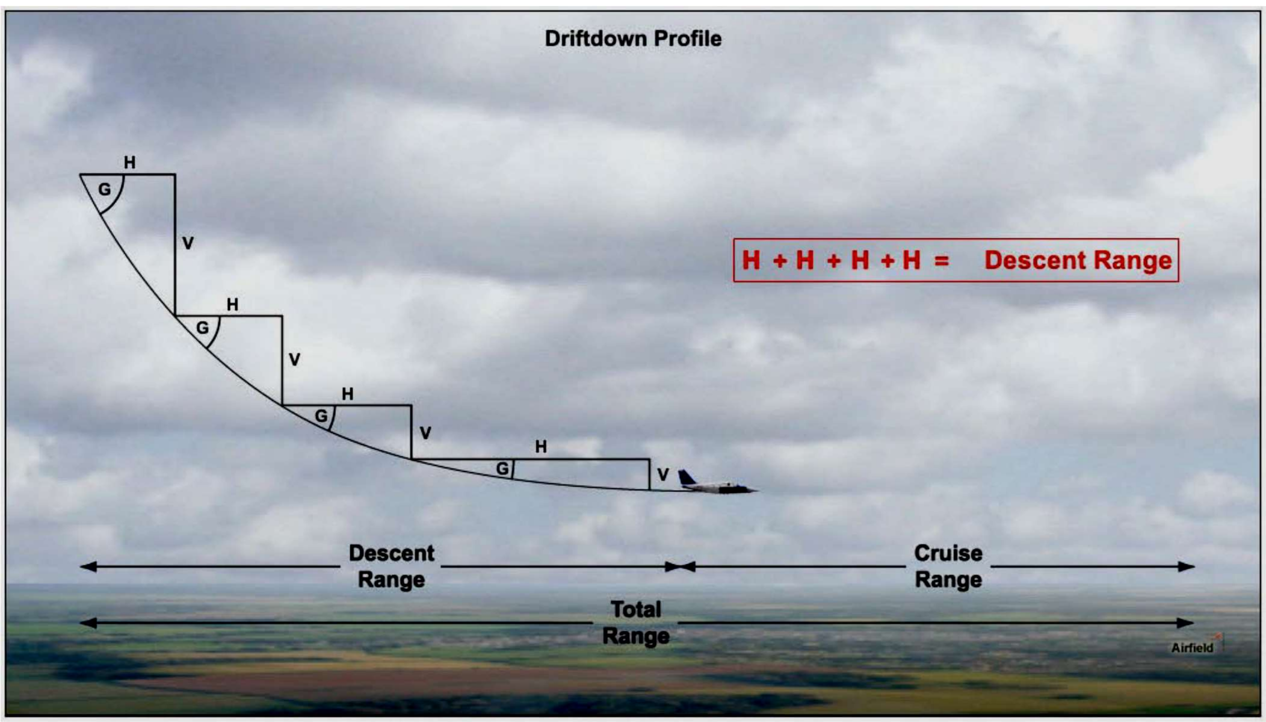
The only way to do this is to lower the nose so that weight can act forward and provide enough weight apparent thrust to balance the excess drag. If the nose is lowered by a sufficient amount, then the forces will once again balance and V_{MD} can be maintained.



The only side effect is that the aeroplane is descending. However, as the aeroplane descends in the atmosphere, the air density increases. This means that the thrust being produced by the remaining engine increases which reduces the excess drag. Now that there is no need for so much weight apparent thrust since the excess drag has reduced. To reduce the amount of weight apparent thrust, the nose is raised a little.

This process can continue until the remaining engine generates sufficient thrust to balance the drag without any need for weight apparent thrust. At the altitude where this balance occurs the aeroplane is able to level off.

In summary then, after engine failure in the cruise, the aeroplane is forced to descend, but as it descends the aeroplane can slowly reduce the descent angle until the aeroplane can once more fly level. This procedure is known as the Driftdown procedure and it produces a Driftdown flight profile



CONSTRUCTION OF THE DRIFT DOWN PROFILE

Since the descent gradient or descent angle is constantly changing, the only possible way of calculating the descent range is to break down the profile into manageable segments and carry out several calculations.

Each of these calculations will need the net descent gradient at that attitude and the vertical interval of that segment. This will give the horizontal distance covered for that segment. To find the descent range, simply add all the horizontal distances in all the segments.

C) Landing

LANDING REQUIREMENTS

There are two main regulation requirements.

1) The landing distance must not exceed the landing distance available
2) If the aeroplane be unable to land, it must be able to climb away from the aerodrome with an adequate climb gradient. This requirement is called the **landing climb requirement**.

LANDING CLIMB REQUIREMENTS / GRADIENT REQUIREMENT

ALL ENGINES OPERATING / BALKED LANDING REQUIREMENT

With all engines operating, the steady gradient of climb must be at least 2.5%. This gradient must be achieved with:

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

ONE ENGINE INOPERATIVE / MISSED APPROACH REQUIREMENTS

With the critical engine inoperative, the gradient of climb must not be less than 0.75% at an altitude of 1500 ft above the landing surface. This gradient must be achieved with:

- The critical engine inoperative and the propeller feathered
- The live engine set at maximum continuous power
- The landing gear (undercarriage) retracted
- The flaps retracted
- Climb speed not less than 1.2 V_{S1}.

The gradient may not be achieved because of the aircraft mass. The term used to describe the maximum mass that can be carried and still attain the minimum gradient is called the **Landing Climb Limit Mass**.

LANDING REQUIREMENT

A multi engined class B aeroplane must ensure that the landing mass of the aeroplane, for the estimated time of arrival, allows a full stop landing from 50 ft above the threshold within **70% of the landing distance.**

$$LD \leq 0.7\,LDA \qquad or \qquad 1{,}43\,LD \leq LDA$$

FACTORS TO BE ACCOUNTED ACCORDING TO CS-23

- the pressure altitude at the aerodrome
- standard temperature
- the runway surface conditions and the type of runway surface
- the runway slope
- not more than 50% of the reported headwind component or not less than 150% of the reported tailwind component

CORRECTION FACTORS

Runway conditions	Correcting factors
Grass up to 20 cm high	x 1,15
Wet	x 1,15
Slope	Increase LD by 5% per each 1% downslope

REFERENCE LANDING SPEED (V_{REF})

The speed at the landing screen height (V_{REF}) for a Class B single engine aeroplane must be no less than 1.3 times the stall speed in the landing configuration (V_{SO}).

$$V_{REF} \geq 1.3\ V_{SO}$$

PRESENTATION OF DATA

Example

Given:

The Landing Distance Available at an aerodrome is 2,500 feet. For a Class B aircraft, what distance should be used in the landing distance graph to obtain the maximum permissible landing weight, if the runway has a paved wet surface with a 1% downhill slope?

a. approximately : 1,665 ft
b. approximately : 1,447 ft
c. approximately : 1,748 ft
d. approximately : 2,500 ft

DESPTACH RULES

The despatch rules, state that for despatching an aeroplane, it must be assumed that:

- The aeroplane will land on the most favourable runway at the destination airfield in still air,

and,

- The aeroplane will land on the runway most likely to be assigned considering the probable wind speed and direction.

If this second assumption cannot be met, the aeroplane may be despatched only if an alternate aerodrome is designated which full compliance of the regulatory despatch requirements can be met.