TECHNICAL INTERVIEW

DAY 2

2014 Autumn

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PRINCIPLES OF FLIGHT

1. Critical Engine

Engine whose failure would most adversely effect on the aircraft's handling and performance quality. Propeller a/c, there is a difference in the remaining yawing moments after failure of the left or the right engine if all propellers rotate in the same direction due to the P-factor.

2. Swept wing

A swept wing is favoured for high subsonic and supersonic speeds, and is found on almost all jet a/c. Compared with straight wings they have a "swept" wing root to wingtip direction angled beyond the span wise axis.

Advantages

- **High Mach cruise speed**: →delays the airflow over the wing from going supersonic and allows the a/c to maximize the jet engine potential for higher Mach cruise. The swept wing is also designed with a minimal chamber and thickness, thereby reducing profile drag, which further increases the wing ability for higher speed.
- **Stability in turbulence**: →poor lift qualities, thereby it is more stable in turbulence compared with a straight-winged aircraft.

Disadvantages

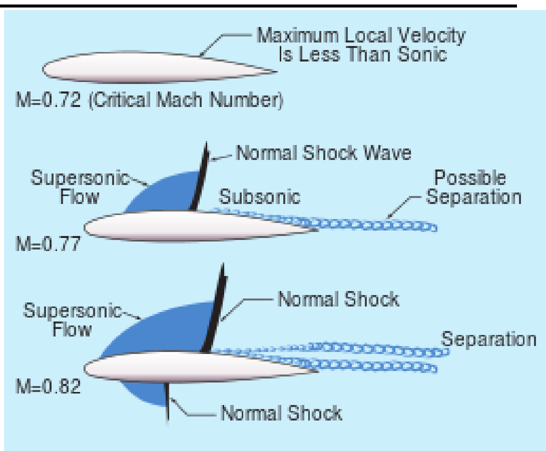
- **poor lift qualities**, because the swept wing has the effect of reducing the lift capabilities of the wing
- **speed instability** at lower speeds and higher stall speeds because of the poor lift qualities
- **wing tip stalling tendency** which makes the aircraft longitudinally unstable, which is a major disadvantage.

3. High lift devices:

Intended to increase lift during certain flight conditions. They include common devices such as leading edge and trailing edge flaps and slats. Larger wing provide more lift and reduce takeoff and landing distance, but increase drag during cruising flight and thus increase the fuel consumption. High-lift devices are allowing the use of an efficient cruising wing, and adding lift for takeoff and landing.

4. Critical Mach number

In aerodynamics, the critical Mach number (M_{CRIT}) of an aircraft is the lowest Mach number at which the airflow over some point of the aircraft reaches the speed of sound (LSS). At the critical Mach number, local airflow in some areas near the airframe reaches the speed of sound, even though the aircraft itself has an airspeed lower than Mach 1.0. This creates a weak shock wave. The actual critical Mach number varies from wing to wing. In general a thicker wing will have a lower critical Mach number.



5. Mach tuck

Is an aerodynamic effect whereby the nose of an aircraft tends to downward pitch as the airflow around the wing reaches supersonic speeds; the aircraft will first experience this effect at significantly below Mach 1.0.

6. Coffin corner

Is the altitude at or near which an aircraft's stall speed is equal to the critical Mach number, at a given gross weight and G loading. At this altitude the aircraft becomes nearly impossible to keep in stable flight. Since the stall speed is the minimum speed required to maintain level flight, any reduction in speed will cause the airplane to stall and lose altitude. Since the critical Mach number is maximum speed at which air can travel over the wings without losing lift to flow separation and shock waves, any increase in speed will cause the airplane to lose lift, or to pitch heavily nose-down, and lose altitude.

7. Stall

A stall is when the angle of attack, the angle at which the wings meet the onrushing air, is exceeded and the wings lose lift causing the planes nose to drop.
The angle of attack at which this happens can vary depending upon the airspeed. Sufficient flow of air must continue over the wings to maintain lift.
A stall can occur when one of the following happen:

- Too steep an angle of attack with insufficient flow of air over the wings causing a stall
- Insufficient airspeed at any angle, again not enough airflow over the wings.

8. Deep stall

(or super-stall) is a dangerous type of stall that affects those aircraft which designs with a T-tail configuration. In these designs, the turbulent wake of a stalled main wing "blankets" the horizontal stabilizer, thus the elevators ineffective and preclude the aircraft from recovering from the stall.

9. What is Dutch Roll?

Combination of rolling and yawing oscillations that normally occurs when the dihedral effect of an a/c are more powerful than the directional stability.

10. Centre of Pressure

The position of the center of pressure is not a fixed point but depends on the distribution of pressure along the chord, which itself depends on the angle of attack. The greater the angle of attack, the higher the suction which moves toward the leading edge. This is so because the distribution of pressure and center of pressure point will be further forward if the angle of attack is higher and further aft if the angle of attack is lower.

11. Why does an aircraft descent quicker when it is lighter?

The heavier aircraft has to maintain a lower of descent that a lighter aircraft, otherwise it would over speed. Heavier aircraft have a greater momentum and this weight-driven momentum will produce a greater speed in a vertical dive.
Therefore a heavier aircraft has to start its descent earlier than a lighter aircraft because it has to maintain a shallower descent.

MASS AND BALANCE

12. Centre of Gravity

The point through which the force of gravity is said to act on a mass.

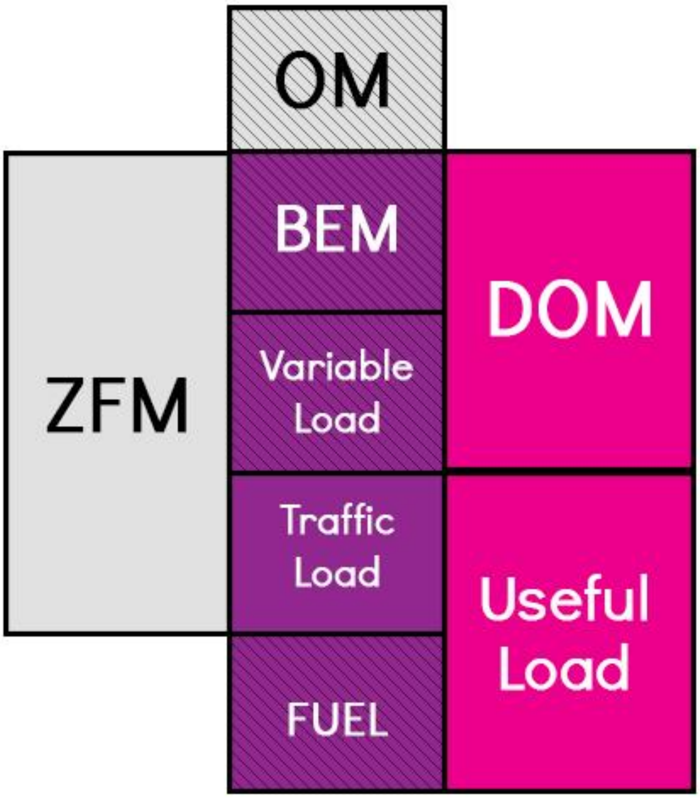
a. **CG outside forward limit**
- Drag **increases**
- Fuel consumption, range, endurance **decrease**
- Longitudinal stability **increases**
- Increases tail down force has same effect as increased weight = higher stall speed.
- Increased takeoff and landing speeds

b. **CG outside aft limit**
- Longitudnional **stability reduced** = very unstable
- Spin recovery more difficult
- Tendency to pitch up

13. Effect of fwd and aft C.G.

	AoA	D_{IND}	Performance & range	Longitudinal stability
fwd CG	high	increase	decrease	increase
aft CG	low	decrease	increase	unstable

14. Weight Planning



a. Basic Empty Mass (Basic Mass):

The mass of an aeroplane plus standard items such as:

- Unusable fuel and other unusable fluids
- Lubricating oil in engine and auxiliary units
- Fire extinguishers
- Pyrotechnics
- Emergency oxygen equipment
- Supplementary electronic equipment

*The **BEM** is therefore the aircraft mass before the crew, fuel, passengers, baggage, cargo and necessary equipment to support them is added.*

c. **Dry Operating Mass (DOM):**

The total mass of the aeroplane ready for a specific type of operation excluding all usable fuel and traffic load, but includes items such as:

- Crew and crew baggage
- Catering and removable passenger service equipment
- Portable water and lavatory chemicals
- Food and beverages

d. **Operating Mass (OM):**

The DOM plus fuel but without traffic load

e. **Traffic Load (TL):**

The total mass of:

- Passengers
- Baggage
- Cargo

f. **Variable Load (VL):**

Includes the:

- Crew and their baggage.
- Catering and other removable passenger service equipment.
- Food and beverages.
- Potable (drinking) water.
- Lavatory chemicals, and
- Any other special operational equipment.

g. **Zero Fuel Mass** (**ZFM**):

The DOM plus traffic load but excluding fuel

15. Structural Limited Masses

h. **Maximum Zero Fuel Mass (MZFM):**
The maximum permissible mass of an aeroplane with no usable fuel.
The MZFM is a structural limitation imposed by the bending moment on the main spar at the wing root.

- **On the ground** the bending moment is caused by the upwards force of the main landing gear acting on the wings.
- **In the air** the bending moment is caused by the upward force produced by lift.

i. **Maximum Structural Take-Off Mass (MTOM):**
The maximum permissible total aeroplane mass at the start of the take-off run.

j. **Maximum Structural Landing Mass (MLM):**
The maximum permissible total aeroplane mass on landing under normal circumstances.

16. Performance Limited Masses

- Performance mass limits are imposed to ensure that the aircraft is light enough to complete the **take-off and landing within the distances available.**
- The aircraft must also be light enough to **comply with climb**
- **and descent requirements**
- Will vary with the conditions of the day

k. **Performance Limited Take-Off Mass (PLTOM)**
The performance limited take-off mass is the maximum take-off mass allowable to comply with departure performance limitations such as

- runway distance available and
- minimum climb gradients required.

l. **Performance Limited Landing Mass (PLLM)**
The performance limited landing mass is the maximum landing mass allowable to **comply with landing runway limitations**, such as

- runway distance available
- and minimum climb gradients required in the case of a go-around

17. Regulated Masses

Depending on the circumstances the aircraft will **either be limited** by **structural** considerations or by **performance** considerations.
A short runway at a high altitude airport on a hot day
= performance limits will be more restrictive than the structural limits.
The **most limiting** of the two considerations **determines** the regulated mass.

OPERATIONAL PROCEDURES – (EU-OPS AND ICAO DOC8168)

18. Aerodrome operating minima

Aerodrome operating minima (AOM) are criteria used by pilots to determine whether they may land or take off from any runway at night or in IMC (visibility, distance from cloud, and ceiling, less than VMC).
AOM consist of two parts: one relating to the cloud base and one relating to the visibility and/or Runway Visual Range (RVR)

19. Conversion of met VIS to RVR/CMV

Lighting elements in operation	RVR/CMV = Reported met. VIS ×	
	Day	Night
HI approach (HIALS) and runway (HIRL) lighting	1.5	2.0
Any type of lighting instal. other than above	1.0	1.5
No lighting	1.0	NIL

Note: Conversion Met visibility to RVR is not allowed, when calculating T/O CAT II/III minima, or when a reported RVR is available.

20. Alternates

a. **Take-off Alternate**

The operational flight plan shall specify a takeoff alternate aerodrome if meteorological and/or performance considerations preclude return to the departure aerodrome

- Within **one hour still air flight time** at the FM **one engine - inoperative** cruising speed in **ISA**, calculated on the actual take-off mass. *This means 250 NM (great circle distance) for A320.*
- Met reports indicate weather is at or above applicable **landing minima** (RVR/Vis) at a period of **1 hour before and after** the ETA and
- If non-precision and or circling approach available ceiling must be taken into account and
- one-engine inoperative limitations taken into account and
- Minimum LDA greater than 1800m

b. **Destination / En–route Alternate AND Isolated Aerodrome**

For selection as a destination alternate, en-route alternate or isolated aerodrome it must satisfy the following condition:

- Meteorological reports and/or forecasts must indicate that the weather at the aerodrome will be **at or above the planning minima** during a period from **1 hour before to 1 hour after ETA**

c. **Number of destination alternates to be selected**

No alternate	▪ **-Both:** ○ The planned duration of the flight from take-off to landing, or in the event of inflight re-planning the remaining flying time to destination does not exceed **6 hours;** and ○ **Two separate runways*** are available and usable at the destination Aerodrome and ○ the appropriate weather reports or forecasts or any combination thereof, indicate that from a period of **1 hour before until 1 hour after ETA**, the **ceiling** will be at least ▪ **2000 ft** or ▪ **circling height + 500 ft,** *whichever is greater* and ○ the **visibility** will be at least **5 km.** ▪ **-Or:** ○ The destination is isolated and no adequate destination alternate exists.
1 alternate	All IFR flights *unless the above or below*
2 alternates	Two destination alternates must be selected when the appropriate **weather reports or forecasts** or any combination of these for the destination indicate that: • From 1 hour before to 1 hour after the ETA the weather conditions will be below the applicable planning minima, **- Or** • When no meteorological information is available

21. Separate runways

Runways on the same aerodrome are considered to be **separate runways** when they are separate landing surfaces which may overlay or cross such that if one of the runways is blocked, it will not prevent the planned type of operation on the other runway and each of the landing surfaces has a separate approach procedure based on a separate aid.

22. Enroute Alternate

At every moment of a flight, an adequate airport has to be reachable.

- This airport shall be **located within one hour still air flight time at the one-engine-inoperative** cruising speed in ISA (great circle air distance 380 NM).
- If **meteorological** and operational conditions permit, **departure and arrival aerodrome may be considered** as an intermediate airport
- If any point on the planned route **exceeds a distance of 380NM** to the departure or arrival airport, an **intermediate airport** has to be chosen, within a radius of 380NM with centre point X.
- It must satisfy the "destination and enroute alternate" conditions

23. Destination Aerodrome

- Meteorological reports and/or forecasts must indicate that the weather at the aerodrome will be at or above the applicable planning minima (RVR/Visibility) during a period commencing **1 hour before and ending 1 hour after the ETA**;

and

- For a non-precision or circling approach the **ceiling** must be at or **above MDH**.

24. Planning minima (ENR & DEST >> !!! N/A for DEP !!!):

Destination / En-Route Alternate & Isolated Aerodrome	
Type of approach	**Planning minima**
Cat II and III	Cat I ***(note 1)***
Cat I	Non-precision ***(note 1 and 2)***
Non-precision	Non-precision + 200 ft/1000 m ***(note 1 and 2)***
Circling	Circling

Note 1 RVR **Note 2** The ceiling must be at or above the MDH

25. Airplane approach categories (Category C for A320)

Approach Speeds for Category C Airplane					
V_{AT} (KIAS)	**Range of Speeds (KIAS) for:**		**Maximum speeds (KIAS) for:**		
	initial approach	**final approach**	**Circling**	**Intermediate missed approach**	**final missed approach**
121/140	160/240	115/160	180	160	240

26. Take off Minima

- Take-off minima for a given aerodrome shall **not be less than landing minima for the same aerodrome unless a take-off alternate aerodrome is available**
- The take-off minima may not be less than the values below:

Facilities / Conditions applying	RVR / VIS
• High intensity runway centreline lights spaced 15 m or less and • high intensity edge lights spaced 60 m or less are in operation; • Crew received LVTO simulator training; • A 90 m visual segment is available from the cockpit at the start of the take-off run; • The required RVR value has been achieved for all of the relevant RVR reporting points.	**125m** LVP in force
RL, CL and multiple RVR information */note 1 & 2/*	**150m** / LVP in force
RL and CL */note 1/*	**200m** / LVP in force
RL and/or RCLM */note 1 & 2/*	**250m** / LVP in force
RL and/or RCLM (no LVP in force), */note 1 & 2/*	**400m**
Nil (day only) */note 1/*	**500m**

Note 1 – RVR/Vis if unavailable can be replaced by pilot assessment.

Note 2 – For night ops. at least RL and Runway end lights required.

27. Abbreviations

- **RL** – Runway edge Lights
- **CL** – Centerline Lights
- **RCLM** – Runway Centerline Markings
- **HIRL** – High Intensity Runway edge Lights
- **ALS** – Approach Lightning System
- **FALS** – Full Approach Lightning System
- **IALS** – Intermediate Approach Lightning Sytem
- **BALS** – Basic Approach Lightning System
- **NALS** – No Approach Lightning System

28. MDA/MDH or DA/DH

MDA or DA/DH		
	Non-Precision LOC, VOR, NDB, Circle	**Precision** PAR, ILS, MLS
	reported ceiling necessary	**reported ceiling NOT necessary**
MDA (MDH) **[lowest ALT, NOT to below!]**	×	
DA (DH) [CAT I] **[decision made, possibly DESC below]**		×
DH [CAT II ; CAT III] w. RA (II) + A/THR		×

29. System Minima for Non Precision approach aids

Facility	Lowest MDH
Localiser with / without DME	**250ft**
VOR/DME	**250ft**
VOR	**300ft**
NDB	**300ft**
NDB/DME	**300ft**
VDF	**350ft**

30. System Minima for Approach Categories

REQUIRED MINIMUMS		
	RVR	**DH**
Non Precision	750m	250ft to 350ft
CAT 1	550m	200ft
CAT 2	300m	100ft
CAT 3 A	200m	50ft
CAT 3 B	75m	-

31. Approach Ban

During all approaches the airplane's descent path must be carefully monitored.
Except in an emergency or when there has been a significant change in reported weather conditions, **no more than two successive approaches** to an aerodrome may be carried out where both approaches have resulted in a go-around.

a. The commander may commence an instrument approach regardless of the reported RVR/Visibility but the approach shall **not be continued** beyond the **outer marker**, or equivalent position, if the reported **RVR/visibility is less than the applicable minima**.

- Where RVR is not available, RVR values may be derived by converting the reported meteorological VIS to RVR.
- If, **after passing** the outer marker or equivalent position and the reported **RVR/visibility falls below** the applicable **minimum**, the **approach may be continued to DA/H or MDA/H**.

b. Where no outer marker or equivalent position exists, the commander shall make the decision to continue or abandon the approach until 1000 ft above the aerodrome.

32. Approach Climb

This corresponds to an aircraft's climb capability, assuming that **one engine is inoperative**. The "approach climb" wording comes from the fact that **go-around performance is based on approach configuration,** rather than landing configuration.
For Airbus FBW, the available landing configurations are **CONF 2 and 3**.

- **A/C conf.**: One engine INOP, TOGA thrust, Gear extended, Slats/flaps in approach config.,
- min climb gradient: **2.1%**

33. Landing Climb

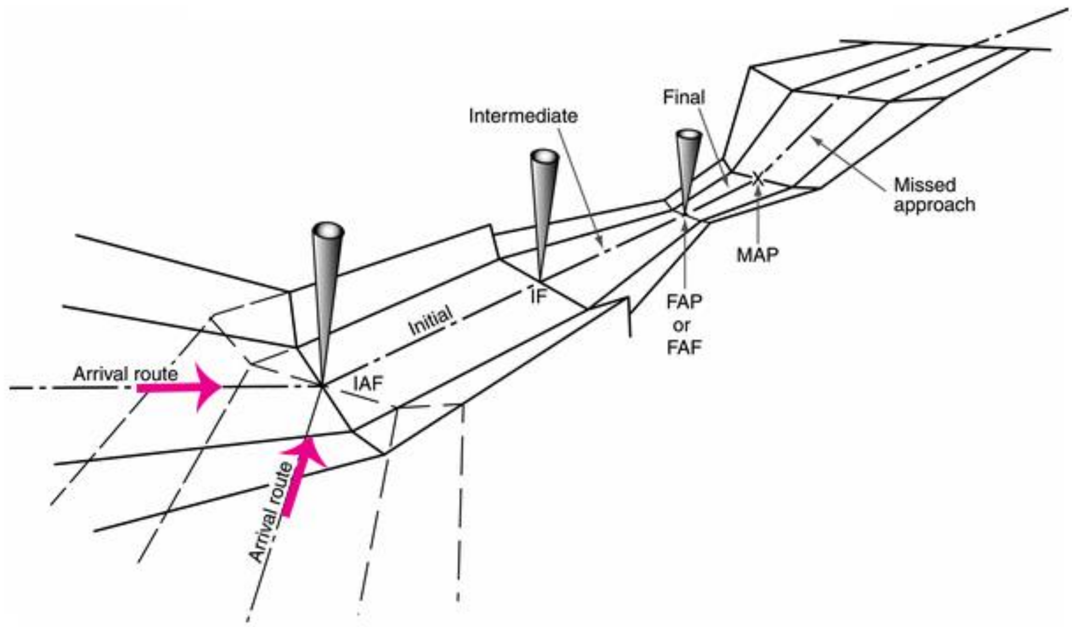
The objective of this constraint is to ensure aircraft climb capability in case of a missed approach with **all engines operating**.
The "Landing climb" wording comes from the fact that go-around performance is based **on landing configuration**.
For Airbus FBW, the available landing configurations are **CONF 3 and FULL**.

- **A/C conf:** all engines, TOGA thrust and the engine have reached go around thrust, Gear extended, Slats/flaps in landing configuration,
- minimum gradient to be demonstrated is **3.2%**

34. Approach Fixes

- **IAF** is defined as an aid/fix where the initial approach segment begins
- **IF** is defined as an intersection between the initial and the intermediate approach segments
- **FAP** (precision app) is defined as an intersection of the intermediate approach ALT/height and the nominal ILS GP
- **FAF** (NPA). FAF is defined as an aid/fix from which descent to the MDA/H is initiated
- **MAPt** is defined as that point in an instrument approach procedure at or before which the prescribed Missed Approach Procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed

35. Approach Segments



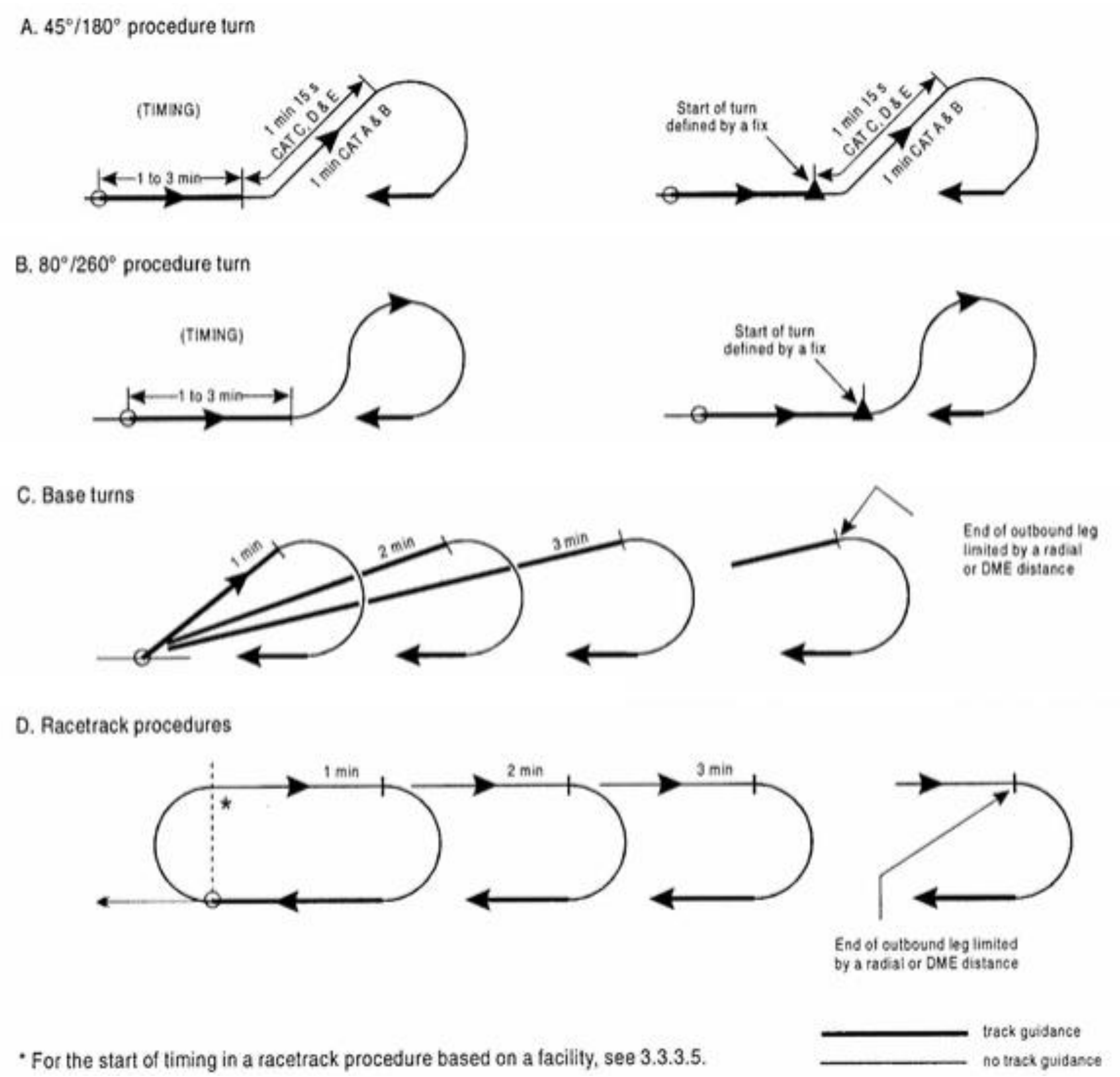
1. **Arrival Segment (-> IAF)**
   Identified in an instrument approach procedure by which aircraft may proceed from the en-route phase of flight to an initial approach fix normally covered by STAR.

2. **Initial Approach Segment (IAF -> IF)**
   The manoeuvres including reversal and racetrack procedures are performed before the aircraft enters the intermediate approach segment.

a. **Wind effect:** to compensate for the effects of wind to regain the inbound track as accurately and as possible to achieve a stabilized approach.

b. **Descent:** The aircraft shall cross the fix or facility and fly outbound on the specified track descending as necessary to the specified altitude. If a further descent is specified after the inbound turn, this descent shall NOT be started until established on the inbound track ("established" is considered as being within half full scale deflection for the ILS and VOR or within +5° of the required bearing for the NDB).

c. **Reversal Procedures**: All turns are designed for a bank angle of 25°
45°/180° PROCEDURE TURN and 80°/260° PROCEDURE TURN



3. **Intermediate Approach Segment (IF -> FAF/FAP)**
The aircraft speed and configuration are adjusted, to prepare the aircraft for the final approach.

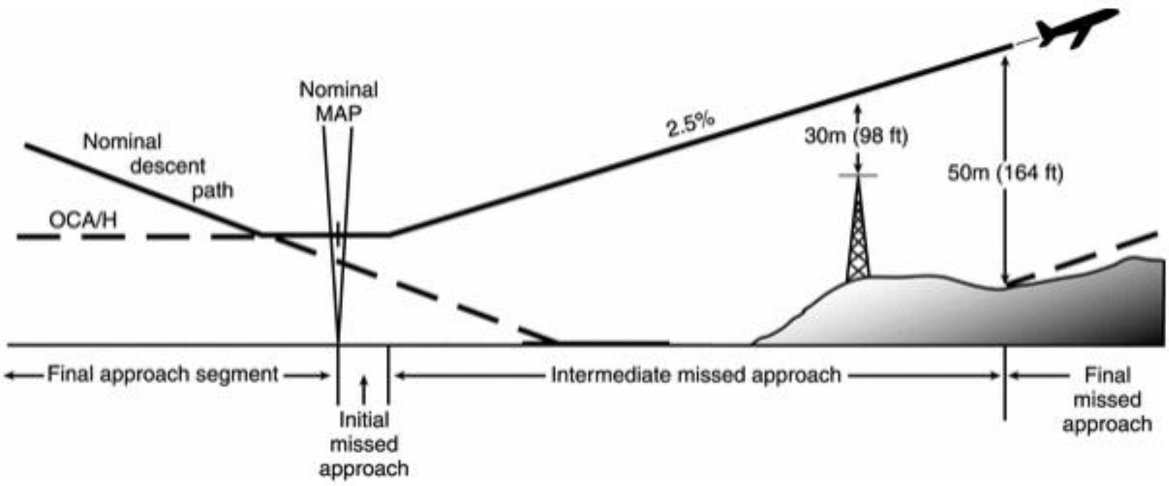
4. **Final Approach Segment (FAF/FAP -> MAP)**
In which alignment and descent for landing are accomplished. The FAF is crossed at, or above, the specified altitude/height and descent is THEN initiated.

5. **Missed Approach Segment (MAP ->)**
   MAPt is established where the MISAP climb should be started at the latest.
   The MISAP prior to the MAPt, it is emphasized that the complete MISAP always be followed.
   The Missed Approach Procedure is based on a **nominal climb gradient of 2.5%,** and the turn is based on a bank angle of **15°**.
   The Missed Approach Segment is divided into three phases:

   1. **Initial MISAP Segment**
      Beginning at the Missed Approach Point (MAPt) and ending at the point where the climb is established (SOC).

   2. **Intermediate MISAP Segment**
      Extending, normally straight ahead, from the end of the point of the initial phase to a point where **50m (164 ft) obstacle clearance is obtained** and can be maintained. **Track** may be changed by a **maximum** of **15°**, it is assumed that the aircraft begins track corrections.

   3. **Final MISAP Segment**
      Extending from the end of the intermediate phase at the point where 50 m (164 ft) obstacle clearance is first obtained to the point where a new approach, holding or a return to the en-route flight is initiated.



36. Circling Approach

Visual Phase of an instrument approach to position an airplane for landing on a runway which is not suitable for a straight in approach. **MDH 600ft / Visibility 4000m**

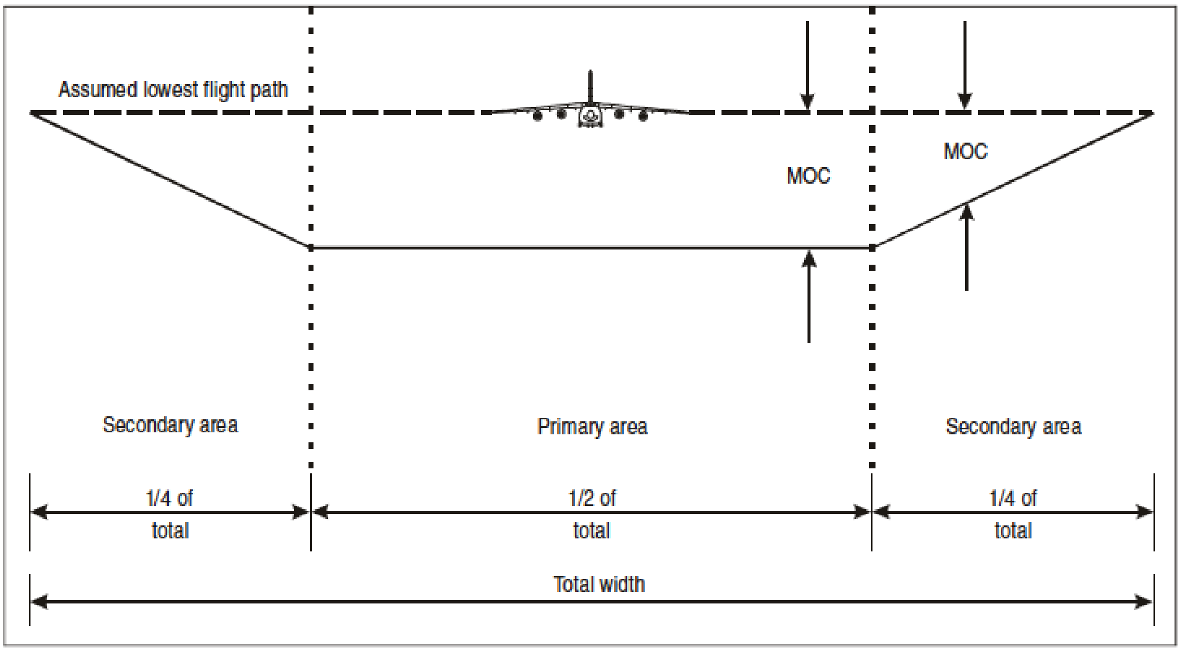
37. Visual Approach

an approach by an IFR flight when either part or all of an instrument approach procedure is not completed and the approach is executed with visual reference to the terrain.

- **Visibility 5000m**
- **Ceiling 2500ft**
- fully stabilised at 1000ft AAL.

38. Obstacle Clearance

- Where track guidance is provided the vertical cross-section of which is an area located symmetrically about the centre line of each segment. The vertical cross-section of each segment is divided into **primary and secondary areas. Full obstacle clearances** are applied over **the primary** areas **reducing to zero** at the **outer edges of the secondary** areas
- On straight segments, the width of the primary area at any given point is equal to one-half of the total width.
- The width of each secondary area is equal to one-quarter of the total width.
- The minimum obstacle clearance (MOC) is provided for the whole width of the primary area. In the secondary area, MOC is provided at the inner edges reducing to zero at the outer edges



39. Obstacle Clearance – Departure Procedures

- The minimum obstacle clearance equals **zero** at the **departure end of the runway (DER).** From that point, it **increases by 0.8%** of the horizontal distance in the direction of flight assuming a maximum turn of 15°.
- In the **turn initiation area** and turn area, a **minimum** obstacle clearance of **90 m (295 ft**) is provided.
- Unless otherwise specified, **departure procedures assume a 3.3 per PDG** and a straight climb on the extended runway centre line **until reaching 120 m (394 ft)** AAL based on all engines operating
- The PDG (Procedure Design Gradient) is made up of:
  - **2.5%** gradient of obstacle identification surfaces or the gradient based on the most critical obstacle penetrating these surfaces, whichever is the higher gradient

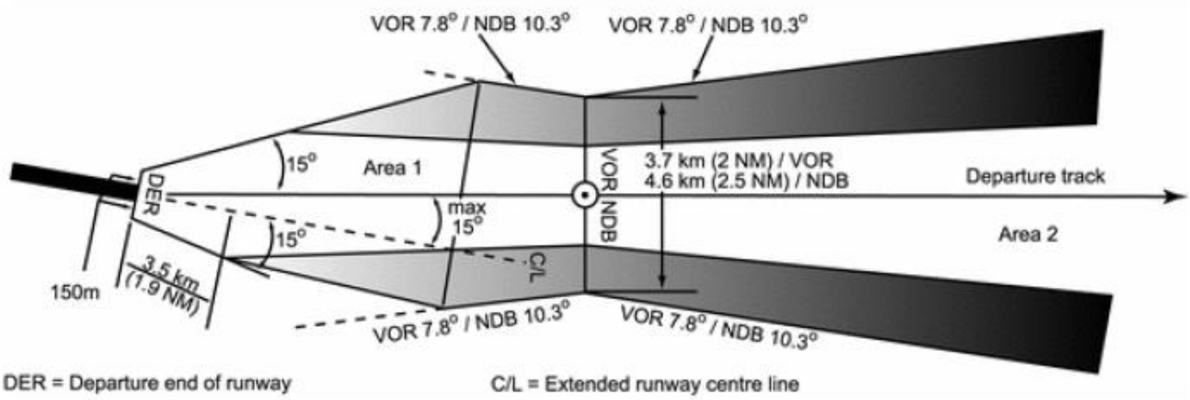
  and
  - **0.8%** increasing obstacle clearance.

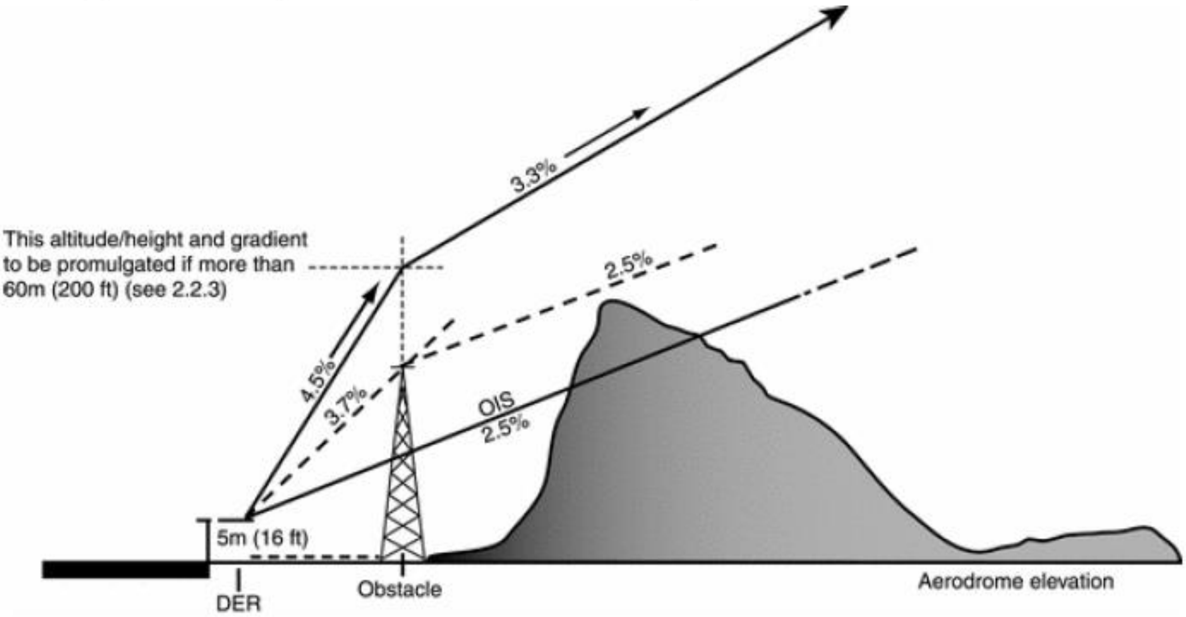
- **Contingency Procedures** to cover engine failure or an emergency in flight after V1 is the responsibility of the operator.
- **Wind effect** is compensated by the pilots while on the procedure and not compensated while being vectored by ATC.

40. Standard Instrument Departure

Straight Departures

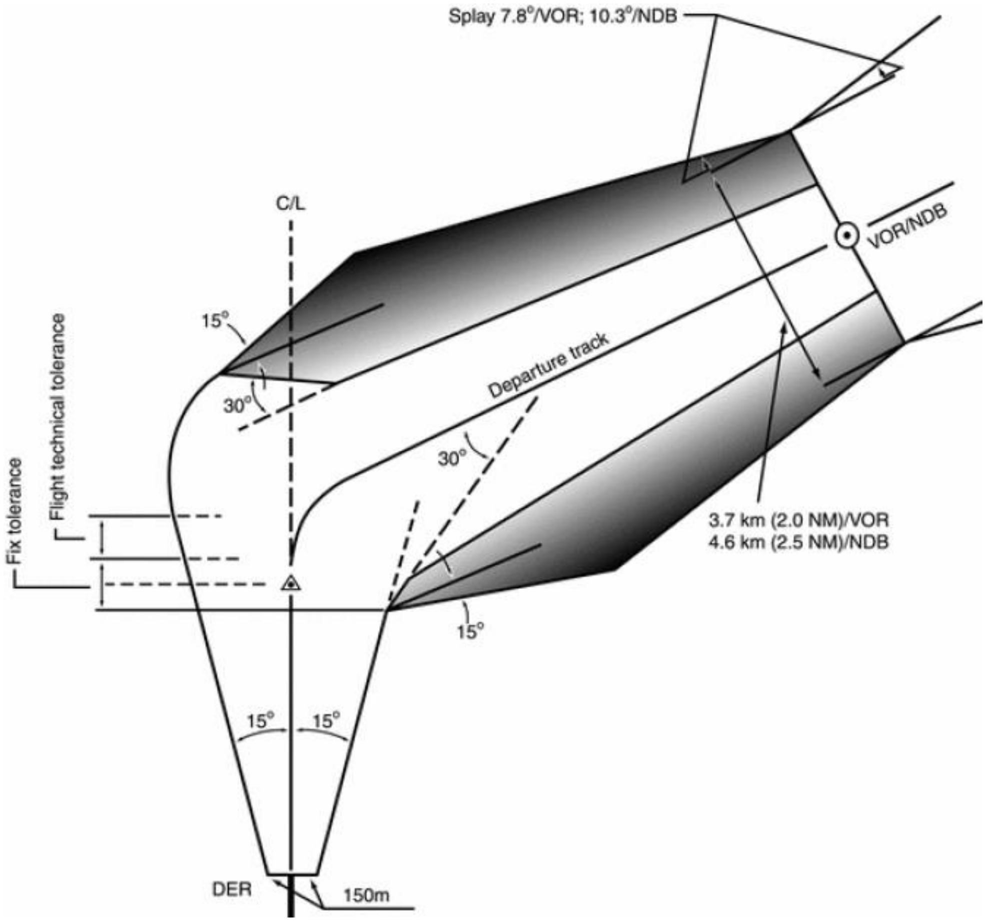
- Initial departure track is within 15° of the alignment of the runway centerline
- When obstacles exist affecting the departure route, procedure design gradients greater than 3.3 per cent are promulgated to an altitude / height after which the 3.3 per cent gradient is considered to prevail. Gradients to a height of 60m (200 ft) or less, caused by close-in obstacles, are not specified.



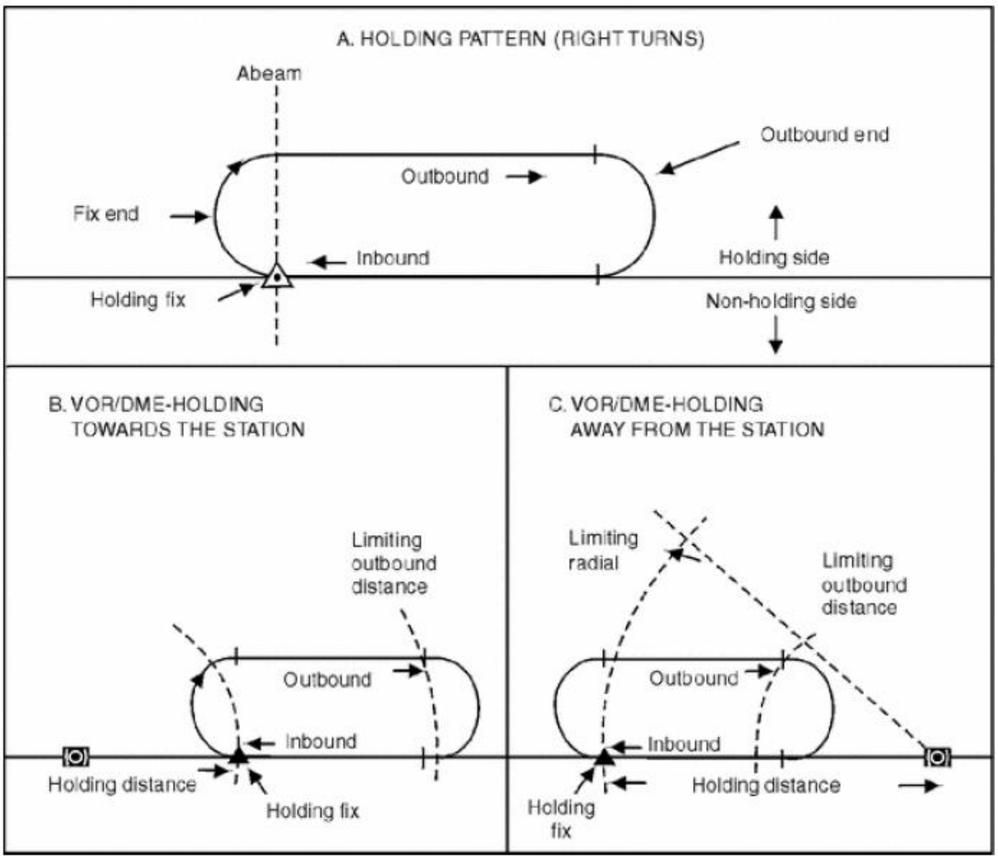


Turning Departures

- When a departure route requires a turn of more than 15°, a turning area is constructed. Turns may be specified at an altitude / height, at a fix, and at a facility. Straight flight is assumed until reaching an altitude / height of at least 120m (394 ft) above the elevation of the DER.


Splay 7.8°/VOR; 10.3°/NDB
C/L
VOR/NDB
15°
30°
Departure track
30°
3.7 km (2.0 NM)/VOR
4.6 km (2.5 NM)/NDB
Flight technical tolerance
Fix tolerance
15°
15°
15°
DER
150m

41. Holdings


A. HOLDING PATTERN (RIGHT TURNS)
Abeam
Outbound end
Outbound
Fix end
Inbound
Holding side
Holding fix
Non-holding side
B. VOR/DME-HOLDING
TOWARDS THE STATION
Limiting
outbound
distance
Outbound
Inbound
Holding distance
Holding fix
C. VOR/DME-HOLDING
AWAY FROM THE STATION
Limiting
radial
Limiting
outbound
distance
Outbound
Inbound
Holding
fix
Holding distance

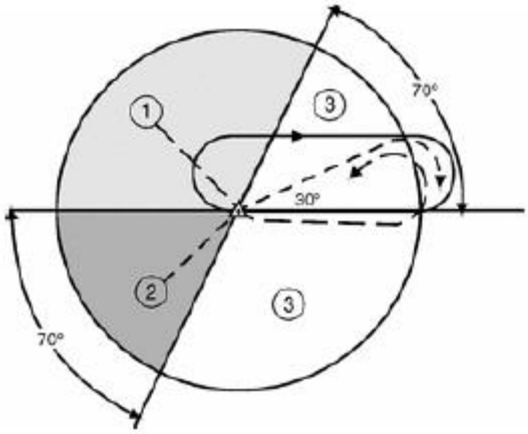
42. Holding Speeds

Rate of turn / Angle of bank: bank angle of 25° or at a rate of 3° per second (rate one), whichever requires the lesser bank

Holding Speeds based on the newer ICAO DOC8168 Vol.1. IV Edition

Levels	Normal Conditions	Turbulent Conditions	Timing
Up to 14.000ft	230kts 170kts for CAT A and B	280kts 170kts for CAT A and B	1 min
14.000ft – 20.000ft	240kts	280kts or Mach 0.8 whichever is less	1.5 min
20.000ft – 34.000ft	265kts		1.5 min
above 34.000ft	Mach 0.83	Mach 0.83	1.5 min

43. Holding Entry



- Parallel Entry (Sector 1)
- Offset Entry (Sector 2)
- Direct Entry (Sector 3)

44. Holding Area Obstacle Clearance

- **Basic holding area** at any particular level is the airspace required at that level to encompass a holding pattern based on the allowances for aircraft speed, wind effect, timing errors, holding fix characteristics, etc.;
- **Entry area** includes the airspace required to accommodate the specified entry procedures.
- **Buffer area** is the area **extending 5.0 NM** beyond the boundary of the holding area within which the height and nature of obstacles are taken into consideration when determining the minimum holding level usable in the holding pattern associated with the holding area.

45. Minimum Holding Level

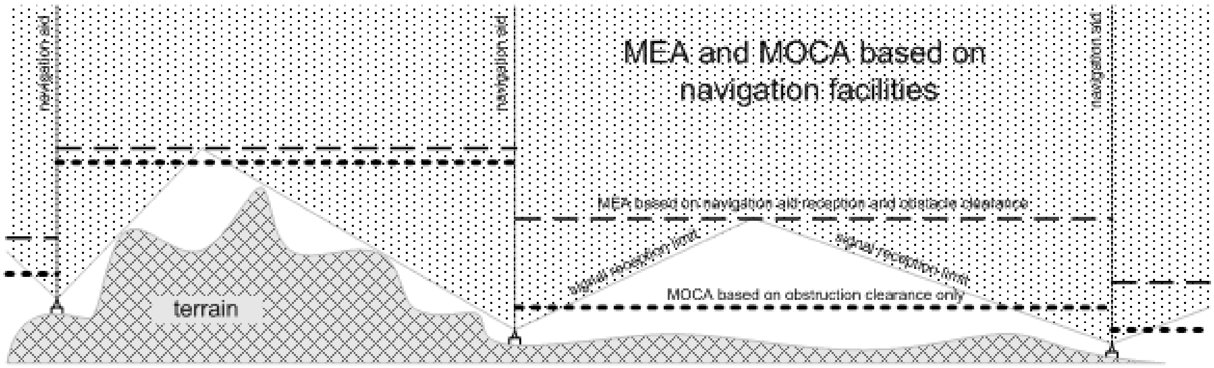
- The minimum permissible holding level provides a **clearance of at least: 984ft** above obstacles in the holding area;
- Furthermore, **over high terrain** or in mountainous areas obstacle **clearance up** to a total of **1,969ft** is provided to accommodate the possible effects of turbulence, down drafts and other meteorological phenomena on the performance of altimeters.

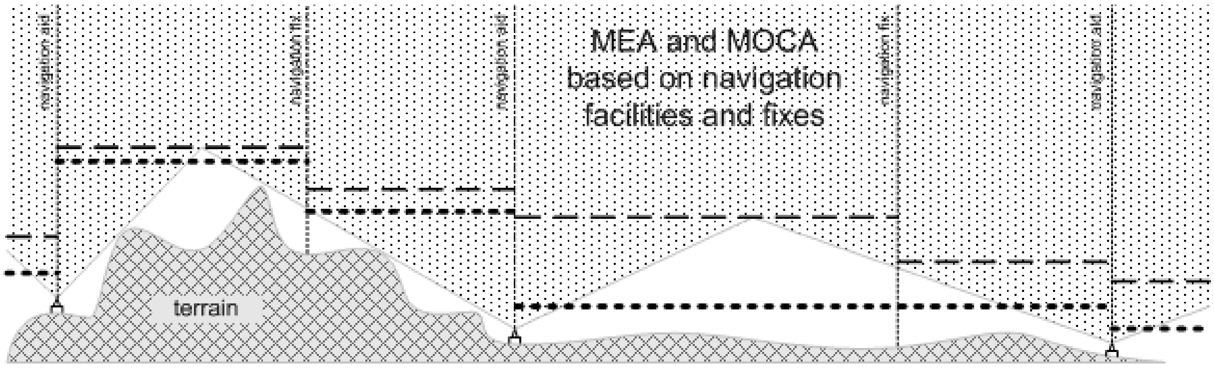
46. MEA - Minimum Enroute Altitude (2300)

The lowest published altitude between radio fixes that assures acceptable navigational signal coverage which applies to the entire width of the airway, segment, or route.

47. MOCA – Minimum Obstruction Clearance Altitude (2300T or *2300)

The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes or route segments which provides obstacle clearance requirements for the entire route segment.





48. MORA–Min Off-Route ALT (2300a)

1000ft OC below **5000Ft MSL** above 2000ft OC from man-made and terrain obstacle.

- **ROUTE MORA** provides a clearance within 10NM of the route centerline and 10NM radius beyond the radio fixes.
- **Grid MORA** is associated with enroute charts. Each charts are divided into sectors and each sector has a minimum useable altitude.

49. MSA – Minimum Safe / Sector Altitude

An altitude, which can found on an instrument approach chart and identified as the minimum safe altitude that provides **a 1000ft obstacle clearance** within a **25NM radius from the navigational facility.** If MSA is divided into sectors, each sector a different altitude, the altitudes in these sectors are referred to as Min. Sector Altitudes.

50. Drift Down Altitude

The altitude to which, following the failure of an engine, above the one engine inoperative absolute ceiling, an aeroplane will descend to and maintain, while using maximum available power/thrust on the operating engine and maintaining the one engine inoperative best rate of climb speed.

51. ETOPS

Extended Twin Operations → An operator is granted permission to operate a twin engine a/c type on a flight in which the a/c is **more than 60 min**. away from suitable ALTN aerodrome in case of one engine INOP for en-route.

- Vary btw. 60 and 180 min.
- A320 one engine INOP → 380NM

52. Noise Abatement Departure Procedure 1 – NADP 1

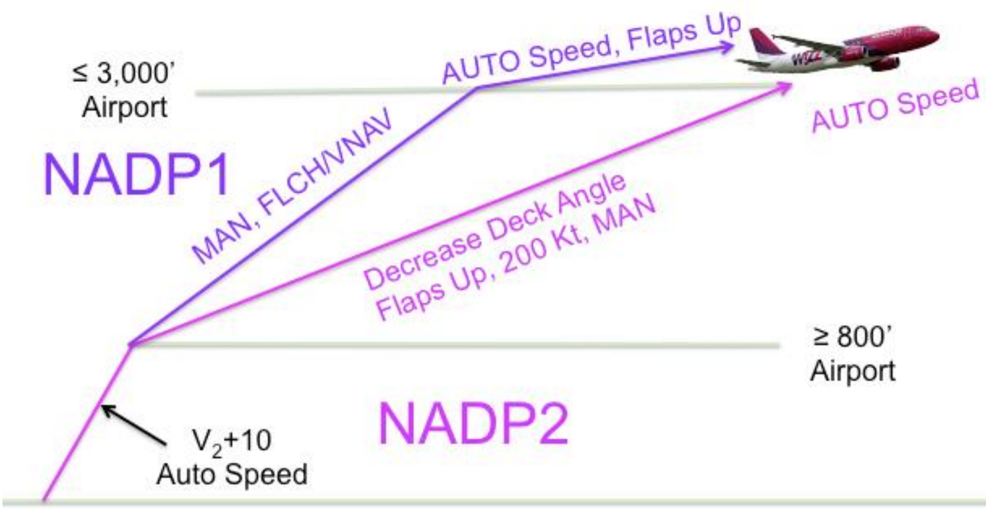
Provide noise reduction for noise sensitive areas in **close proximity** to the DEP end of the RWY.

- **T/O THR: V_2 +10 kt** → power/thrust reduction at or above the prescribed minimum altitude (**800ft** above APT elevation) and
- **CLB THR: V_2 + 10 to 20 kt** → delaying flap/slat retraction until the prescribed max. altitude (3000ft above APT elevation) is attained.
- Than accelerate smoothly and retract flaps/slats on schedule while maintaining a positive rate of climb.

53. Noise Abatement Departure Procedure 2 – NADP 2

Provide noise reduction to areas **more distant from the runway** end.

- **T/O THR: V_2 +10 to 20 kt** → at minimum altitude **(800ft** above APT elev.) positive rate of climb, body angle is reduced and flaps/slats are retracted on schedule
- **V_{ZF}(green DOT)** → power/thrust is reduced during the flap/slat retraction sequence at a point that ensures satisfactory acceleration performance.
- At the prescribed altitude (3000ft above APT elev.) transition smoothly to en-route climb speed



54. Noise Abatement Procedures – Operational Limitations

Take-off

Noise abatement procedures in the form of reduced power take-off should not be required in adverse operating conditions such as:

- if the runway surface conditions are adversely affected (i.e., snow, slush, ice or water, or by mud, rubber, oil or other substances);
- when the horizontal visibility is less than 1 NM
- when the crosswind component, including gusts, exceeds 15kt
- when the tailwind component, including gusts, 5kt
- When wind shear has been reported or forecast or when thunderstorms are expected to affect the approach or departure.

Approach

In noise abatement approach procedures which are developed:

- the aeroplane shall not be required to be in any configuration other than the final landing configuration at any point after passing the outer marker or 5 NM from the threshold of the runway of intended landing, whichever is earlier;
- excessive rates of descent shall not be required

Compliance with published noise abatement approach procedures should not be required in adverse operating conditions such as:

- if the runway is not clear and dry, i.e., it is adversely affected by snow, slush, ice or water, or by mud, rubber, oil or other substances;
- in conditions when the ceiling is lower than 500ft above aerodrome elevation
- when the horizontal visibility is less than 1 NM
- when the crosswind component, including gusts, exceeds 15kt
- when the tailwind component, including gusts, exceeds 5kt;
- when wind shear has been reported or forecast or when adverse weather conditions, e.g., thunderstorms, are expected to affect the approach

Landing

Noise abatement procedures shall not contain a prohibition of use of reverse thrust during landing.

55. Airplane Performance Classes

- **CLASS A (multi-engine JETs and some Turboprops (> 5700kg or > 9 seats) Wizz Air A320**
- CLASS B (small propeller)
- CLASS C (large reciprocating engine -propeller)

56. Airplane Approach Categories by Airspeed

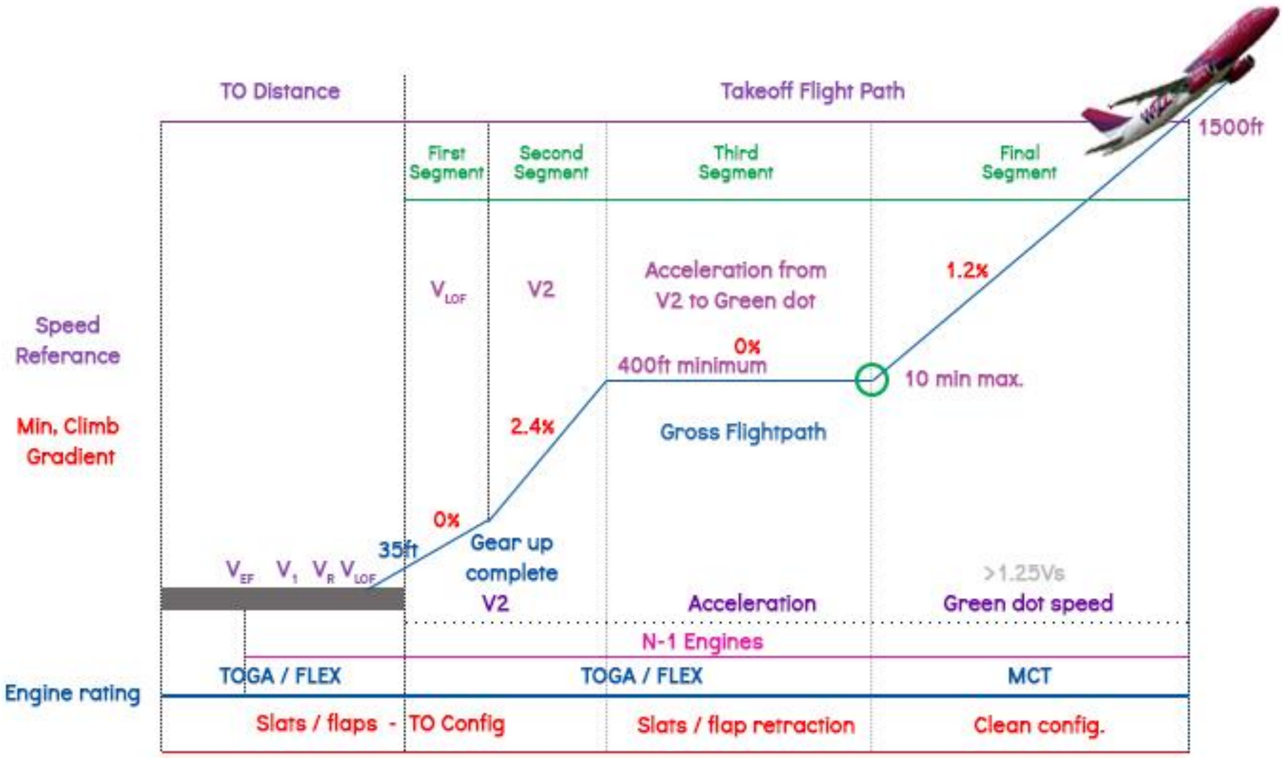
	V_{AT}: 1.3 × V_{SO}	V max circling
A	Less than 91 kt	90 KIAS
B	From 91 to 120 kt	120 KIAS
C	**From 121 to 140 kt**	**140 KIAS**
D	From 141 to 165 kt	165 KIAS
E	From 166 to 210 kt	

57. Screen Height

An imaginary screen that is just cleared by the lowest part of the aircraft with undercarriage extended and in an unbanked attitude when taking off and landing. Usually **35ft**

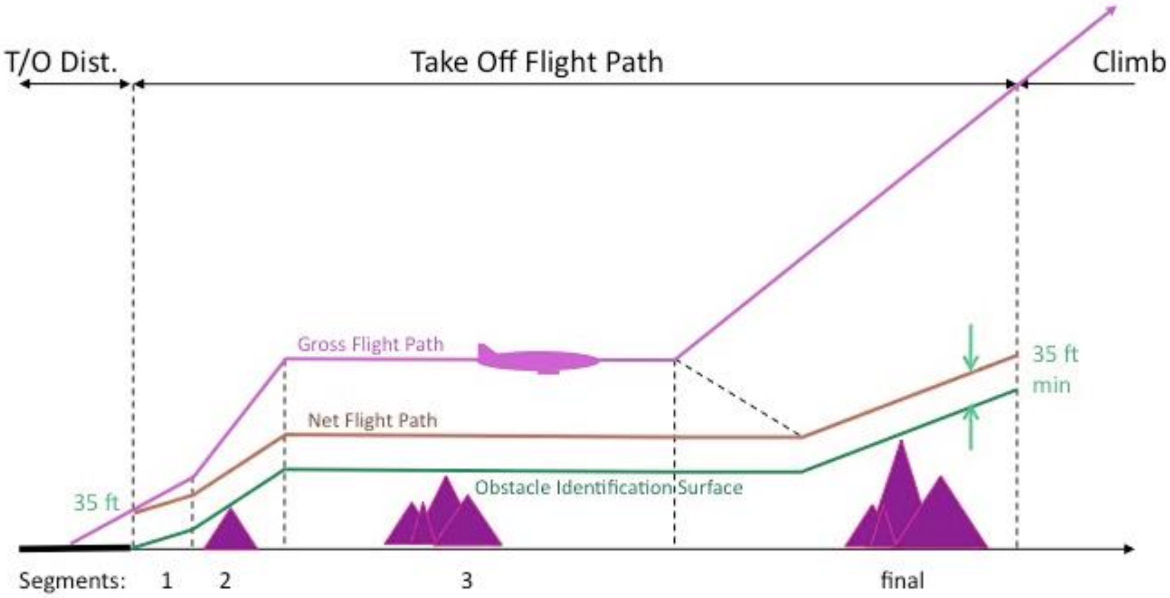
58. Takeoff Path and Segments

Segment (one engine INOP) +0,8% all engine	Gear	S/Flaps	Speed	CLB gradient	Thrust
1st: from 35 ft point until landing gear is retracted	down	T/O	V_2	positive	T/O
2nd: from gear up point until acceleration ALT 400ft is reached	up	T/O	V_2	2.4%	T/O
3rd: a.) distance covered before flap retraction, accelerating to green dot speed b.) after flap retraction accelerating to final T/O climb speed	up	acc. → retract.	acc. V_2 → green dot O	0%	T/O MCT
4th: from 400 FT to 1500 ft is reached	up	up	green dot	1.2%	MCT



59. Gross – Net Gradients

To **ensure obstacle clearance** while allowing for aircraft performance degradation and less than optimum pilot technique, the **gross gradients are reduced by 0.8% for MEJ, to calculate a net gradient**.
The aircraft net gradient capability, correctable for temperature, altitude and pressure, is published in the AFM and in operations, **must ensure that the limiting obstacle can be cleared by a minimum of 35'**.
If there is an obstacle within the departure path that cannot be avoided and would not be cleared by 35', **the planned takeoff weight must be reduced** until minimum obstacle clearance can be achieved.
Note that, by regulation, turns immediately after takeoff cannot be initiated below the greater of 50'AGL or one half of the aircraft wingspan and, that during the initial climb, turns are limited to 15° of bank. Turning will result in a reduction in aircraft climb capability.



60. TOD – Take off Distance

The Takeoff Distance on a **dry runway** is the greater of the following values:

- Distance covered from the brake release to a point at which the aircraft is 35 feet above the takeoff surface, assuming the failure of the critical engine at V_{EF} (Engine Failure Speed) and recognized at V_1
- 115% of the distance covered from brake release to a point at which the aircraft is 35 feet above the takeoff surface, assuming all engines operating

The Takeoff Distance on a **wet runway** is the greater of:

- Takeoff Distance on a dry runway
- Distance covered from brake release to a point at which the aircraft is 15 feet above the takeoff surface, ensuring that the V_2 speed can be achieved before the airplane is 35 feet above the takeoff surface, assuming failure of the critical engine at V_{EF} and recognized at V_1

Takeoff Distance must not exceed the Takeoff Distance Available (TODA), with a clearway distance not to exceed half of the TODA

61. TOR – Take off Run

Takeoff Run (TOR) calculations incorporate a clearway when one is present on the departure runway. If no clearway exists, TOR = TOD.

When a clearway exists, the Takeoff Run on a **dry runway** is the greater of the following values:

- Distance from brake release to a point equidistant between the point at which V_{LOF} (Lift-off Speed) is reached and the point at which the aircraft is 35 feet above the takeoff surface, assuming failure of the critical engine at V_{EF} and recognized at V_1
- 115 % of the distance covered from brake release to a point equidistant between the point at which V_{LOF} is reached and the point at which the aircraft is 35 feet above the takeoff surface, assuming all engines operating

When a clearway exists, the Takeoff Run on a **wet runway** is the greater of:

- Takeoff Distance (TOD) wet runway
- 115 % of the distance covered from brake release to a point equidistant between the point at which V_{LOF} is reached and the point at which the aircraft is 35 feet above the takeoff surface, assuming all engines operating.

Takeoff Run must not exceed Takeoff Run Available (TORA)

62. ASD – Accelerate Stop Distance

Accelerate Stop Distance calculations assume the following:

- Delay between V_{EF} and V_1 = 1 second
- ASD is determined with the wheel brakes at the fully worn limit of their allowable wear range
- Reverse thrust is not considered for a dry runway distance determination, it can be used for wet runway calculations

The Accelerate Stop Distance on a **dry runway** is the greater of the following values:

- Sum of the distances necessary to:
  - Accelerate the airplane with all engines operating to V_{EF}
  - Accelerate from V_{EF} to V_1 (assumes that engine fails at V_{EF} and first action to reject is taken at V_1)
  - Come to a full stop
  - Plus an additional distance equivalent to 2 seconds at constant V_1 speed
- Sum of the distances necessary to:
  - Accelerate the airplane with all engines operating to V_1 (assumes that first stopping actions are taken at V_1)
  - With all engines still operating come to a full stop
  - Plus an additional distance equivalent to 2 seconds at constant V_1 speed

The Accelerate Stop Distance on a **wet runway** is the same as above but reverse thrust can be used.

Accelerate Stop Distance must not exceed the *Accelerate Stop Distance Available (ASDA)*

63. TORA – Take off Run Available

The length of the runway itself. The aircraft must be airborne by the end of the TORA.

64. Stopway:

An area beyond the take-off runway, no less wide than the runway and centred upon the extended centreline of the runway, able to support the aeroplane during an abortive take-off, without causing structural damage to the aeroplane.

65. ASDA - Accelerate Stop Distance Available:

The length of the pavement plus any stopway at the end of the runway. It is suitable for the ground run of an aircraft executing an aborted takeoff. It must be able to support the weight of the aircraft. ASDA = TORA + Stopway.

66. Clearway

It is the length of an obstacle-free area at the end of the runway (upward slope not exceeding 1.25%), with a minimum width of 150m (500ft) and centrally located about the extended centreline of the runway.

67. TODA – Take off Distance Available

The length of the runway, plus any clearway at the end of the runway. The aircraft takeoff weight shall be such that it will reach at least 35ft AGL by the end of the CWY, following the failure of the critical engine at V_1.

68. TODR – Take off Distance Required

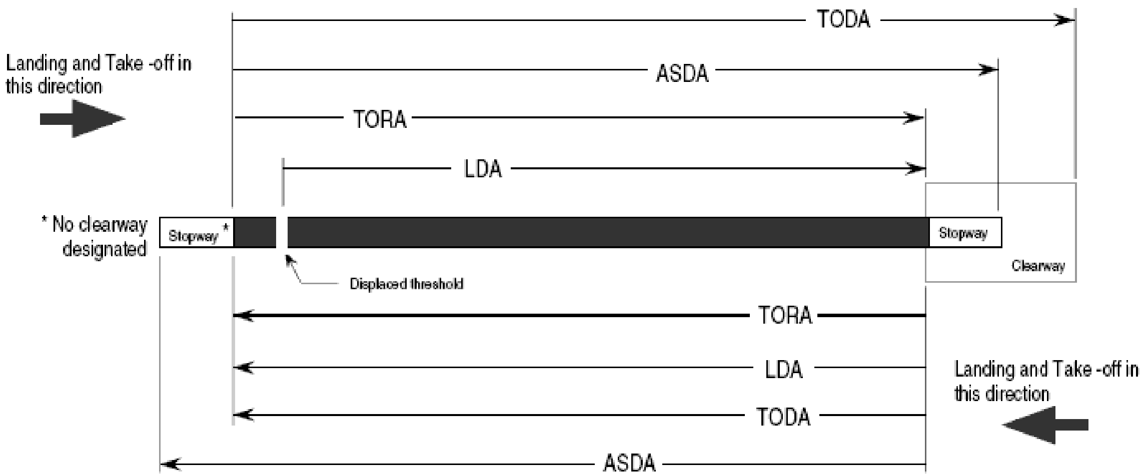
The distance required for the aircraft to reach 35ft AGL following the failure of the critical engine at V_1.

69. LDA - Landing Distance Available

The length of runway declared suitable for landing run, starting at the landing threshold, or displaced/relocated threshold.

70. LDR – Landing Distance Required

Is the landing airborne distance plus the landing ground distance. LDR < LDA x .6 (You need to be able to land in 60% of the LDA).



71. Speeds

Decision Speed (V_1): Maximum speed during takeoff at which a pilot can safely stop the aircraft without leaving the runway. This is also the minimum speed that allows the pilot to safely continue to V2 takeoff even if a critical engine failure occurs between V1 and V2. V1 cannot be less than V_{MCG} and cannot be greater than Vr.

Engine Failure Speed (V_{EF}): The CAS at which the critical engine is assumed to fail.

Rotation Speed (V_R): The speed at which the pilot starts to rotate the aeroplane for take-off to achieve V2 at the screen height. V2 ≥ V1. It is a function of aeroplane weight and flap setting but can also vary with pressure altitude and temperature.

Takeoff Safety Speed (V_2), achieved by the screen height 35ft and maintained to 400ft AGL in the event of an engine failure. $V_2 \geq 1.2 \times V_S$

Lift-off Speed (V_{LOF}): The speed at which the aeroplane first becomes airborne.

Stall Speed (V_S): Vs is the speed at which the airflow over the wings will stall. It is varies with weight and configuration. The stall speed is the reference speed for the other performance speed i.e. V2, Vref

Minimum Control Speed on the Ground (V_{MCG}): The minimum speed on or near the ground at which the take-off can be continued safely when the critical engine becomes inoperative, with the remaining engines at take-off thrust.

Minimum Control Speed in the Air (V_{MCA}): The minimum speed at which the aeroplane is controllable in flight with a maximum 5 degrees of bank, when the critical engine becomes inoperative, with the remaining engines at take-off thrust.

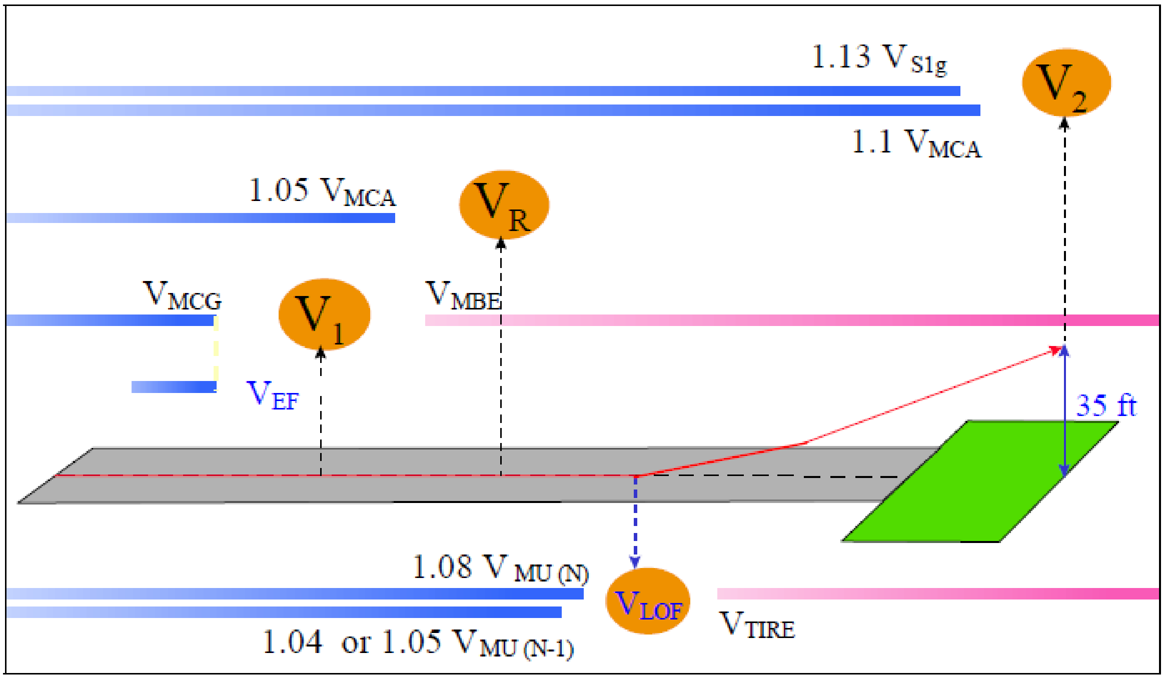
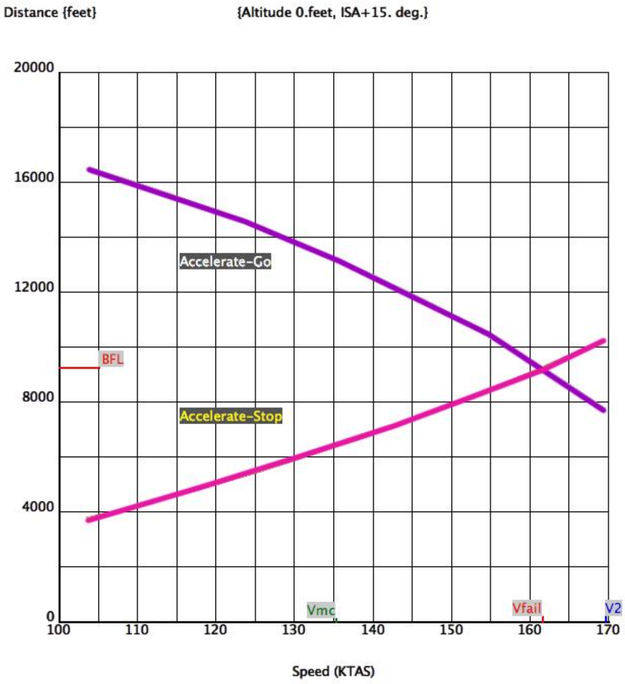
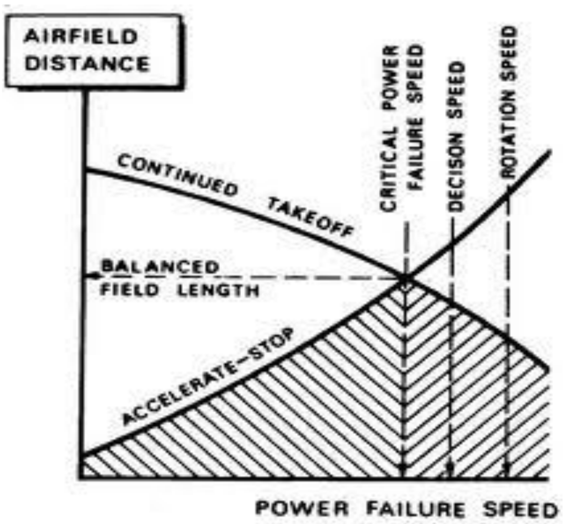


Figure C4: Takeoff Speed Summary and Limitations related to V_1, V_R, V_{LOF} and V_2

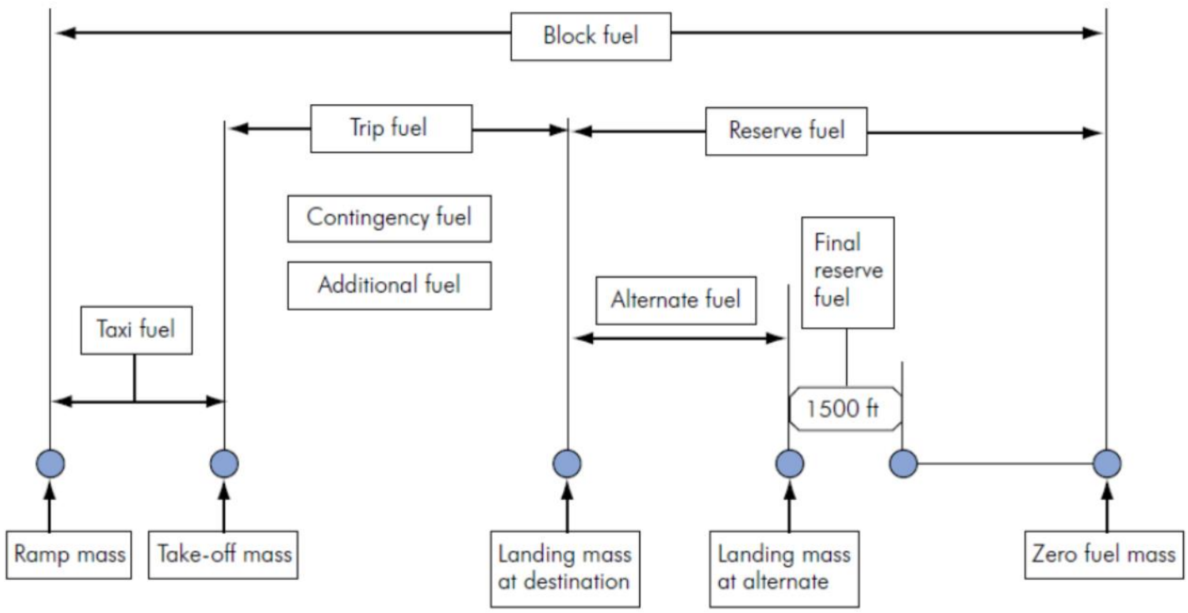
72. Balance Field Length

If **TODR equals ASDR** it is known as a balanced field.
For a given takeoff weight any increase in V_1 leads to a decrease in TODR and an increase in ASDR.
A minimum distance is achieved in a particular V_1 speed, called 'balance V_1' and the corresponding distance is called 'balance field'.





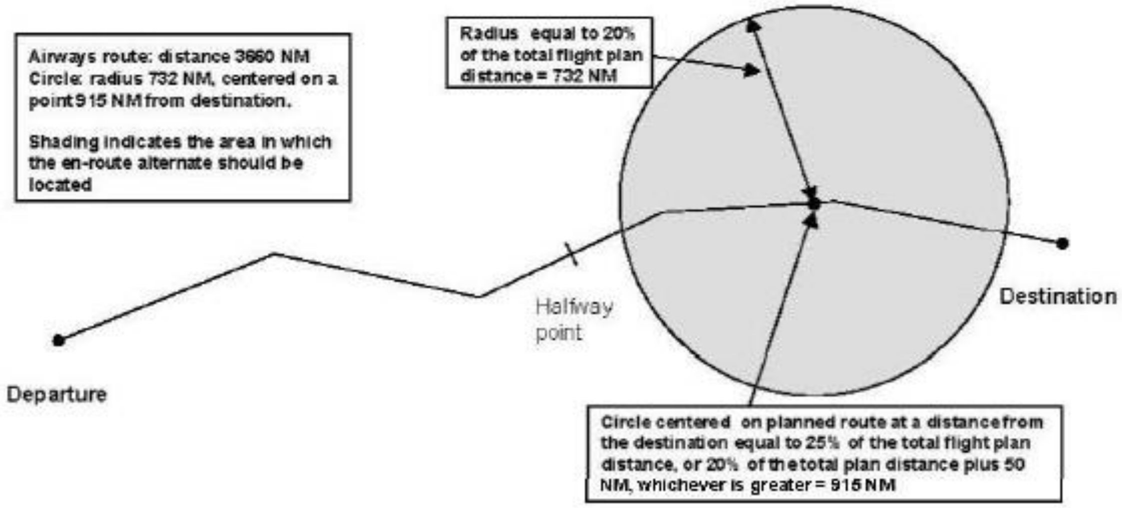
73. Fuel Policy



- **Taxi Fuel**
  Total amount of fuel prior to take-off including operation of ice protection system and APU (200kg for A320)

- **Trip Fuel**
  Fuel used during the route -> T/O, CLB, CRZ: TOC to TOD, DES, APP, LDG

- **Contingency Fuel**
  5% of TRIP Fuel or
  Amount to fly 5 min' holding speed at 1500ft over destination, in standard conditions (200kg for A320)
  OR
  Not less than 3% or 5 minutes, whichever is greater, of the planned Trip Fuel or in the event of in-flight re-planning, 3% of the Trip Fuel for the remainder of the flight, provided that an en-route alternate is available in accordance with the diagram below.



The en-route alternate should be located within a circle having a radius equal to 20% of the total flight plan distance, the centre of which lies on the planned route at a distance from the destination of 25% of the total flight plan distance, or at 20% of the total flight plan distance plus 50 NM, whichever is the greater.

- **Alternate Fuel**
  Destination to alternate - G/A from MDA/H + MISAP, CLB, CRZ: TOC to TOD, DES, APP, LDG

- **Final Reserve Fuel**
  30 minutes at 1500ft ARP elev. in ISA calculated with the estimated landing mass at the alternate (or destination if no alternate)
  If no alternate is required it must be increased to 45 minutes.

- **Additional Fuel**
  For the alternate aerodrome procedure: if required, but not less than fuel to fly for two hours, calculated with the normal cruise consumption, after arriving overhead the destination aerodrome, including final reserve fuel;

- **Extra Fuel**
  At the discretion of the commander.

74. Low Fuel State Emergency

If, for whatever reason, it becomes apparent that the aircraft **may** land with less than Final Reserve Fuel a **PAN PAN** must be reported to ATC reporting the estimated fuel time remaining in minutes. ATC must be kept informed thereafter.
If it becomes apparent that the aircraft **will** land with less then Final Reserve Fuel a **MAYDAY** call to ATC is to be made reporting the estimated fuel time remaining in minutes.

75. Icing conditions

May be expected when the OAT or when the TAT is at or below 10°C and there is visible moisture in the air or standing water, slush, ice or snow is present on the taxiway or runways.

a. **Clear ice**: is a crystal clear and solid layer of ice on the top of the aeroplane critical surfaces, which can almost not be detected visually. It is formed by a relatively slow freezing of large super-cooled droplets from freezing fog, drizzle or rain.
b. **Blade ice**: it can form on the back side of fan blades when the engine rotates overnight, in a humid atmosphere, at temperatures close to or below 0 degrees C°
c. **Rime ice:** is a whitish rough deposit of ice formed by instantaneous freezing of small super-cooled water droplets on any part of the aeroplane.
d. **Frost**: it can form on aircraft surfaces in clear air when the aeroplane is parked in sub-zero temperatures.

76. Anti-Icing

Anti-icing is the process of protecting against the formation of frozen contaminant, snow, ice, and slush on surface.
Anti-icing is accomplished by applying a protective layer, using a viscous fluid called anti-ice fluid, over a surface to absorb the contamination. All anti-ice fluids offer only limited protection.

- **One step de-icing and anti-icing** → with this method de-icing and anti-icing are carried out in one single step. One-step de-icing/anti-icing includes anti-icing. In this process the rest of the fluid film will provide only a very limited duration of anti-ice protection.
- **Two step de-icing and anti-icing** → with this method de-icing is carried out in the first step with just hot water or a hot mixture of anti-icing fluid and water. Anti-icing is carried out in the second step with a hot or cold anti-icing fluid to give protection against freezing or refreezing.

    - Critical surfaces: leading edges and upper surfaces of wings, vertical and horizontal stabilizers, all control surfaces, slats and flaps
    - Effect of frozen deposits: loss of lift, more drag, and weight, increase of stall speed, stall before warning, stall at lower angle of attack, fan/engine vibration, incorrect readings on instruments

77. De-Icing

De-icing is the process of removing frozen contaminant, snow, ice, and slush from a surface. De-icing can be accomplished by mechanical methods; through the application of heat; by use of chemicals. De-icing fluids are always applied heated and diluted.

78. Hold Over Time – HOT

HOT is the estimated time an anti-icing fluid will prevent frost, ice, snow or slush to form on surfaces of an a/c. It will be shortened in heavy weather conditions or high wind or jet as well. Before take-off the commander shall make sure that the holdover time has not run out, if so, the aircraft has to be de-iced/anti-iced again.

79. Routine Actual Weather Report – METAR

Compiled half-hourly or hourly.

CAVOK
Visibility is greater than 10km, no clouds below 5000ft or below highest MSA, no Cumulonimbus, no precipitation, thunderstorm, shallow fog or low drifting snow.
SKC
If any of the above conditions are not met but there is no cloud to report
TREND
When significant changes are forecasted in the next 2 hours. BECMG and TEMPO used.
FM - From, TL – Until, AT – at.
NOSIG
When no significant changes expected the trend is replaced by this.

80. Aerodrome Weather forecast – TAF

9 hour TAF
Issued and updated every 3 hours
12-24 hour TAF
Issued and updated every 6 hours
TEMPO
The `TEMPO` group is used for any conditions in wind, visibility, weather, or sky condition which are expected to last for generally less than an hour at a time (occasional), and are expected to occur during less than half the time period

81. RNP – Required Navigational Performance

NAVIGATION ACCURACY

Each aircraft operating in RNP airspace shall have a total system navigation position error equal to, or less than, the RNP value for 95 % of the flight time

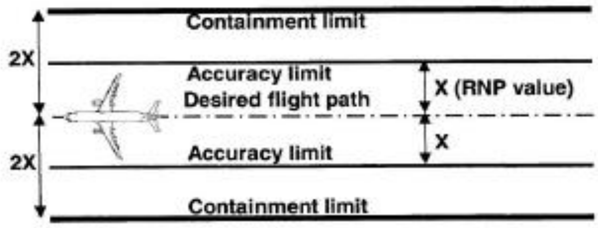


Fig. 1 RNP-X accuracy and containment limit

FUNCTIONALITY REQUIREMENTS

- FMS flight path definition and construction
- FMS functions
- Navigation database
- Navigation display
- APs and FDs, etc.

RNP ROUTES SUPPORTED BY RADIO NAVAID COVERAGE

- Typical RNP values are RNP-5 and RNP-4, but RNP-2 is considered for US domestic airspace.
- In Europe, Basic RNAV **(BRNAV)** airspace (**RNP-5**) was implemented in April 1998.
- RNP-1 is progressively introduced for RNAV SIDs and STARs in Europe (March 2003).

RNP ROUTES OUTSIDE RADIO NAVAID COVERAGE

En-route oceanic navigation or for continental areas outside radio navaid coverage.
Typical RNP values are **RNP-10** and **RNP-12**

AIRCRAFT WITH GPS PRIMARY

When GPS PRIMARY is available in flight, on-board navigation performance exceeds the currently known requirements for any kind of route, including RNAV approaches. The availability of GPS PRIMARY, on any given route, is a function of the:

- Satellite constellation configuration;
- Aircraft equipment;
- Aircrafts geographical position;
- required navigation accuracy;
- GPS integrity.

With the GPS PRIMARY function, the **Receiver Autonomous Integrity Monitoring (RAIM)** of Honeywell FMS or the **Autonomous Integrity Monitored Extrapolation (AIME)** of Litton FMS ensures navigation position integrity.

The operational requirements and procedures are determined by the type of RNP route or airspace, and will differ for:

- RNP en-route, in oceanic, or remote areas **(RNP-10);**
- RNP en-route, or terminal area within radio navaid coverage **(RNP-5/4);**
- SID/STAR, based on RNP **(RNP-1);**
- RNAV approach, based on RNP **(RNP-0.3).**

82. RNAV – Area Navigation

A navigation method that enables aircraft **operations on any desired flight path** within station-referenced navigation aids or within capability limits OF self-contained aids, or a combination of both.
An RNAV system may be used in the **horizontal plane**, which is known as **lateral navigation (LNAV),** but may also include functional capabilities for operations in the **vertical plane**, known as **vertical navigation (VNAV).**

RNAV is now also used in Terminal Areas for SID, STAR and **Instrument Approach Procedures (IAP)** of NPA type.

83. RNP-10 in oceanic or remote areas

RNAV has been used for years over oceanic or remote areas.
But the RNP concept is recent and MNPS over North Atlantic does not refer to any RNP value. MNPS over North Atlantic may be considered equivalent to about **RNP-12**. RNP-10 is implemented over North, Central and East Pacific areas.

84. BRNAV (RNP-5) based on radio navaid

- B-RNAV (also referred to as RNP-5) means a required navigational performance accuracy that shall be within 5 NM of the desired flight path at least 95% of the flight time.
- Wizz Air aircraft are certified by the Authority to operate according to B-RNAV requirements,
- Aircraft equipped with GPS PRIMARY fulfil all RNP requirements up to RNP-1 when GPS PRIMARY is available.

85. PRNAV (RNP-1) Precision RNAV

P(precision)-RNAV defines European RNAV operations which satisfy a required track-keeping accuracy of ±1 NM for at least 95% of the flight time (RNP-1).

P RNAV procedures apply to operations including **departures, arrivals, and approaches** up to the point of the Final Approach Waypoint (FAWP). This may involve flight below Minimum Sector Altitude/Minimum Flight Altitude/Minimum Radar Vectoring Altitude.

Specific operator approval is required for the use of P-RNAV. Wizz Air Hungary has obtained this approval from the Hungarian CAA.

<u>Navigation Sources</u>
The aircraft position can be determined by the following navigation sources:

- DME/DME;
- VOR/DME;
- INS (with radio updating or the length of time that a particular IRS can be used to maintain PRNAV accuracy without external update is determined at the time of certification)
- GNSS

86. Receiver Autonomous Integrity Monitoring - RAIM

RAIM, or an equivalent means of integrity monitoring as part of a multi-sensor navigation system, must be provided, where GNSS is used as the primary navigation source.

87. In-flight Equipment Failure

The minimum equipment required to be serviceable in order to fly a P-RNAV or RNP-1 procedure is:
One RNAV system, which includes:

- One FMGC
- One MCDU
- One GPS receiver, or one VOR and one DME, for FM navigation update
- Two IRS, and
- One FD in NAV mode.

In addition:

- On the PF side: PFD and ND must be operative.
- On the PNF side: at least one of the two EFIS must be operative (to enable temporary display of ND information through the PFD/ND switch).

88. RNAV Instrument Approach Procedure - RNAV IAP

- RNAV approach, procedure, designed in overlay to a conventional IAP, based on ground radio navaids.
- Stand-alone RNAV approach, not associated with an RNP.
- Stand-alone RNAV approach requiring GPS accuracy, sometimes called GPS (standalone)
- RNAV approach with associated RNP value, with and/or without GPS. (RNP-0.3)

89. RVSM - Reduced Vertical Separation Minima

RVSM airspace in Europe the airspace **between FL290 to FL410**, inclusive is considered special qualification airspace.
All Wizz Air airplanes are authorized to conduct RVSM operations.

FLIGHT PLANNING
For all flights planned through RVSM airspace a Significant Weather Chart shall be available.

SERVICEABLE EQUIPMENT
The following equipment shall be serviceable before entering RVSM airspace:

- Two primary altimeter systems (agree within ± 200 feet);
- One automatic altitude control system;
- One altitude alerting system;
- A transponder that can be connected to the altitude measurement system in use for maintaining altitude.

90. Ground Proximity Warning System Procedures

The (Enhanced) Ground Warning Proximity System ((E)GPWS) is designed to alert pilots that the aircraft position in relation to the terrain is abnormal and, if not corrected, could result in a Controlled Flight Into Terrain (CFIT).
Cannot be deactivated.

Mode	Condition	Aural Alert	Aural Warning
1	Excessive descent rate	"SINKRATE"	"PULL UP"
2	Excessive terrain closure rate	"TERRAIN TERRAIN"	"PULL UP"
3	Excessive attitude loss after take off or go-around	"DON'T SINK"	(no warning)
4a	Unsafe terrain clearance while gear not locked down	"TOO LOW - GEAR"	"TOO LOW - TERRAIN"
4b	Unsafe terrain clearance while landing flap not selected	"TOO LOW - FLAP"	"TOO LOW - TERRAIN"
4c	Terrain rising faster than aircraft after take off	"TOO LOW - TERRAIN"	(no warning)
5	Excessive descent below ILS glideslope	"GLIDESLOPE"	"GLIDESLOPE"(1)
6	Advisory Callout of Radio Height	(for example) "ONE THOUSAND"	(no warning)
6	Advisory Callout of Bank Angle	"BANK ANGLE"	(no warning)
7	Windshear protection	"WINDSHEAR"	(no warning)
-	Terrain Proximity	"CAUTION TERRAIN"	"TERRAIN TERRAIN PULL UP"

91. TCAS

An aircraft collision avoidance system designed to reduce the incidence of mid-air collisions between aircrafts.
TCAS is **based on** secondary surveillance radar (**SSR) transponder** signals, and operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft.

- SSR C mode +ALT / only transmit
- SSR S mode +SPD +HDG / transmit + receive (TCAS required)

<u>Procedures:</u>
<u>All engine</u>:
◇ WHITE rhombus „pussy" (NO action)

● **Traffic Advisory**
TA YELLOW circle symbol ~40sec → „traffic-traffic"
PF should have prepare himself; callout: „I have control"

Resolution Advisory

RA RED square symbol ~25sec →„climb-climb" or „descent-descent" or „maintain/adjust vertical speed"

PF: AP- disengaged, CLB or DESC based on RA

TCAS will show the necessary vertical SPD on the VSI (red and green ARC)

PNF: „TCAS RA" on radio

When „Clear of conflict"

PNF: „Clear of conflict" to the radio and go back to the desired ALT

One engine INOP or emergency DESC:
Switch **TA mode only**: TCAS two way communication is remain, but NO resolution advisory for you, just the intruder.

92. Communication Failure

7500 UNLAWFUL INTERFERENCE **7600** RADIO FAILURE **7700** MAYDAY

If in VMC

- Continue to fly in VMC
- Land at the nearest suitable airport and
- Report arrival to the appropriate ATC unit

If in IMC

- Maintain the last assigned speed and level, or a minimum flight altitude if higher, and report your position over the CRP. After 20 minutes adjust level and speed in accordance with the filed flight plan
- Fly to the appropriate navigation aid serving the DEST airport and hold over this aid
- commence descent from the navigation aid as close as possible to
  - the expected approach time last received and acknowledged, or
  - the estimated time of arrival in accordance with the filed flight plan.
- Make a normal instrument approach from the designated navigation aid. Land, if possible, within 30 minutes after the ETA or the last acknowledged expected approach time, whichever is later.

93. Turbulence

Light turbulence
Defined as turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, and yaw). Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. In flight service does not have to be suspended, however the safety of the passengers must be assured.

Moderate turbulence
Defined as turbulence that is similar to light turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged.

Severe turbulence
Defined as turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in airspeed. Occupants are forced violently against their seatbelts and loose objects will move around the aircraft.

94. Airport Firefighting Categorisation

A320 is category 6, but category 4 is also suitable for the A320 if there are infrequent A320 movements at the airfield. Not more than 8 movements per day.
If the destination is a category 4 airfield the alternate has to be a category 6.

95. Wake Turbulence Categories

Mass Categorys for wake vortex seperation	
Super	Airbus A380
Heavy	MTOM > 136.000kg
Medium	7000 < MTOM < 136.000kg
Light	MTOM < 7000kg

96. Separation of Aircraft on Departure

Leading aircraft	Following aircraft		Min. spacing at the time aircraft is airborne
Heavy	Medium / Light	Departing from the same position	2 minutes
Medium	Light		
Heavy (full length takeoff)	Medium / Light	Departing from an intermediate point on the same runway	3 minutes
Medium	Light		

97. Separation of Aircraft on Landing

Leading Aircraft	Minimum distance
A380	7nm
Heavy	5nm
Medium	3nm

98. Low Visibility Operations

Low visibility operations (LVO) are operations which include:

- Manual take-off (RVR below 400 m);
- Auto-coupled approach to below DH, with manual flare, landing and roll-out;
- Auto-coupled approach followed by auto-flare, auto landing and manual roll-out;
- Auto-coupled approach followed by auto-flare, auto landing and auto-roll out, when the applicable RVR is less than 400m.

99. MEL – Minimum Equipment List

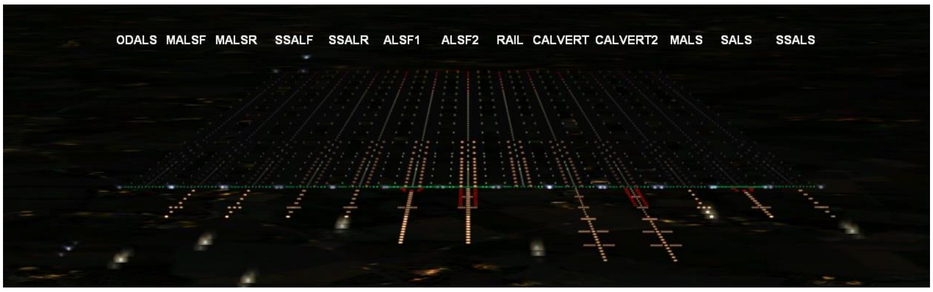
MEL lists all the equipment, systems and installations that must be serviceable before a particular flight is undertaken.
Items that may be unserviceable are indicated, together with any additional limitations that may apply to flights with such items inoperative.
The MEL is based on, but may not be less restrictive than, the Master MEL which is given by the manufacturer.

100. CDL – Configuration Deviation List

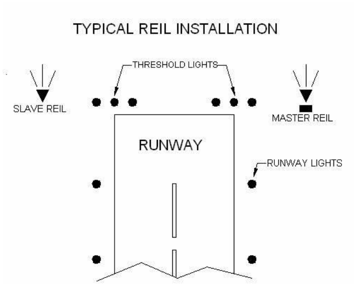
Lists the aeroplane panels and doors that may be missing for a particular operation and graphically indicates areas of damage to the aeroplane skin/structure that are considered acceptable for flight.

101. Approach Lighting System

- **HIRL** – High Intensity Runway Light system
- **MALSR** – Medium intensity Approach Light System with Runway alignment indicator lights
- **TDZ/CL** – runway Touchdown Zone and Centerline Lighting system
- **ALSF 1** – high intensity Approach Light System with Sequenced Flashing lights, system length 2,400 to 3,000 feet
- **ALSF 2** – high intensity Approach Light System with Sequenced Flashing lights and red side row lights the last 1,000 feet, system length 2,400 to 3,000 feet
- **SALS/SALSF** – Short Approach Lighting System, high intensity (same as inner 1,500 feet of ALSF 1)
- **SSALF** – Simplified Short Approach Lighting system with sequenced Flashing lights and runway alignment indicator lights, system length 2,400 to 3,000 feet
- **MALD/MASLF** – Medium intensity Approach Lighting, with and without Sequenced Flashing lights, system length 1,400 feet
- **ODALS** – Omni Directional Approach Lighting System with sequenced flashing lights, system length 1,400 feet
- **RAIL** – Runway Alignment Indicator Lighted sequence flashing lights (which are only installed in combination with other light systems)



102. Runway Lights



- **Runway End Identification Lights (REIL)** – unidirectional (facing approach direction) or omnidirectional pair of synchronized flashing lights installed at the runway threshold, one on each side.

- **Runway end lights** – a pair of four lights on each side of the runway on precision instrument runways, these lights extend along the full width of the runway. These lights show green when viewed by approaching aircraft and red when seen from the runway.

- **Runway edge lights** – white elevated lights that run the length of the runway on either side. On precision instrument runways, the edge-lighting becomes yellow in the last 2,000 ft (610 m) of the runway, or last third of the runway, whichever is less.

- **Taxiways** are differentiated by being bordered by blue lights, or by having green center lights, depending on the width of the taxiway, and the complexity of the taxi pattern.

- **Runway Centerline Lighting System (RCLS)** – lights embedded into the surface of the runway at 50 ft (15 m) intervals along the runway centerline on some precision instrument runways. White except the last 900 m (3,000 ft): alternate white and red for next 600 m (1,969 ft) and red for last 300 m (984 ft).

- **Touchdown Zone Lights (TDZL)** – rows of white light bars (with three in each row) at 30 or 60 m (98 or 197 ft) intervals on either side of the centerline for 900 m (3,000 ft)

- **Taxiway Centerline Lead-Off Lights** – installed along lead-off markings, alternate green and yellow lights embedded into the runway pavement. It starts with green light at about the runway centerline to the position of first centerline light beyond the Hold-Short markings on the taxiway.

- **Taxiway Centerline Lead-On Lights** – installed the same way as taxiway centerline lead-off Lights, but directing airplane traffic in the opposite direction.

- **Land and Hold Short Lights** – a row of white pulsating lights installed across the runway to indicate hold short position on some runways that are facilitating land and hold short operations (LAHSO).

103. Supplemental Oxygen Requirements

SUPPLY FOR	DURATION AND CABIN PRESSURE ALTITUDE
All occupants of flight deck seats on flight deck duty	Entire flight time when the cabin pressure altitude **exceeds 13000ft**
	Entire flight time when the cabin pressure **altitude exceeds 10000ft** but does **not exceed 13000ft** after the first **30 minutes** at those altitudes
	but in **no case less than 2 hours** for airplanes certificated to fly at altitudes more than 25000ft
All required cabin crewmembers	Entire flight time when cabin pressure altitude **exceeds 13000ft** but **not less than 30 minutes**
	Entire flight time when cabin pressure altitude is **greater than 10000ft** but does **not exceed 13000ft after** the first **30 minutes** at these altitudes.
100% of passengers	Entire flight time when the cabin pressure altitude **exceeds 15000ft** but in **no case less than 10 minutes**
30% of passengers	Entire flight time when the cabin pressure **altitude exceeds 14000ft** but does **not exceed 15000ft**
10% of passengers	Entire flight time when the cabin pressure altitude **exceeds 10000ft** but does **not exceed 14000ft after the first 30 minutes** at these altitudes.

104. ACN – PCN

ACN: expressing the relative effect of an aircraft on the runway pavement for a specified standard subgrade category.
PCN: (five-part code) to indicate the strength of a RWY, TWY or APRON. It helps to ensure that the airport ramp is not subjected to excessive wear and tear, thus prolonging its life.

ACN<PCN

INSTRUMENTATION

105. IAS – INDICATED AIRSPEED

IAS is the speed shown on our airspeed indicator (AIS). It is not actually a real speed but an indication of dynamic pressure. This is because lift depends on dynamic pressure. Increasing dynamic pressure results in reducing static pressure and producing lift.

106. CAS – CALIBRATED AIRSPEED

CAS is IAS corrected for position and instrument errors. It is a slightly more accurate IAS. Larger modern aircraft have air data computers that remove the instrument and position error, the display of speed on these aeroplanes is CAS. Almost all the V speeds used in performance (such as V_1 and V_R) are CAS.

107. EAS - EQUIVALENT AIRSPEED

EAS is CAS corrected for compressibility, and is the most accurate of the indicated airspeed family; however IAS, CAS, and EAS are all measures of dynamic pressure. V_{MO}, which is the maximum operating speed of a large aeroplane, is a very fast speed and the air is compressing and it is an EAS.

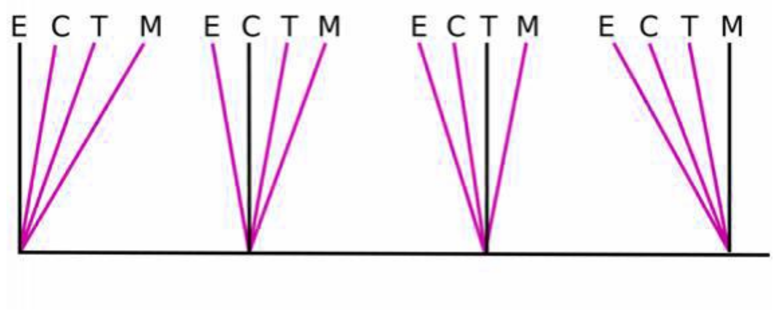
108. TAS – TRUE AIRSPEED

TAS is the actual speed of the aircraft relative to the air mass in which it is flying
It is a real speed, not a dynamic pressure. TAS is the true value of a/c performance in cruise, thus listed in aircraft specs, manuals, performance comparisons, pilot reports, etc., it is the speed also normally listed on the flight plan.

109. M - MACH NUMBER

Mach number is not a speed but a ratio of TAS to the local speed of sound (LSS). Mach number =TAS/LSS
The local speed of sound varies with air temperature. As altitude increases, the air temperature normally decreases and the speed of sound decreases. This means that if an aeroplane climbs at constant Mach number, its TAS decreases.

LSS Formula: 38.94 * $\sqrt{T\ (Kelvin)}$ 0°C = 273°K



110. ASI – Air Speed Indicator

The ASI measures dynamic pressure as the difference between the total pitot pressure measures in the instruments capsule and the static pressure measures in the case.
The dynamic pressure represents the indicated airspeed as knots per hour. The ASI is calibrated to ISA at MSL.
The ASI suffers from the following errors:

- Instrument, pressure, density, compressibility, maneuver, blocked pitot static system.

If the static probe becomes blocked:

- at constant altitude, the ASI will read correctly
- During descent, the ASI will over read
- During climb, the ASI will under read

If the static probe becomes blocked:

- at constant altitude, the ASI will not change
- During descent, the ASI will under read
- During climb, the ASI will over read

111. Altimeter

As the aircraft climbs the static pressure in the instrument case decreases, which allows the enclose capsule to expand, and this in turn moves the needle on the instrument face to indicate a corresponding altitude. For a descent the opposite function applies.
Errors of the ALT are:

- Instrument, pressure, time-lag, barometric, density, temperature, blocked static port.

If the static probe becomes blocked:

- The indication will be stuck

112. VSI – Vertical Speed Indicator

The capsule is fed with static pressure and reacts immediately to any change is static pressure, whereas the static pressure feed into the case is restricted or slowed by a metering unit, thus creating a differential static pressure between the capsule and the case. As long as the a/c continues to climb or descent the VSI will translate this as a rate of climb or descent measurement on the instrument dial face.
Errors:

- instrument time-lag, pressure, manoeuvre

If the static probe becomes blocked:

- The indication will slowly move back to 0 and not change.

113. Gyroscope

The gyroscope measures the force experienced on its rotor body during a maneuver of an a/c. The rotor is usually suspended in a system of frames called gimbals, which are arranged at right angles to each other and are used as a conduit to transfer the force experienced on the rotor to displayed measurement on the instrument face.
The gyro's rigidity property allows it to remain stable in space while the a/c moves around it.
Any force applied to the gyro as a result of the a/c changing direction or attitude around the gyro will presses the gyro.

114. Turn and slip Indicator

It is two instruments combined as a single unit. One measures turn, the other measures slip or skid.
Turn is the movement about the aircraft's yaw axis that result in a change of direction.
Slip is a lateral force into the turn,
Skid is a lateral force out of a turn.
The instrument consists of the following: a rate gyroscope which rotates about a horizon axis, one gimbal, which is pivoted about the a/c's fore and aft axis, two planes freedom
A: the gyroscope's spin axis, B: yaw axis of the gimbals.
The gyroscope's axis is aligned to the aircraft's lateral axis.

115. Magnetic compass

It is comprised of a freely suspended horizontal magnet attached to a compass card that is enclosed in a liquid-filled case. The magnet will swing so that its axis points roughly north-south, and aircraft moves around the magnet so that the compass heading of the aircraft is read off the compass card against a lubber line on the instrument case.

Errors:

- acceleration /deceleration: ANDS – Accelerate North, Decelerate South (on an east – west heading – Northern Hemisphere)
- turning errors: UNOS – Undershoot North, Overshoot South (Northern Hemisphere)

116. Autopilot Landing Systems

Fail-passive Automatic Landing System
An automatic landing system is fail-passive if, in the event of a failure, there is no significant out-of-trim condition or deviation of flight path or attitude - but the landing is not completed automatically.

The following are typical arrangements:

- A monitored automatic pilot in which automatic monitors will provide the necessary failure detection and protection.
- Two automatic pilots with automatic comparison to provide the necessary failure detection and protection.

Fail-operational Automatic Landing System.
An automatic landing system is fail-operational if, in the event of a failure, the approach, flare and landing can be completed by the remaining part of the automatic system.

The following are typical arrangements:

- Two monitored automatic pilots, one remaining operative after a failure.
- Three automatic pilots, two remaining operative (to permit comparison and provide necessary failure detection and protection) after a failure.

Fail-operational Hybrid Landing System
A system which consists of a primary fail-passive automatic landing system and a secondary independent guidance system enabling the pilot to complete a landing manually after failure of the primary system.

117. Frequency Ranges

- NAV 108.000 - 117.975
- COM 118.000 – 136.975
- ILS 108.000 – 111.975 odd
- VOR 108.000 – 111.975 even
- NAV aids: enroute 200 - 300NM / terminal below 100NM 112.000 – 117.975

HUMAN PERFORMANCE

1. Airmanship

Airmanship is the ability to operate an airplane with competence both on the ground and in the air. The three fundamental principles of expert airmanship are: skill, proficiency and discipline.

Tony Kern has authored seven books on human performance, including the award-winning “Plane of Excellence” trilogy (Redefining Airmanship, Flight Discipline, and Darker Shades of Blue). He uses the analogy of an airmanship as a building composed of a foundation, pillars and capstones. (Like a pantheon).
The foundation stones of the airmanship model, discipline, skill and proficiency. Good airmanship requires us to draw upon multiple knowledge bases. Five critical bases of knowledge described as ’pillars of knowledge’. They include a knowledge of self, aircraft, team, environment and risk. The capstones of the airmanship are situational awareness and judgment.

2. CRM – Crew Resource Management

It is the effective use of all available resources for flight crew personnel to assure a safe and efficient operation, reducing error, avoiding stress and increasing efficiency.

CRM encompasses a wide range of knowledge, skills and attitudes including

- communications,
- loss of situational awareness,
- problem solving,
- decision making, and
- teamwork;

Together with all the attendant sub-disciplines which each of these areas entails.

The elements which comprise CRM are not new but have been recognized in one form or another since aviation began, usually under more general headings such as 'Airmanship', 'Captaincy', 'Crew Co-operation', etc.

CRM can also be defined as a **management system which makes optimum use of all available resources - equipment, procedures and people** - to promote safety and enhance the efficiency of flight operations.

CRM is concerned not so much with the technical knowledge and skills required to fly and operate an aircraft but rather with the cognitive and interpersonal skills needed to manage the flight within an organized aviation system.
In this context, cognitive skills are defined as the mental processes used for gaining and maintaining situational awareness, for solving problems and for taking decisions.
Interpersonal skills are regarded as communications and a range of behavioral activities associated with teamwork.
In aviation, as in other walks of life, these skill areas often overlap with each other, and they also overlap with the required technical skills.

3. Situational awareness

Keeping track of 'what is going' on around you in a complex environment. The crew has to be aware of what's happening in the vicinity, in order to understand what will happen in the near future. It is essential for the correct decision making.

4. Decision making – DODAR Model

DODAR is an acronym for decision making.
D – **Diagnose** (what is the problem)
O – **Options** (hold, divert, immediate landing etc.)
D – **Decide** (which option)
A – **Act** or Assign (carry out selected option and assign tasks)
R – **Review** (can involve addition of new information, and/or the ongoing result(s) of selected option).

5. Decision making – FORDEC Model

F **- Fact and Fuel** (what is the problem, what is the fuel on board, if relevant)
O **- Options** (hold, divert, immediate landing, etc.)
R - **Risks** (what is the downside of each option, what is upside, for example a runway may be further away but is longer)
D **- Decision** (which option)
E - **Execute** (carry out selected option)
C - **Check** (did everything work/go to plan, what else needs to be done).

- **Facts** is the first step to solve a problem or make a decision. It is necessary to find out what is has happened, what is wrong and if possible what causes it. Often an aircraft's computers (EICAS – Boeing, ECAM – Airbus) will diagnose the fault but it is important to confirm and to avoid "confirmation bias". The Facts stage involves determining and confirming the problem.
- **Options** is determining what choices you have given the problem and circumstances. Not all faults are urgent or require immediate action. If action is required, such as a diversion there may be choices in airfields such as one where there is engineering or company support, length of runway given the fault.
- **Risks** is assessing the potential downsides and benefits of each viable option. Often there are several choices available and there needs to be a reasonable decision made. This is normally associated with airport and runway choice but there are other scenarios as well. Even the act of diverting requires risk assessment and it may be less risk adverse to continue (short runways, bad weather etc.) When all options are equally safe, an airport with maintenance or company support has greater benefit.
- **Decide** is choosing the best option available to you. In a modern cockpit environment this should be discussed with both crew members.
- **Execution** is carrying out the appropriate action and to assign tasks to people who are to execute them.
- **Check** is a constant process, not solely when the actions are complete. It is needed to ensure that everything is proceeding according to plan, and the desired safe outcome is likely. If this is not the case the process can be started again to fact check what has changed or what is not working and then adapt as necessary.

6. Decision making – DECIDE model

Processes of decision making can be divided into the followings:

- **Detect** - when pilot detect something has happened that requires attention – *emergency occurs*
- **Estimate** - estimate the significance of the change to the flight – *what is the problem*
- **Choose** - choosing a safe outcome – *what are the options*
- **Identify** - identifying of action that will control the change- what is the best course of action
- **Do** - do the action of the best option - carry out the action
- **Evaluate** - evaluate the effect of the change - review of the situations