1. Air Transport as part of overall Traffic

→ **Air traffic/transport:** Describes all operations that are used to change the location of people, freight and post by air and incorporates all services indirectly and directly associated with the change of location (flight catering, airport etc)

→ **Aviation:** In addition to air transport, the in-kind service required to produce air transport services (for example, the manufacture of aircraft or air traffic control systems)

→ **Performance metrics**

- PKM (passenger kilometers) = PAX × KM
  ↳ for passenger transport
- TKM (tonnes kilometers) = Tons × KM
  ↳ for freight transport
  * Also for nautical miles **1 NM = 1.852 KM**
- ASK (available seats kilometers) = available seats × KM
- RPK (revenue seats kilometers) = sold seats × KM
- SLF (seat load factor) = RPK/ASK
- CLF (cargo load factor)

→ **Air transport Data**

Net profit (USD):	35.3bn (16.4) → USD 9.89/PAX
Profit margin:	7,7% (5,5% / 1.5%)
New aircraft:	1700 (USD 180bn Inv.)
Aircraft >50 seats:	28,000
Employees:	2.55m
SLF/CLF:	80% / 45%
PAX:	3.545bn (+240m)
RPK:	6610bn / +7,4% (1840km/PAX)
ASK:	8200bn / +6,7% (6.3%)
Freight:	51.3m tonnes
City pairs:	16,620
Accidents:	1/ 3.1m flights

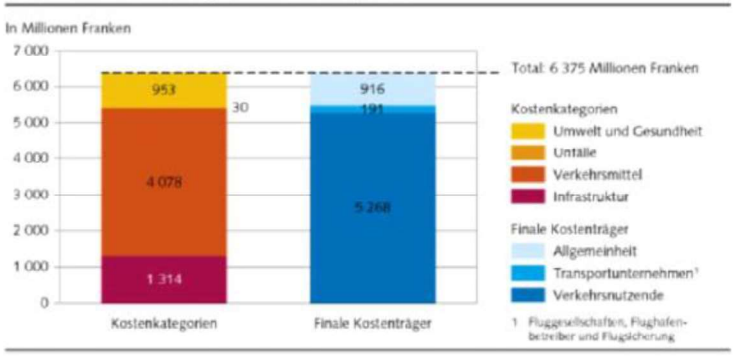
→ **Modal split (% of total transport)**

	PASSENGER CARS	P2W	BUS & COACH	RAILWAY	TRAM & METRO	AIR	SEA
1995	73.3	2.2	9.4	6.5	1.3	6.5	0.8
2000	73.0	1.8	9.2	6.2	1.3	7.7	0.7
2001	73.5	1.8	9.0	6.2	1.3	7.5	0.7
2002	74.1	1.9	8.8	6.0	1.3	7.3	0.7
2003	74.0	1.9	8.8	5.8	1.3	7.5	0.7
2004	73.8	1.9	8.6	5.8	1.3	7.9	0.7
2005	73.0	2.0	8.6	6.0	1.3	8.4	0.7
2006	72.8	1.9	8.4	6.1	1.3	8.7	0.7
2007	72.6	1.8	8.5	6.1	1.4	8.9	0.7
2008	72.4	1.9	8.5	6.3	1.4	8.7	0.7
2009	73.5	1.9	8.2	6.2	1.4	8.1	0.7
2010	73.2	1.9	8.2	6.3	1.4	8.4	0.6
2011	72.5	1.9	8.2	6.4	1.4	8.9	0.6
2012	72.2	2.0	8.2	6.6	1.5	9.0	0.7
2013	72.3	1.9	8.1	6.6	1.5	9.0	0.6

air transport is increasing ↵

Value creation:	CHF 33.5bn
Share of GDP:	5.6%
Employees (dir/ind)	190,000
Share CO2 Emissions	2.5%

Kosten und Finanzierung des Luftverkehrs, 2010



→ Total transport cost (2010) → CHF 94.7 bn
↳ of which CHF 6.4bn are air transport

ground transport is still at almost 76% of the total transport

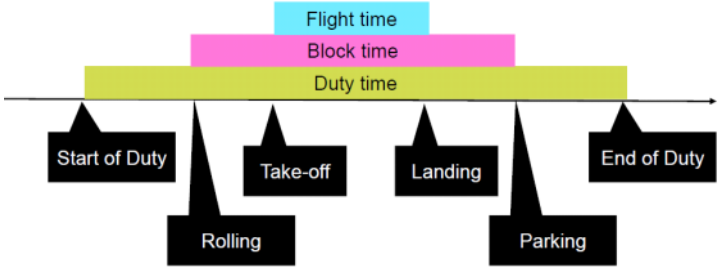
→ **Cool info:**

- Largest airport in terms of total passenger transport is **Heathrow**
- Largest airport in terms of total freight transport is **Frankfurt**
- Strongest airport pairs: **Paris – Toulouse** and **Madrid – Barcelona**
  Nearly all domestic flights
- Largest growth: **Rome – Catania**

2. Aircraft Operations

AFIS	Aerodrome Flight Information Service
AFM	Aircraft Flight Manual
ALT	Altimeter
AI	Attitude Indicator
ASI	Airspeed Indicator
FIC	Flight Information Center
GA or MISAP	Go-Around or Missed Approach
IAS	Indicated Airspeed
KIAS	Knots IAS
ROC	Rate of Climb
RTF	Radiotelephony
V STALL	Stall Speed

→ **AFM** (Aircraft flight manual): book that provides information about aircraft systems, limitations and performance



→ Preparation at home

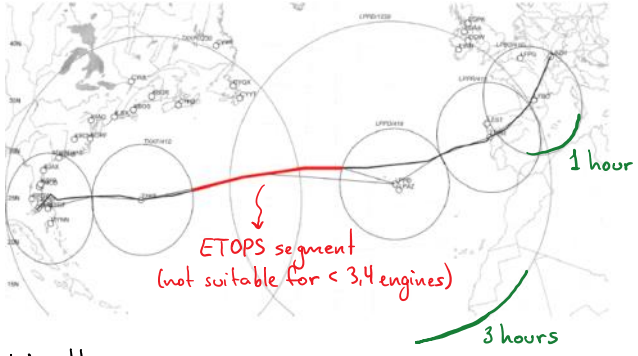
Rest periods Home-Base	Rest periods Abroad	Block times	Duty Times
previous duty time or 12 hours, the greater of	previous duty time or 10 hours, the greater of	100h in 28 days or 900h in a calender year	60h in 7 days, 190h in 28 days or 2000h in a calendar year

→ Crew

- **Crew** (Seating position): 1 Commander (CMD) (left), 1 Co-pilot (COPI) (right), 1 Senior Cabin Crew Member & 3 Cabin Crew Members (also F/A)
- **Commander** (Rank): Senior Captain or Captain
- **Co-pilot** (Rank): Senior First Officer (SF/O), First Officer (F/O) or Second Officer (S/O)
- Division of workload: 1 Flying Pilot (FP) & 1 Pilot Monitoring (PM)

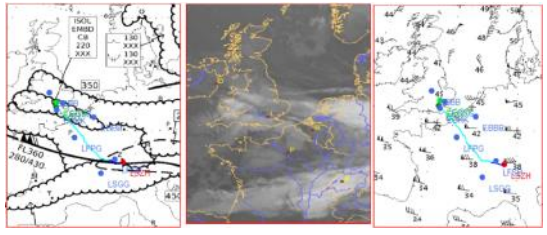
→ Airports → alternate airports

- Short haul: reachable within 60 min
- Long haul: (3 and 4 engines) reachable within 120 min
- ETOPS: (Twin OPS e.g. A330) reachable within 180 min



→ Weather

- Forecast: TAF (Terminal Aerodrome Forecast)
- Current: METAR (Meteorological Aerodrome Report)



angle of wind

scattered clouds at FL017 (at FL033)

METAR: EGLL 260750Z 08005KT 9999 SCT017 SCT033 16/15 Q1003

- EGLL: time (UTC)
- 08005KT: wind speed
- 16/15: temperature
- Q1003: QNH

if we go from 16 to this value (15) → high fog chances

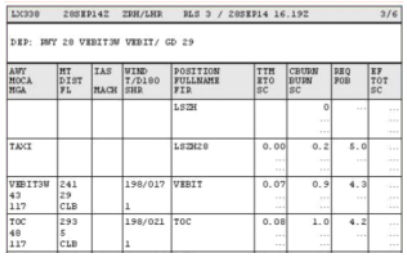
→ NOTAM (Notice to airmen)

- For airfields, airspaces, hazards

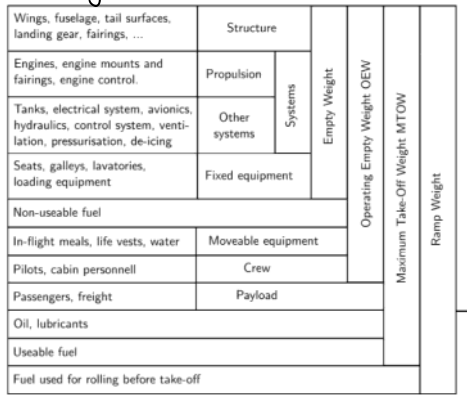
```
EGGW / LTN  04:55 - 10:55
-12AUG14 Radioactive material on board

     AD is not equipped to handle radioactive materials.
     In the event that an ACFT carrying radioactive materials has
     no alternative but to divert to Luton, pilot must inform Luton ATC
     on first contact.
-01JUL14

     CONSTRUCTION CRANE OPR BEARING 270DEG MAG, 3300M FM ARP, HGT
     582FT
     AMSL, MAX JIB HEIGHT 247FT AGL
-21OCT13

     DECLARED DIST CHANGED AS FLW:
     RWY  LDA        TODA      ASDA      TORA
     26   2080 M     3243 M    2219 M    2162 M,
     26A  0          2657 M    1828 M    1771 M,
     26C  0          1580 M    1110 M    1053 M,
     08C  0          1698 M    1132 M    1132 M,
     08B  0          2532 M    1688 M    1688 M,
     08   2162 M     3243 M    2162 M    2162 M.
```

→ Operational Flight Plan (OFP)

- Route
- Performance
- ATC Flight plan
- Mass & Balance
- Fuel Calculation



→ Weights and Fuel



aircraft, crew, PAX, freight etc (without the fuel)

→ Zero Fuel Weight

	A320-200	A321-200	A340-300	B777-300	B747-400	A380
Zero Fuel Weight (T)	61,0	71,0	181,0	237,8	251	369
Max Take-Off Weight (T)	73,5	83,0	275,0	350,0	397	577
Max LDG Weight (T)	64,5	75,0	192,0	251	295	391
Max Fuel (T)	18,8	18,6	120	145	216	256
Range (NM)	3500	3500	8500	7900	7300	8200
Passengers	168	200	230	300	400	853

• for example, A321 cannot fly fully tanked with fuel

Max fuel = 18T
Zero fuel weight = 71T
} 18+71 = 89T > Max T/O weight!

→ NOTOC (Notification to the captain)

• Dangerous goods → volume
  - where
  - weight
• Emergency response drill

→ At the Gate

• CMD → walk around
  * Log file, MEL

• COPI ⇒ Cockpit preparation, FMS (flight management system)

→ Take-Off (T/O) and Landing (LDG)

• Categories of aircraft

Wake Turbulence Categories (WTC)

WTC Category		Definition
J	SUPER	A380-800
H	HEAVY	ACFT types of 136000KG (300000LBS) or more
M	MEDIUM	ACFT types less than 136000KG (300000LBS) and more than 7000KG (15500LBS)
L	LIGHT	ACFT types of 7000kg (15500LBS) or less

• Separation T/O and LDG

2.12.5.3 Radar Separation

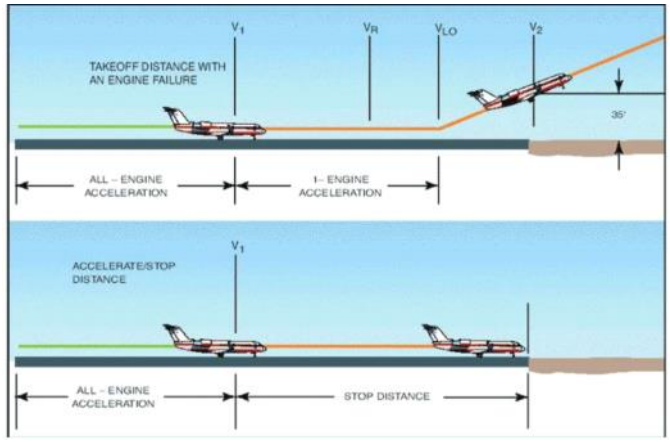
	Separation Minima (NM)			
WTC of Leading ACFT	WTC of Following ACFT			
	J	H	M	L
J	3 (1)	6 (2)	7 (2)	8 (2)
H	3 (1)	4 (2)	5 (2)	6 (2)
M	3 (1)	3 (1)	3 (1)	5 (2)
L	3 (1)	3 (1)	3 (1)	3 (1)

⇒ Most efficient sequence: L, M, H, J

• Wind limits & Contaminated RWY

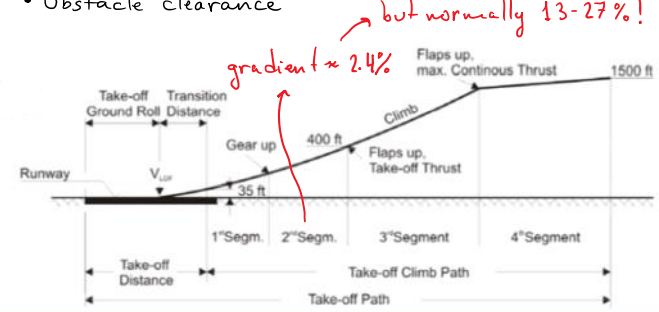
RUNWAY SURFACE CONDITIONS			RELATED TAKEOFF PERFORMANCE		
RUNWAY STATE and / or RUNWAY CONTAMINANT	Coverage	BAE/SF[1]	LPC RWY COND	THRUST RATING	Max Crosswind [3] (Gusts included)
dry	irrespective	—	DRY	FLEX	38
damp wet water patches ≤ 3mm (¼")	irrespective	GOOD	WET	FLEX	38
slush ≤ 3mm (¼") dry snow ≤ 3mm (¼") wet snow ≤ 3mm (¼")				TOGA [2]	29
rime or frost					
OAT at or below -15°C compacted or rolled snow	≤ 25 %	GOOD	WET	TOGA [2]	29
	26 — 100 %	GOOD to MEDIUM	COMPACTED SNOW	TOGA [2]	29
slippery when wet	irrespective	MEDIUM	WATER ¼"	TOGA [2]	25
OAT at or below -15°C compacted or rolled snow	≤ 25 %	GOOD	WET	TOGA [2]	29
	26 — 100 %	MEDIUM	COMPACTED SNOW	TOGA [2]	25
frozen ruts or ridges	irrespective				
dry snow >3 mm (¼") ≤ 101 mm (4") wet snow > 3 mm (¼") ≤ 25 mm (1")	≤ 25 %	GOOD	WET	TOGA [2]	29
	26 — 100 %	MEDIUM	WATER ¼" [4] WATER ½"	TOGA [2]	25
water > 3 mm (1/8") ≤ 13 mm (½") slush > 3 mm (1/8") ≤ 13 mm (½")	≤ 25 %	GOOD	WET	TOGA [2]	29
	26 — 100 %	MEDIUM to POOR	WATER ¼" [4] WATER ½"	TOGA [2]	20
ice (cold and dry)	irrespective	POOR	ICY	TOGA [2]	15 [5]
wet ice water on top of comp. snow dry snow over ice wet snow over ice	irrespective	NIL	NO OPS		

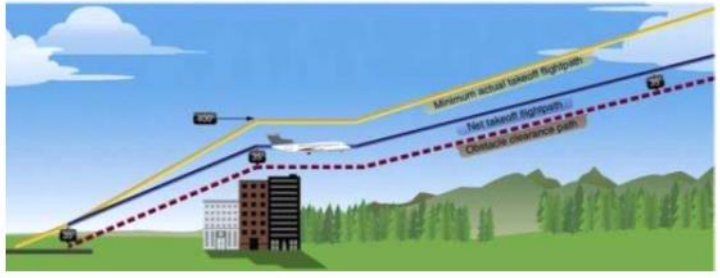
• T/O Performance calculation



$V_1 = 149\,KT$, $V_R = 150\,KT$, $V_2 = 153\,KT$

• Obstacle clearance





• Minimum flying altitude
  * Minimum Grid Altitude (MGA)
  * Minimum Sector Altitude (MSA)
  * Minimum Terrain Clearance Altitude (MTCA)

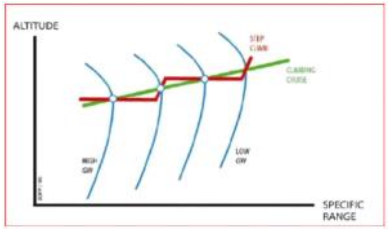
If the values for MGA, MSA, MTCA are lower than 6000ft, we can be sure not to find any obstacles above 5000ft ⇒ 1000ft margin

below 6000ft ⇒ 1000ft margin
above 6000ft ⇒ 2000ft margin

→ Climb

• Under FL100 ⇒ Max 250KT
• Over FL100 ⇒ manufacturer/airline (efficiency) (no limit)

- As the aircraft burns fuel, it becomes lighter and so it climbs to the «Optimum Cruise Level».
- In practice, therefore, a step climb is carried out.

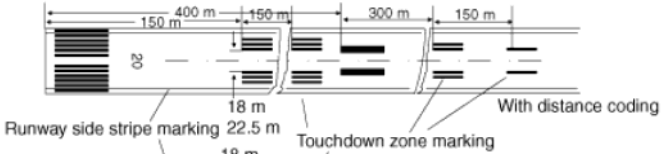


→ Approach

• Precision Approach (ILS) ⇒ lateral (localizer) and vertical (glideslope) adjustment

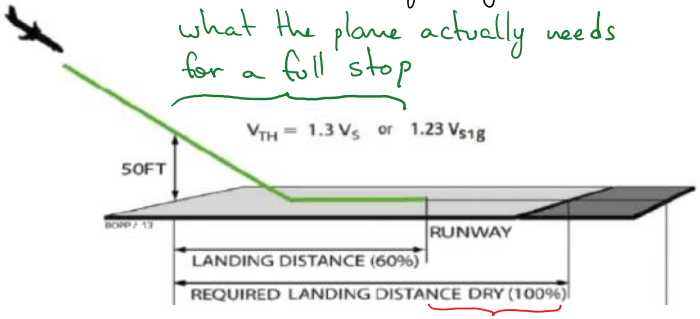
• Non-Precision Approach (VOR, NDB) ⇒ only lateral adjustment

→ Landing



• The landing distance is the effective distance 50ft to still stand. A safety margin is built in

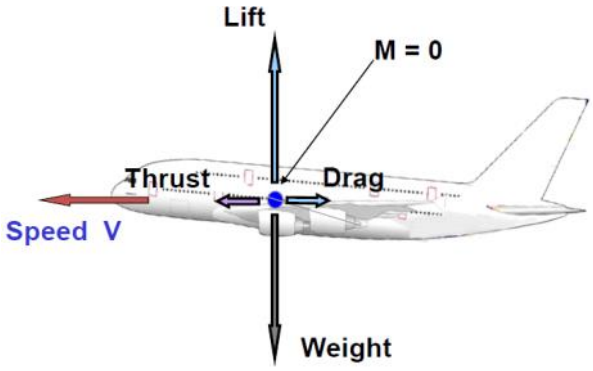
what the plane actually needs for a full stop



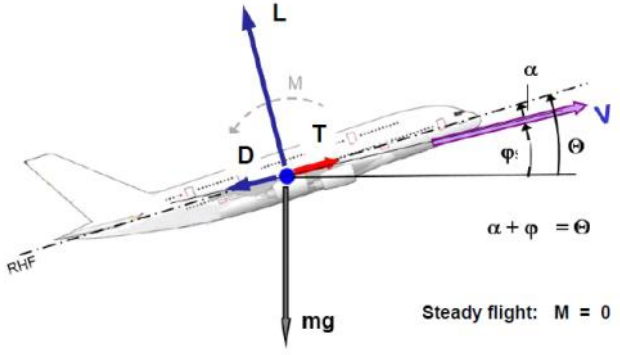
safety margin

3. Aerodynamics

→ Equilibrium ⇒ Drag = Thrust and Lift = Weight



• Design goal: Minimize drag → have a high lift to drag ratio



→ Definitions

• **Lift**: aerodynamic force perpendicular to the flight vector

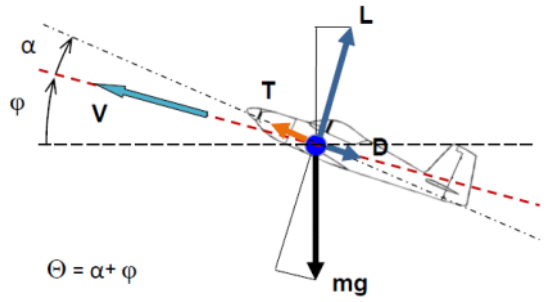
• **Drag**: aerodynamic force in opposite direction to the flight vector

C_D for drag
C_L for lift

$$F_x = C_x \frac{1}{2} \rho_\infty V_\infty^2 A$$

- C_x: force coefficient [-]
- F_x: force in x direction [N]
- ρ_∞: density (air) [kg·m⁻³]
- V_∞: Airspeed [m·s⁻¹]
- A: Reference area [m²]

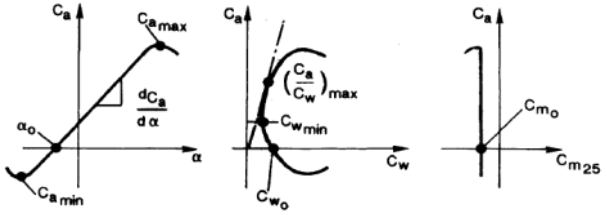
• This equation can be used for both lift and drag



equilibrium ⇒

$$T\cos(\alpha) - D - mg\sin(\varphi) = 0$$
$$L + T\sin(\alpha) - mg\cos(\varphi) = 0$$

• The force coefficients (c_D and c_L) depend on the attack angle



• Considering no friction, the induced drag coefficient C_{D_i} can be calculated as follows

$$C_{D_i} = \frac{C_L^2}{\pi \Lambda} \quad \text{where} \quad \Lambda = \frac{b^2}{F}$$

- b = Wing span
- F = Wing area
- Λ: Aspect ratio

C_{D_i} depends on the lift coefficient and the aspect ratio

⇒ Slim wing (with high aspect ratio) produces less induced drag than a compact wing (low aspect ratio)

→ Total drag force

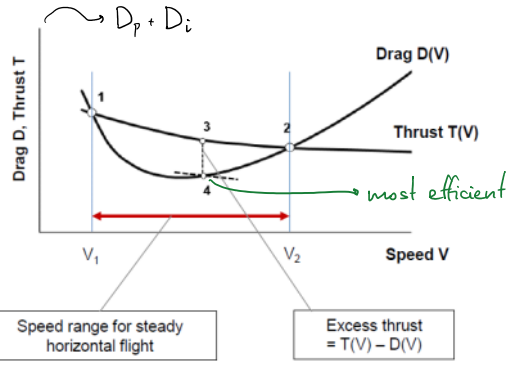
• Total drag $D_{Total} = D_{parasite} + D_{induced}$

• Total drag force coefficient $C_D = C_{D_{parasite}} + C_{D_{induced}}$

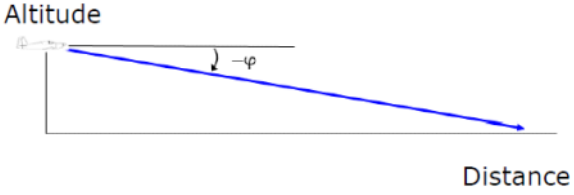
$$= C_{D_{parasite}} + \frac{C_L^2}{\pi \Lambda}$$

⇒ Total drag

$$D_{Total} = \frac{1}{2}\rho V^2 C_{D_{parasite}} + \frac{1}{2}\rho V^2 \frac{C_L^2}{\pi \Lambda}$$



→ No thrust (T = 0) ⇒ glide



$$\tan(\varphi) = -\frac{D}{L} = -\frac{C_D}{C_L}$$ → glide ratio

→ Fuel consumption

specific fuel consumption

$$\frac{SFC}{M_\infty} = \frac{\text{weight}}{\text{lift / drag}}$$

M_∞: mach number

→ General equations

$$\text{Lift to drag ratio} = \frac{\Delta s}{\Delta h} = \frac{V_{horizontal}}{V_{vertical}} = \frac{L}{D} = \frac{C_L}{C_D}$$

$$\text{Vertical speed} = \text{spent altitude per time} \Rightarrow \frac{L^3}{D^2} = \frac{C_L^3}{C_D^2}$$

Lift to drag ratio = Gleitzahl
vertical speed = Sinkzahl

4. Air Law

→ In order to fly a plane you need
- Pilot licence
- Medical licence
- Aircraft rating

1. Pilot Licence

- 4 types

		Restriction
LAPL*	Light Aircraft Pilot License	Single-engine, land aircraft with piston-engine up to 2000kg departure weight, max 3 passengers/non-commercial
PPL*	Privat Pilot License	Non-commercial
CPL**	Commercial Pilot Licence	Commercial for certain type ratings (Single Pilot); or classes
ATPL***	Airline Transport License	Commercial/for MPA (multi pilot aeroplane) compulsory

* For fixed-wing aircraft, helicopters, gliders and balloons
** For fixed-wing aircraft, helicopters and balloons
*** For fixed-wing aircraft and helicopters

2. Medical Licence

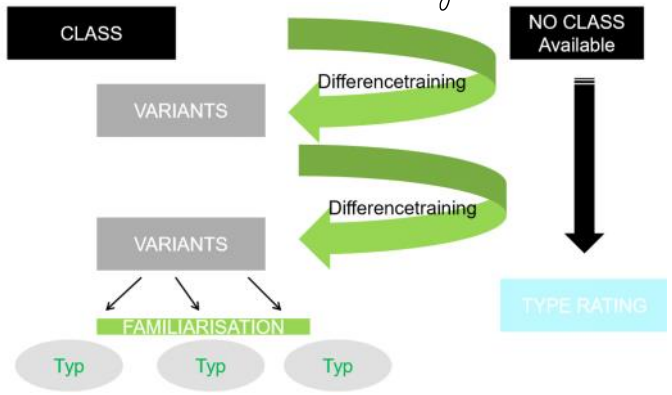
Age	LAPL/Class 2	PPL/Class 2	CPL/ATPL/Class 1
Till 40 yrs	5 yrs	5 yrs	12 months*
40-49	24 months	24 months	
>50		12 months	
>60			6 months
>65			6 months

*Single Pilot with Pax: 6 months

3. Aircrcraft Rating

→ Category, Class, Type Rating

- Categories: Overarching classification of an aircraft
  - helicopter
  - airplane
  - glider etc.
- Classes: Airplanes can be single-engine or multi-engine (and further sea or land)
  - SEP LAND- Single Engine Piston
  - SEP SEA - dito
  - SET – Single Engine Turbo Prop
  - TMG – Touring Motor Glider
  - MEP LAND- Multi Engine Piston
  - MEP SEA - dito
- Type Ratings: Difference training within a class
  - SEP(land) with Variable-Pitch-Propeller **(VP)**
  - SEP(land) with Retractable Undercarriage **(RU)**
  - SEP(land) with Turbo engine **(T)**
  - SEP(land) with Pressurized Cabin **(P)**
  - SEP(land) Tailwheel aircraft **(TW)**
  - SEP(land) with Single-Lever-Power-Control **(SLPC)**
  - SEP(land) with Glass cockpit, Electronic-Flight-Information-System **(EFIS)**
  - MEP(land) requires Difference Training for each type of aircraft flown
- Familiarization within a class rating



→ Revalidation of Licences

Classes and model extensions for single-engine piston-engine aircraft are generally valid for 2 years.

Renewal takes place with at least 12 flight hours' experience, 6 of which as PIC (Pilot-in Command).
Additionally, 12 take-offs/landings and a 1 hour training flight with a flight instructor is required.

Classes and model extensions for multi-engine piston-engine aircraft are generally valid for 1 year.
Generally, a type rating is required for:
- all aircraft with 2 pilots
- all multi-engine aircraft with 1 pilot and turboprop or jet-engine
- all single-engine aircraft with 1 pilot and jet-engine.

- Extensions

There is a variety of extensions, such as:
- Aerobatics
- Towing of gliders and banners
- Night flight
- Mountain flight authority for skiers and/or wheels
- FI-Flight Instructor/CRI-Class Rating Instructor

→ Radio-Licenses (ELP) → To use the aeronautic radio service → English Language Proficiency Check (ELP)

→ Required Documents

VLL § 22 (Act about Airworthiness of Aircrafts)
1) The following boarding documents and papers are to be kept in any aircraft which is approved for flight:

a. the registration certificate;

b. the certificate of airworthiness or the air permit with the annex "permit area" in the flight handbook; in addition for towed aircraft, the towage certificate;

In addition, the valid airworthiness review certificate or the valid verification of the airworthiness checks;

c. the noise certificate, if such is required

d. proof of third party liability insurance on the ground and, where required, proof of liability insurance against passengers;

e. the «concession for aircraft station» for aircraft supplied with radioelectric reception and transmission equipment;

f. the aircraft flight manual; → AFM

g. the flight book or equivalent documents, including clearance certificates;

h. the checklist issued by the manufacturer or a check list created by the owner

- Additional documents for **IFR** flight planning
  - Weather (SWC, Wind & Temp. METAR/TAF)
  - Navigation (OFP) & Fuel Calculation
  - NOTAM
  - Mass & Balance
  - Performance
  - **Flight plan**
- Additional documents for **VFR** flights
  - GAFOR (General Aviation Forecast)
  - DABS (Daily Airspace Bulletin Switzerland)
  - **AIP** (Aeronautical Information Publication) for VFR maps, airport information and basic information
  - **AIC** (Aeronautical Information Circular): publishes changes which affect aviation safety. For example, new rules (incl. in NOTAM).

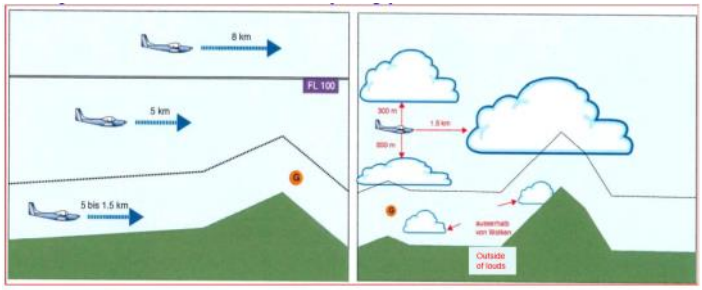
→ Submiting a Flight Plan

A flight plan needs to be submitted for:
- IFR-flights
- VFR-night flights (NVFR)
- VFR-flights with landings in other countries
- Zurich and Geneva Airport
- *Can* be submitted for VFR-flights
  - Facilitates search and rescue operations

→ General Traffic Rules

- Reserve fuel → 30 min (Jet/Turboprop), 45 min (others)
- Maximum speed → Under FL100 ⇒ max 250KTS
- No VFR over FL200
- No dumping stuff without permission

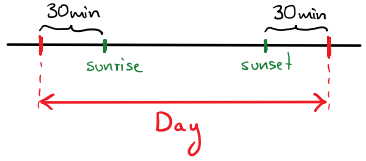
→ Requirements for VFR (Day)



- Special requirements for Night-VFR, Special-VFR (within control zones under reduced weather conditions) and Controlled-VFR.
- In CTRs is 5km required
- Airspace G: 600m/2000ft above ground (1.5km allowed if aircraft speed allows a 180° turn within visibility); Helicopters may fly with less than 1.5km if they may recognize obstacles and other traffic to avoid conflicts)

- Day = beginning an end of civil twilight

⇒ 30 min before sunrise and 30 min after sunset

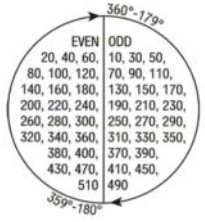


→ Altitude

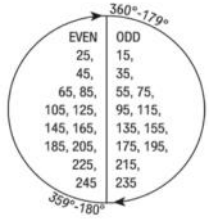
West= Even
East= Odd
VFR: +5 (+500ft)

Allowed FLs → direction specific

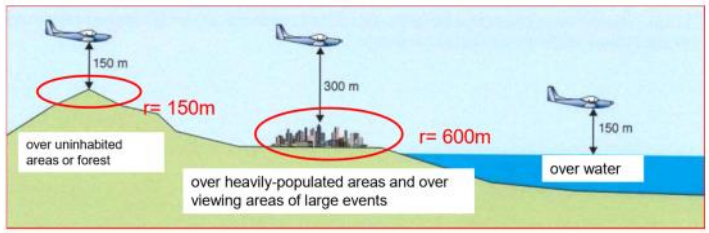
ICAO-IFR



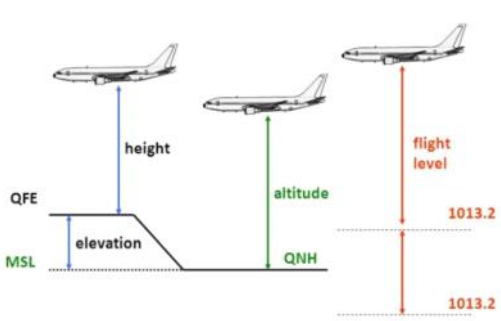
ICAO-VFR



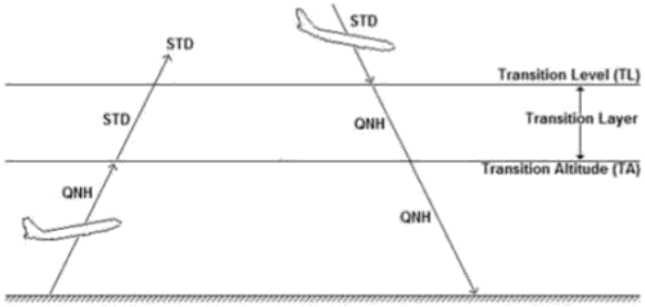
- Minimum altitude



- Setting the QNH for the altimeter



QNH: Elevation set at sea-level shows height above sea
QFE: Altimeter shows zero at airfield (pressure to airfield elevation)
QNE: Standard pressure (1013 hPa) for flight-level (FL) display

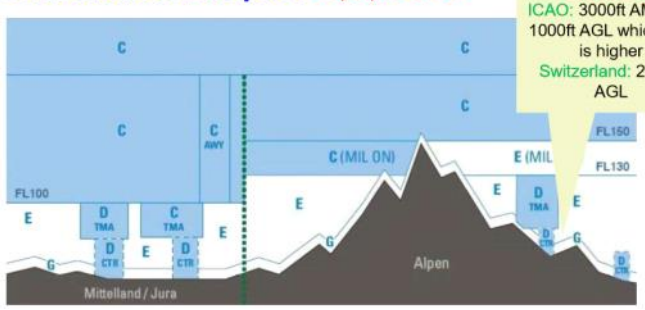


For IFR/VFR flights **in a closely-controlled zone or a control zone**, the altitudes are set to:
Flight levels (QNE;1013.25 hPa), if the aircraft finds itself above the transition altitude.
In altitudes above sea level (QNH, Alt above sea level), when below the transition level.

For VFR flights, **outside a closely-controlled zone or a control zone**, the altitude is set:
a. over 900m (3000ft) above ground: FL (Flight levels) → QNE
b. up to 900m above ground: Altitudes above sea level (QNH)

In the case of flights with gliders and hot-air balloons the altitude is only expressed in altitude above sea level.

Switzerland: Airspace C,D,E & G



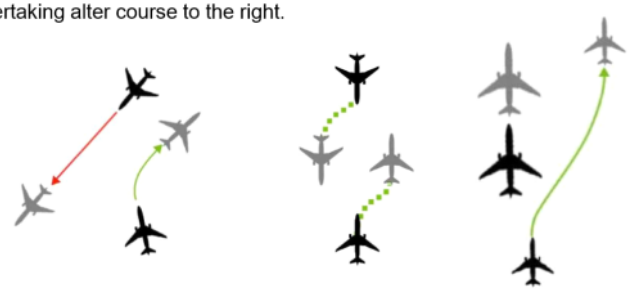
Airspace "G"
ICAO: 3000ft AMSL or 1000ft AGL whichever is higher
Switzerland: 2000ft AGL

Class	Rules	Service	Clearance	Separation	FIS	Speed Limit (1)	Radio Watch	CTR SVFR
A	IFR only	ATC	YES	ALL		NO	YES	YES
B	IFR	ATC	YES	ALL		NO	YES	YES
	VFR							
C	IFR	ATC	YES	IFR - IFR		NO	YES	YES
				IFR - VFR				
				VFR - IFR				
	VFR	ATC			VFR - VFR	YES		
		FIS						
D	IFR	ATC	YES	IFR - IFR		YES	YES	YES
	VFR	FIS (4)			IFR - VFR			
					VFR - IFR			
					VFR - VFR			
E	IFR	ATC	YES	IFR - IFR		YES	YES	NO (2)
	VFR	FIS	NO		IFR - VFR		NO	
					VFR - IFR			
					VFR - VFR			
F	IFR	ADV ATC	NO	IFR - IFR (3)	ALL	YES	YES	NO
	IFR	FIS					YES	
	VFR						NO	
G	IFR	FIS	NO	NONE	ALL	YES	YES	NO

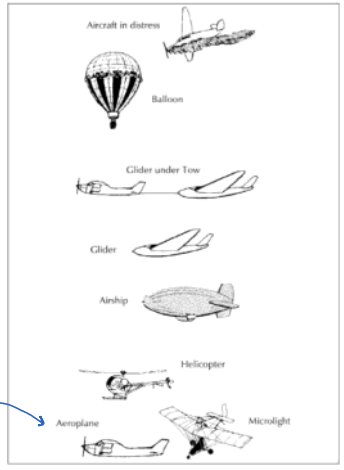
(1) : General speed limit is 250kts IAS enforced below FL100 (10'000ft)
(2) : Separation as far as practical
(3) : Service to participating IFR traffic only (non participating IFR to file FP and maintain 2-way comms)
(4) : Radar information / advice may be provided to augment FIS in CAS

→ Collision avoidance

An aircraft with right of way maintains its course and speed (also converging traffic). When head-on alter course to the right. When overtaking alter course to the right.



• Priorities → give way



lowes priority :

Collision avoidance/landing

- Landing aircraft takes precedence
- The lower-flying aircraft takes precedence
- Gliders take precedence over powered aircraft
- An aircraft in an emergency situation always takes precedence

Collision avoidance/On ground

- Starting aircraft takes precedence over rolling aircraft
- On the ground, rolling aircraft must stop if they are on a collision course, or turn to the right
- On the ground, right of way applies

5. Business Models

→ The airline industry
- is very complex
- is cyclical
- is directly linked to GDP
- has constant decrease in yield
- has high fixed costs
- serves various networks

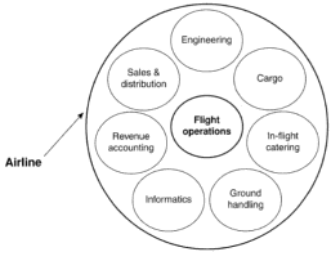
1. Network Airline (FSC)

→ Full service carriers

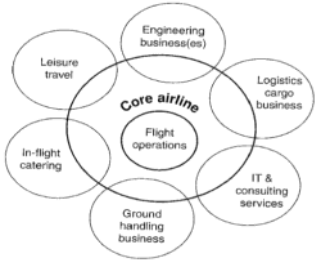
→ Hub & Spoke

→ 2 types

Traditional – Lufthansa

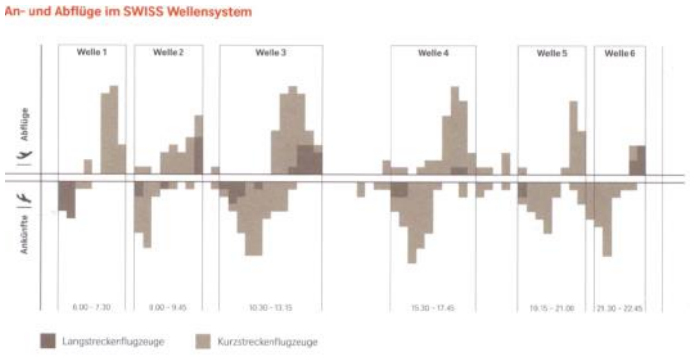


Aviation Business - Swiss



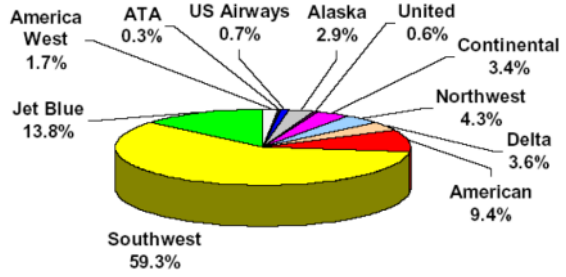
→ Advantages
- Connect many local regions which could otherwise not be served
- Many connections
- Large and attractive network
- Hub dominances (slots, gates)

→ Disadvantages
- Optimal connection leads to "waves" → higher personnel requirement or hub overload
- Flights take longer because they are not direct (first hub)
- Long ground times for network
- "Primary airports" have higher charges



2. Low Cost Carriers (LCC)

→ No Fare (Frill) Airline

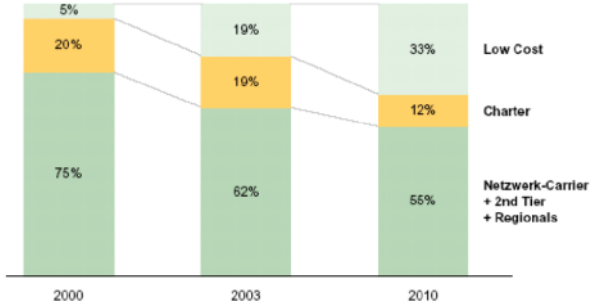


Total Market Cap: $20.9 billion

LFAs	Traditional airlines	LFA advantages
Operate from mostly secondary, underutilised, regional airports	Operate from mostly primary international hub airports	Lower airport charges, faster turnaround times, less air traffic control-related delays
Fast turnarounds (25 min.)	Slow turnarounds due to use of congested hub airports	Better fleet utilisation
Direct point-to-point flights, no transfers, short-haul routes	Mix of long, medium and short haul routes with transfers ("connecting flights")	Lower complexity, higher capacity utilisation
Standardised fleet (only one aircraft type), higher seating density	Various aircraft types, low seating density	Cheaper aircraft financing; Lower maintenance and training costs; Simpler swapping around of flight and maintenance staff; Higher capacity utilisation
Distribution primarily through direct channels (internet, call centres)	Most tickets sold via travel agencies (high GDS costs, travel agent commissions, etc.)	Lower distribution costs, lower complexity
No "frills", extras paid for (e.g. catering, excess baggage)	Entertainment programmes, express check-in, VIP lounges, paper tickets, business class, "free" catering	Lower ancillary costs, less complexity; Additional revenues
Highly incentivised work force (variable proportion of salary up to 40%)	High basic salaries (variable proportion less than 10 %)	High employee productivity

- Minimize cost for everything
(no catering onboard ⇒ no need for cleaning)

- LCCs are increasing



3. Charter Airlines

→ Four types
- Vertical Integrated Organisations → tour Operating, travel agents, hotels and ground transport (e.g. TuiFly)

vertical → parent company (or tour operator) takes over 70-90% of the capacity
- Independents (e.g. Germania)
- Subsidiaries of network carriers (e.g. Edelweiss or Condor)
- Line charters (e.g. Air 2000)

→ As the tickets are sold through the mother company (or tour operator) and the destination is not regularly flown, high seat load factors result
- But LCCs make it difficult for charter airlines. In particular flights under 2.5 h (one-way, flexibility, frequency)
- On the other hand, charters often have lower unit costs

Characteristics	LCCs	Integrated Charter	Independent Charter
Larger Aircraft		✓	(✓)
Longer Sectors		✓	(✓)
Higher Load Factors		✓	✓
Higher A/C Unitisation	(✓)	✓	(✓)
Higher Labour Productivity		✓	(✓)
Lower Distribution Costs		✓	✓
Lower Pass. Service Costs	✓		
Lower landing Fees	(✓)	✓	(✓)
Lower Insurance Costs		✓	(✓)
Lower Aircraft leasing Costs		✓	(✓)
Lower Administration & Finance Costs		✓	(✓)

- Air charter is the business of renting an entire aircraft as opposed to individual aircraft seats

⇒ In LCCs and FSCs the prices rise as the load factor increases right before flight.

⇒ In charters not, since quotas are sold to travel agents and tour operators at an early stage

4. Regional Airline (Feeder)

→ "Fewer than 100 seats and distances flying up to 800 km"

→ 50% of the regional airlines are subsidiaries of a network carrier (Swiss European and Lufthansa Cityline)

- Mainly doing hub to non-hub flights

5. Business Only (Longhaul)

→ Only business seating → 48-56 seats

- Larger overhead bins, PC-laptop connection, VIP service
- Private-Jet feeling

→ They did not last long ⇒ Bankruptcy or OPS suspended

Boeing vs Airbus

- Boeing:
  - "Smaller and, above all, more aircraft are needed as the market is becoming more fragmented → new routes and more direct flights."

Lower cabin pressure, more humidity, 50% larger windows, virtually larger cabins etc.

- Airbus:
  - "The markets have to consolidate, which requires larger aircraft"

Bars, casinos, sleeping areas, shower rooms etc. / 20% lower operational costs

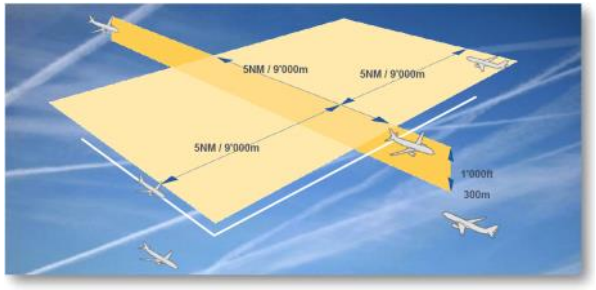
Strategies for success

- *Clear strategy/positioning*
- *Activity System*
- *Adapted networks/alliances*
- *S-curve*
- *Slots/Hub dominance (gates)*
- *Eco of Densities (seating/aircraft sizes)*
- *Ideal capacity efficiency*
- *Low "cannibalization"*
- *Flat waves at the hub*
- *Freq. Flyer Program*
- *Larger aircraft*
- *Longhaul*
- *Secondary airport*
- *Short turnaround times- high A/C utilization*
- *Direct flights*
- *Standardized fleet*
- *Yield management*
- *Direct sales (Website)*
- *Few "Frills" or modular sales*
- *Performance-based salaries*
- *Consideration of emerging markets and/or trends*

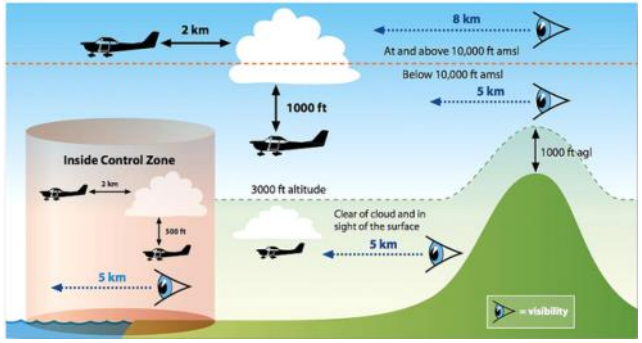
6. Air Traffic Control

→ Main tasks of air traffic control
- Avoid collisions in the air and on the ground
- Provide flight information services
- Provide alerting services and support search and rescue crews

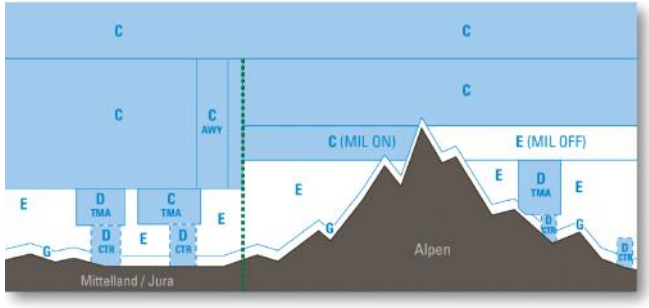
→ Standard Minimum Separation: 5NM / 1000 ft



→ IFR vs VFR



→ Airspace Classification in Switzerland



→ Air Traffic Control Officers (ATCO)
- Normally come in pairs

Radar executive
Radar planner
} 2 persons per sector
↳ future planning

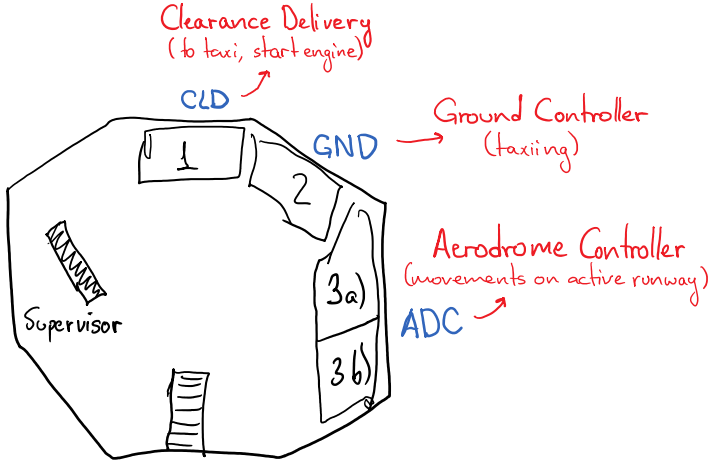
- 60 ATC centers in Europe → 2 in Switzerland

Tower Control

→ In the control towers (TWR) air traffic controllers monitor taxiing, manoeuvres, takeoffs and landings

↳ up to 10'000ft

→ They oversee traffic in the immediate vicinity of the airport, i.e. the **Control Zone (CTR)** of approximately 20 km around the airport



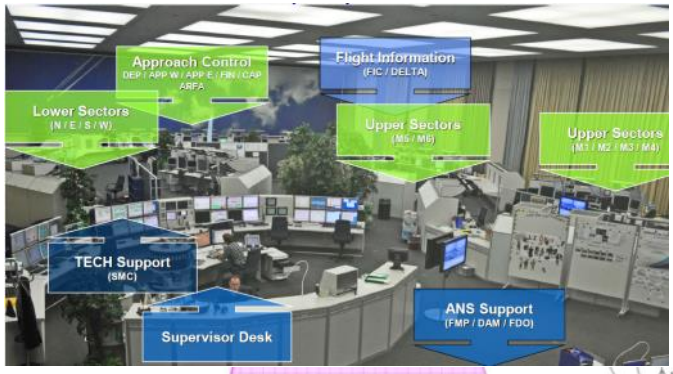
→ Airport Layout LSZH

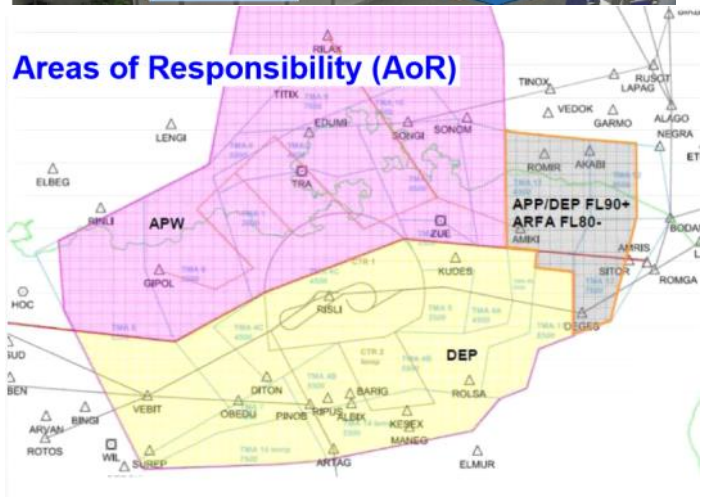
Approach and Departure Control

→ Approach (APP) air traffic controllers manage the arriving and departing aircraft flying according to IFR within a specific section of the control zone and **Terminal control area (TMA)**.

↳ Up to a distance of around 60 km around the airport

- They manage on the one hand the traffic climbing to upper airspace airways, and on the other hand the descending traffic that leaves these airways towards the airport
- Common IFR room (CIR)

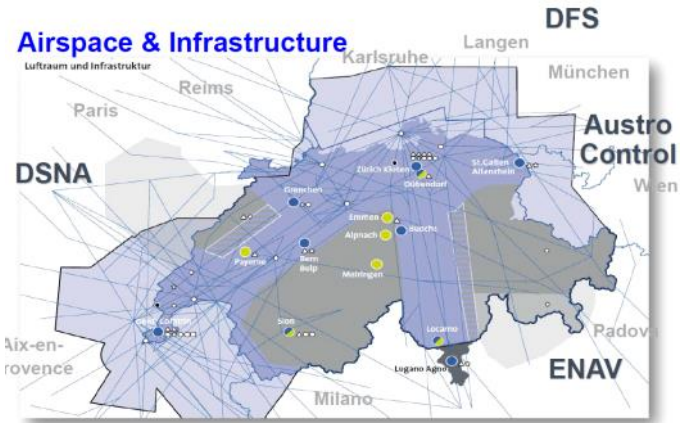




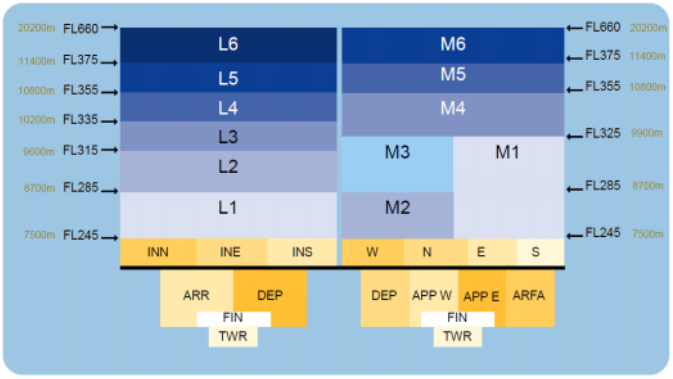
Area Control (Enroute Control)

→ Sectorisation of the airspace to ensure safety and efficiency of traffic movements through the airways

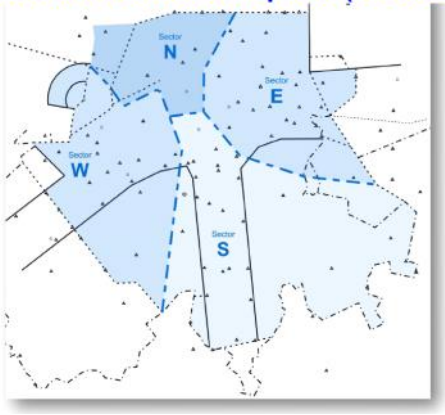
→ In Switzerland, the controlled ares include part of France, Germany, Italy and Austria from 7'000 ft to 66'000 ft



Sectorization in the Geneva & Zurich ACCs



Sectorisation ZH Lower Airspace (FL125 – 245)



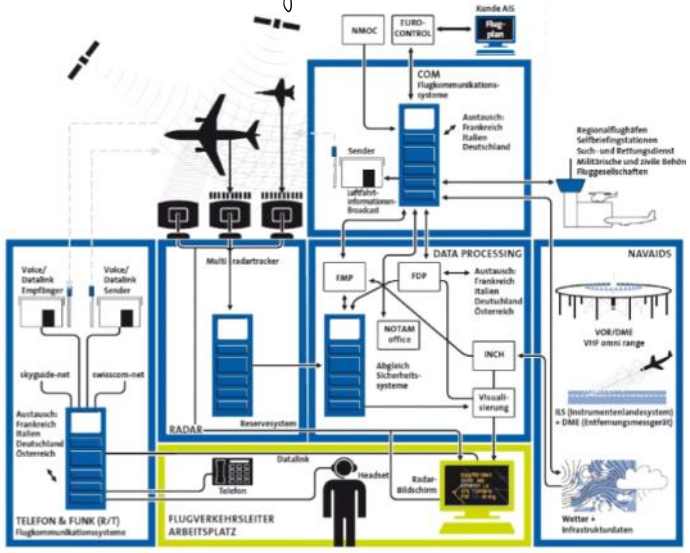
→ Enroute Controllers (RE, RP, RC)
- Manage the sectors

Military Air Traffic Control

- When working in the ADDC, air traffic controllers are called "fighter controllers" and use their highly-specialised expertise to support air force pilots in tactical air combat exercises.
- They also manage all military aircraft in transit flights within Switzerland. Like civil air traffic controllers, fighter controllers monitor the airspace on radar consoles.
- The ADDC also helps the air police with the critical task of recognising aircraft with a questionable identity.
- Specific deployment procedures are used in air defence training, and the protection of specified areas, e.g. the World Economic Forum.

The Technology

→ Communication, Navigation, Surveillance



→ Surveillance
- Multi radar tracking
- Increase traffic distance if one radar fails ⇒ lower position accuracy

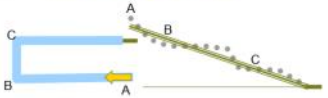
primary and secondary surveillance radars

→ Navigation
- NDB (non-directional beacon), VOR, ILS
- Satellite navigation → new possibilities

- Curved flight paths

- Less steep approach profiles

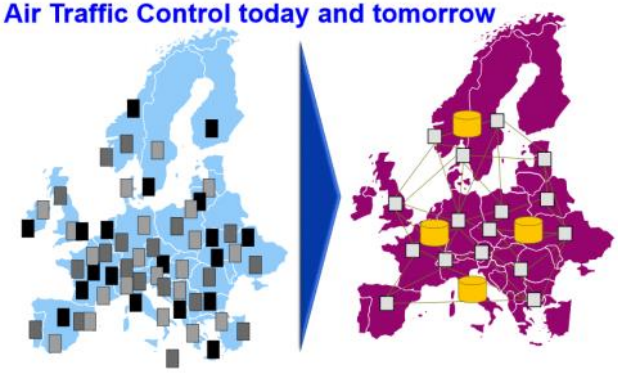
- Continuous Descent OPS



- Higher navigation precision

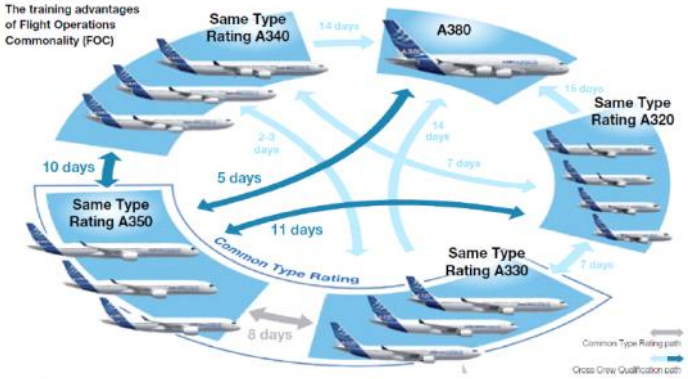
→ Data management

Air Traffic Control today and tomorrow

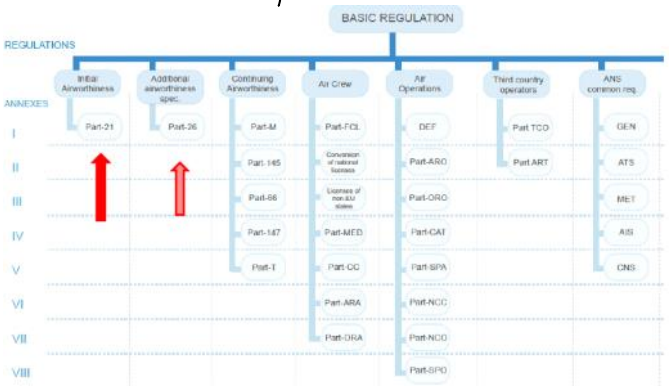


11. Manufacturing and Maintenance

→ Common Type Rating



→ Certification in Europe



1. Manufacturing

• The A/C has to be approved by EASA. EASA is the primary certification authority for A/Cs built in Europe. The FAA just validates EASA's approval (with some minor additional checks)

→ Aircraft manufacturers need an EASA Part 21 (and 26?) for production approval

• Inside Part 21 there are many certification specifications for the products

- CS-22 Sailplanes
- CS-23 Normal, Utility and Commuter Aeroplanes
- CS-31 Balloons
- **CS-34 Aircraft Engines Emissions and Fuel Venting**
- **CS-25 Large Aeroplanes** (Doc with 920 pages)
- CS-27 Small Rotorcraft (up to 3'175kg and 9 PAX)
- CS-29 Large Rotorcraft (> 3'175kg)
- **CS-36 Aircraft Noise**
- CS-LSA Light Sport Aeroplanes
- **CS-E Engines**
- CS-ETSO European Technical Standard Order
- ...
- **CS-26** Additional airworthiness specifications for operation (Part-26)

↳ Specifications in bold are the ones needed for the A350

• Example: CS 25.851 → Lightning Protection
• Example: CS 25.803 → Emergency Evacuation ↴
everybody should be evacuated in less than 90 seconds
• There are 19 Part-21 G Organisations in Switzerland

→ MMEL (Master Minimum Equipment List)

• The dispatch conditions (broken stuff etc) are published in the Master Minimum Equipment List. The MMEL is an approved deviation from the Type Certificate (TC)
• The MMEL ensures an acceptable level of safety, while operating an aircraft with unoperative equipment

→ MEL (Minimum Equipment List)

• It is developed from the MMEL and must not be less restrictive than the MMEL
• Contains operations specific items based on A/C configuration, equipments installed etc

Rectification Intervals	A	B	C	D
Consecutive calendar days	No standard rectification Interval (Mentioned in the dispatch conditions)	3	10	120

may be extended one time

• Example:

A330 MEL – ILS (Instrument Landing System)

34-30-04	Instrument Landing System (ILS)

Ident.: MI-34-30-00007913.000.001 / 29 MAR 12
Applicable to: ALL 330

34-30-04A

Repair interval	Nbr installed	Nbr required	Placard
C	2	1	No

(o) ILS 2 may be inoperative (MMR 1 is operative).
For ER operations, ILS 1 (MMR 1) must be operative if ILS is required for intended flight.
If ILS 1 is inoperative, the GPWS/TAWSG/S mode (mode 5) is also inoperative.
Note: *Maximum landing capability is CAT 1.*

• The pilot can read the MEL prior the flight to see what is and what is inoperative

2. Maintenance

→ On "Continuing Airworthiness"

• Planning for the continuing airworthiness of aircraft is done in the **Part-M/Subpart-G** organisation

• Execution of maintenance is done in a **Part-145** or **Part-M/Subpart-F** organisation

• Personnel wanting to do the maintenance need a **Part-66** license

• Organisations seeking to conduct training and examination of Part-66 personnel need a **Part-147** license

→ Planning for continuing Airworthiness (Part-M)

• In the case of comercial or complex aircraft, the continuing airworthiness must be ensured by a **Continuing Airworthiness Management Organisation (CAMO)**. Task are:
  * Creating and updating the maintenance program
  * Preparing workorders for the required Maintenance Organisation
  * Ensure that maintenance is carried out

→ Performance of maintenance (Part-145)

• Perform maintenance according to the workorder received from the owner or CAMO
• Must have licensed Part-66 personnel
• Must have the approval for the type of aircraft and scope
• Certifies the work performed in the Technical Logbook on the **Certificate of Release to Service (CRS)**

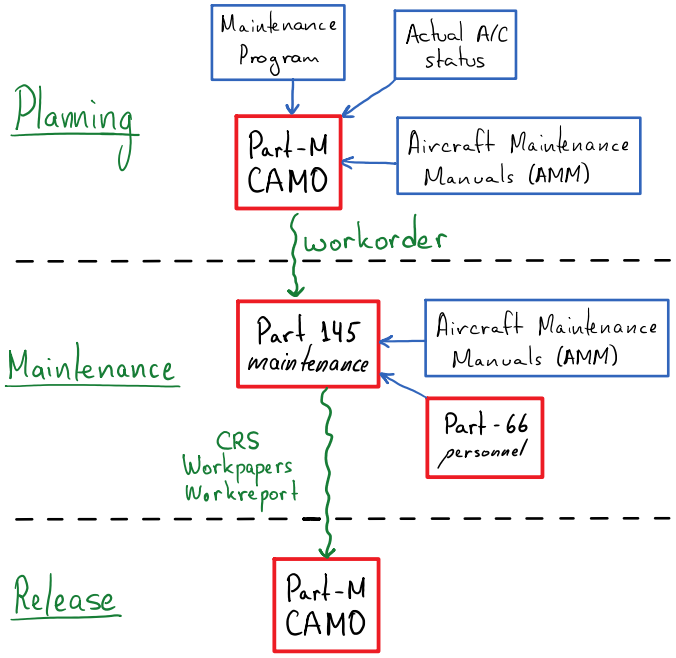
→ Organisations in Switzerland

- Part-M/Subpart-G: Total 96 CAMO Organisations
  z.B.: Air Zermatt, Jet Aviation Business Jets, Pilatus, Rega, SR Technics, Swiss, ...
- Part-145: Total 81 Maintenance Organisations
  z.B.: Air Zermatt, Bucher Leichtbau, Jet Aviation, Pilatus, Rega, Ruag, SR Technics, Swiss, ...
- Part-147: SR Technics, Pilatus, Aviotrace, QCM

→ Maintenance Program for Swiss A330-300

CHECK	MAX. INTERVAL	EFFECTIVE DATE
MX PFC PFC	Before each departure	since ops start
W	14 calendar days	since ops start
A	800 FH	since ops start
C	1C = 18 months 2C = 36 months 4C = 72 months 8C = 144 months	since ops start since ops start since ops start since ops start
IV	1IV = 6Y = 72 month	since ops start
D	1D = 12Y = 144month	since ops start

Line Maintenance
Base Maintenance



• If the aircraft comes from another continent, the organisations need additional approval to release a maintenance

→ Questions

Block 1 Questions: (Slide 12)

Q. 1: What is a specialty of the A350 XWB in respect to the used material on the airframe?
The use of Carbon Fiber Reinforced Polymer (CFRP) (53% of weight).

Q. 2: What is an "Iron"-Bird and what is it used for?
It is a "Zero-Test"-Rig and is used to test the complete hydraulic, electrical and flight control systems. It contains the same components as installed on MSN 001. It is also used to test the interface between Cockpit and A/C systems.

Q. 3: What was the reason to bring an A350 to the McKinley Climatic Lab?
To demonstrate the whole operational spectrum (on ground) of the aircraft.

Q. 4: Is the FAA the primary certification authority for the A350?
No, because the EASA is the authority to certify the aircraft, as it is built in Europe. The FAA only validates the A350 approval based on the EASA approval and on some minor additional checks (Bilateral agreement US-EU).

Q. 5: Why are six of the same screens used in the cockpit?
Dispatch reliability/exchange capability, less stock of screens needed by the operator / 1st A/C with large screens like that.

Block 2 Questions: (Slide 30)

Q. 1: To produce an A350 what kind of approval does Airbus need?
Airbus requires a EASA 21.G. Certificate (EASA.21G.0001) for Production approval.

Q. 2: What are the main Certification Specifications used by Airbus for the A350?
CS-E Engine, CS-25 Large Aircraft, CS-34 Engine Emissions, CS-36 Aircraft noise plus CS-26 Additional CS for operation.

Q. 3: What is the advantage of a common type rating?
Only 8 days of training are required to transition from e.g. A330 to A350 and only one common type rating is endorsed in the pilots license.

Q. 4: How fast must an aircraft be evacuated?
Within 90 seconds, must be basically demonstrated for large aircraft.

Q. 5: Is the MEL a burden or a help for the Pilot/Operator?
It is a help for the pilot/operator as it provides good hints what to expect resp. look for if a safety relevant defect occurs.

Block 3 Questions: (Slide 50)

Q. 1: Can the Swiss Intl. Air Lines CAMO send it's A330 to SR Technics into a Base Maintenance Check?
The Swiss CAMO is approved to manage the A330 and therefore can send it's A330 to the approved Base Maintenance facility of SR Technics.

Q. 2: A Middle East Airline flies to ZRH with it's A380. Is SR Technics allowed to perform Line Maintenance on these aircraft and release it?
SRT has the A380 Line Maintenance approval from EASA. This does not allow SR Technics to release the Middle East aircraft! However, SRT has a separate MEA approval to do maintenance, which is based on the EASA approval!

Q. 3: Can a pilot see if any maintenance has been performed on "his" A/C prior to his upcoming flight?
With the Certificate of Release to Service, which must be entered in the Logbook after any Mintenance has been performed.

Q. 4: What is the main interface document between a CAMO and a Part-145 organisation?
The Workorder and the Workreport when the maintenance is done.

Q. 5: What kind of License do you need to work as a mechanic?
An EASA Part-66 License with the A/C Type endorsed as well as current experience on that type.