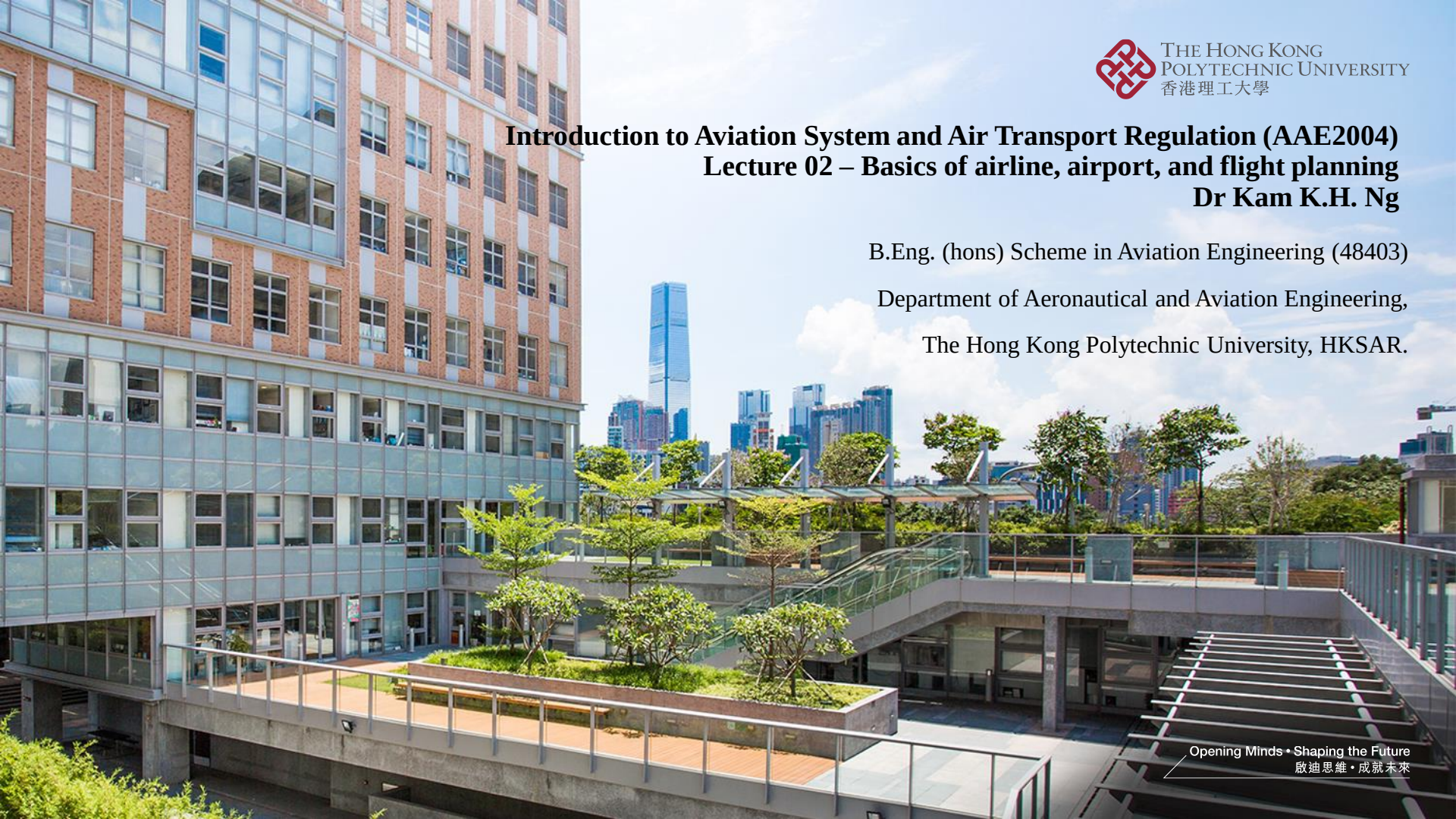

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Introduction to Aviation System and Air Transport Regulation (AAE2004)
Lecture 02 – Basics of airline, airport, and flight planning

Dr Kam K.H. Ng

B.Eng. (hons) Scheme in Aviation Engineering (48403)

Department of Aeronautical and Aviation Engineering,

The Hong Kong Polytechnic University, HKSAR.

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Agenda

- Airline
- Air Operator's Certificate (AOC)
- Airports
- Air Traffic Control Operations

Infrastructure and vehicles

The key businesses in air transport operations are the infrastructures like airports, and the vehicles in the form of airlines that service them.

Airline operations

- Air operator’s certificate
- Airline operations
- Flight operations
- Minimum flight altitude, take-off and landing minima
- Reduced Vertical Separation Minima (RVSM)
- Engineering operations

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Airline

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Airline basics

- An airline's basic function is to transport passengers and their luggage from one point to another.
- Just like any other business, it provides such a service for a set price for a profit.
- Airlines lease or own their aircraft with which to supply these services and may form partnerships or alliances with other airlines for mutual benefit.
- Airlines can be those with only a single airplane carrying mail or cargo, or full-service international airlines and no-frills operating hundreds of airplanes.
- Airline services can be international and domestic.
- There are 3105 active airlines in the world today.

History of airlines

The first airline by founded data is:

- DELAG, founded on November 16, 1909.
- It ceased operation on March 21, 1935.
- The DELAG operated Zeppelin airships. Merged with Deutsche Zeppelin Reederei (DZR) in 1935, which continued transatlantic flights until the Hindenburg disaster in 1937.
- Company dissolved in 1940.

History of airlines (cont'd)

- St. Petersburg-Tampa Airboat Line operated between 1913-1914.
- It carried the world's first commercial air passenger in an heavy-than-air air vehicle.

History of airlines (cont'd)

The oldest operating airlines in the world are:

- KLM: since October 7th 1919.
- Avianca: since December 5th 1919.
- Qantas: since November 16th 1920.
- Aeroflot: since February 9th 1923
- Czech Airlines: since October 6th 1923
- Finnair: since November 1st 1923





- The oldest airline in Asia is the Philippine Airlines found February 26, 1941.
- In Hong Kong, Cathay Pacific Airways was founded on September 24, 1946.
- Hong Kong Airlines was established on September 22, 2006.

Biggest airlines in the world

There are several definition for the biggest:

- Fleet size: as in the number of aircraft operated by the airline
- Passenger carried
- Available seat kilometre (ASK): the capacity of the airline
- Revenue passenger kilometre (RPK): revenue generated by the airline

Biggest airlines in the world

By fleet size:

Rank	Airline	Fleet size
1	American Airlines	956
2	Delta Air Lines	879
3	United Airlines	765
4	Southwest Airlines	749
5	China Southern Airlines	597
6	China Eastern Airlines	525
7	Ryanair	439
8	Air China	418
9	Turkish Airlines	350
10	Lufthansa	338

Biggest airlines in the world (cont'd)

By passenger carried:

Rank	Airline	Passengers carried (2019, Millions)
1	American Airlines Group	215
2	Delta Air Lines	204
3	Southwest Airlines	162
4	United Airlines	162
5	Ryanair	152
6	China Southern Airlines	151
7	Lufthansa Group	145
8	China Eastern Airlines	130
9	International Airlines Group	118
10	Air China Group	115

Biggest airlines in the world (cont'd)

By ASK:

Rank	Airline	Ranked by ASK/Week
1	United Airlines	7,593,105,385
2	Delta Air Lines	7,097,533,389
3	American Airlines	5,253,314,537
4	Emirates	5,250,226,571
5	Southwest Airlines	3,662,356,392
6	Lufthansa	3,393,925,160
7	British Airways	3,205,062,172
8	Air France	2,933,176,964
9	US Airways	2,870,221,036
10	China Southern Airlines	2,633,933,480

Biggest airlines in the world (cont'd)

By RPK:

Rank	Airline	Pax traffic RPK (millions)
1	Delta Air Lines	310,466
2	United Airlines	288,680
3	American Airlines	203,299
4	Emirates	188,618
5	Southwest Airlines	165,753
6	Lufthansa	149,780
7	Air France	135,824
8	British Airways	126,436
9	China Eastern Airlines	109,113
10	China Southern Airlines	107,000

Types of air operator certificates (AOC)

AOC can be granted for the following operations:

- Aerial surveying
- Aerial spotting
- Agricultural operations
- Aerial photography
- Aerial advertising
- Fire fighting
- Air ambulance or aeromedical
- Flight Training
- Charter
- Public transport

} Airlines

Types of airlines

Airlines can be classified into the following:

- Full-Service or Legacy airlines
- Passenger airlines
- Charter airlines
- Regional airlines
- Low cost airlines
- Cargo airlines

Full service carriers

- Characteristic of full-service or legacy carriers: usually provide high quality services.
- A legacy carrier typically offers:
  - 3 class cabin layout - first, business and economy class seating
  - A frequent-flyer program
  - Exclusive airport lounges
- Many legacy carriers are members of an airline alliance through which it has partner legacy carriers that agree to provide these services to their own passengers on different flight routes and enhance operational efficiency and frequency.
- Legacy carriers generally have better cabin services
  - E.g. meal service & in-flight entertainment
- Cathay Pacific Airways has been named the winner of the 2014 World Airline Award for airline of the year.

Low cost carriers

- Known as a no-frills, discount or budget carrier, is an airline that generally has lower fares, offers one class seating and fewer comforts.
- Currently the world's largest low-cost carrier is Southwest Airlines, which operates in the United States and some surrounding areas.
- In 2013, Ryanair is Europe’s largest low-cost carrier.

One Airplane Type

- Costs is cut by using only one kind of plane. Southwest and Ryanair only uses Boeing 737s. This saves money on maintenance and repair, on pilot and mechanic training.

Secondary Airports

- Flies to smaller, less congested secondary airports near major cities to take advantage of lower landing fees.

Regional carriers

- Airlines that operate smaller commuter aircraft to provide passenger air service to communities without sufficient coverage by mainline service, hence filling the niche markets that the major and national airlines may overlook.
- Smaller commuter aircraft with seating up to 100 passengers, usually smaller, and operating over shorter non-intercontinental distances.
- Two main ways of regional airline operations:

1. As an affiliated airline, contracting with a major airline, operating under their brand name – to fill the market that the major airline overlooked.
2. Operating as an independent airline, providing service to small and isolated communities in the region.

Cargo airlines

- Cargo airlines (or air freight carriers) are airlines dedicated to the transport of cargo by air.
  - E.g. FedEx Express & UPS Airlines
- Some cargo airlines are divisions or subsidiaries of larger passenger airlines.
  - E.g. Emirate SkyCargo & Cathay pacific Cargo
- Cargo airlines tend to use new or recently built aircraft to carry their freight.
  - Airbus A330-200F is one of the latest purposely built cargo aircraft.
- Many cargo airlines use older aircraft, like the Boeing 707, Boeing 727, Douglas DC-8, DC-10, MD-11, Boeing 747, etc.

Cargo airlines (cont'd)

By scheduled freight ton-kilometres (millions)

Rank	Airline	2018
1	FedEx Express	17,499
2	Emirates SkyCargo	12,713
3	Qatar Airways Cargo	12,695
4	UPS Airlines	12,459
5	Cathay Pacific Cargo	11,284
6	Korean Air Cargo	7,839
7	Lufthansa Cargo	7,394
8	Cargolux	7,322
9	Air China Cargo	7,051
10	China Southern Airlines	6,597

Airlines of Hong Kong

- Airlines which have a current airline operator's certificate issued by the Hong Kong Director-General of Civil Aviation Department (CAD), and for which oversight as recognised by the ICAO lies with the CAD:

Airline	Category	Founded	ICAO	IATA
Cathay Pacific Airways Limited	Scheduled	1947	CPA	CX
AHK Air Hong Kong Limited	Scheduled	1986	AHK	LD
Hong Kong Express Airways Limited	Scheduled	1997	HKE	UO
Hong Kong Airlines Limited	Scheduled	2001	CRK	HX
Hong Kong Air Cargo Carrier Limited	Scheduled	2017	HKC	RH
Sky Shuttle Helicopters Limited	Non-scheduled	1997	HHK	3E
Heliservices (Hong Kong) Limited	Non-scheduled	1978	HSV	/

Example of FSC carriers

Example of LCC carriers

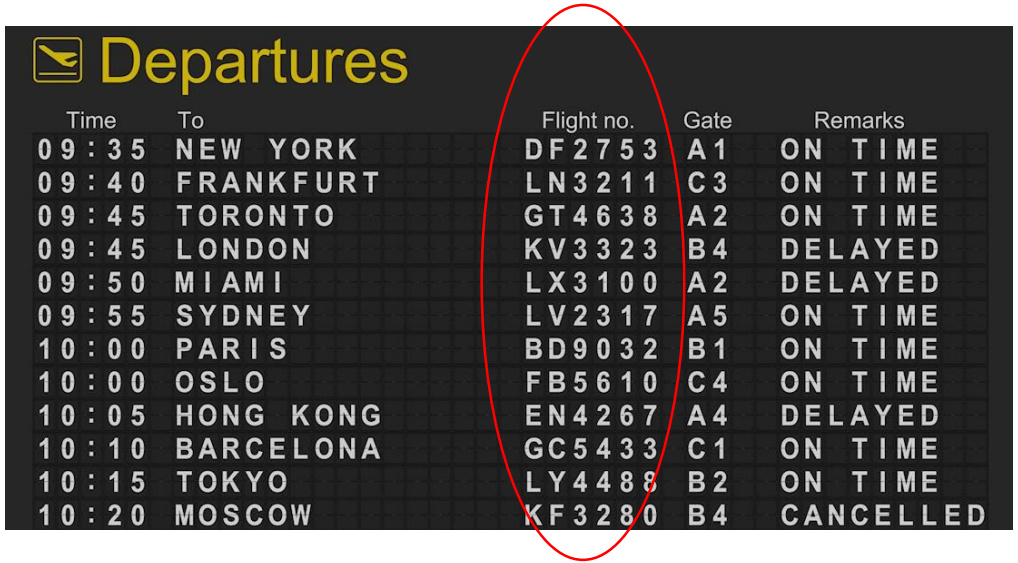
Example of cargo carriers

香港華民航空
air Hongkong

HONGKONG AIR CARGO
香港貨運航空

Flight number

- A flight number should not be confused with the tail number (or registration) of the aircraft.
- Represent a scheduled flight route that is made up of a combination of the carrier's two letter IATA code (Qantas QA and Cathay CX, Lufthansa LH) and up to as many as 4 numbers, and time.
- The same flight is not always serviced by the aircraft of a given registration.



Flight number (cont'd)

- In some countries, flights going eastbound or north are assigned even numbers, and those headed west or south get odd numbers. Return flights are assigned a number that is one higher/lower than the outbound flight.
- In some other countries, like Australia, Qantas gives odd numbers to outbound international flights, and even numbers for inbound flights to Australia.
- Airlines tends to organise flight numbers according to the importance of the routes.
  - One or two-digit numbers are typically assigned to popular or important routes.
  - E.g. Qantas QF1 flies from Sydney-Dubai-London.
- Flight numbers may also be related to geographical origin/destination.

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Air operator certificate

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Air operator certificate (AOC)

- A certificate authorising an operator to carry out specified commercial air transport operations.
- By law, in order to operate a commercial flight, the operator must hold a valid operating certificate or license, registered with the national aviation authority.
- The AOC shall contain at least the following:
  a) Operator's identification (name, location)
  b) Date of issue and period of validity
  c) Description of the types of operations authorised
  d) The type(s) of aircraft authorised for use
  e) Authorised areas of operation or routes

AIR OPERATOR'S CERTIFICATE

香港特別行政區政府
THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION
民航處
CIVIL AVIATION DEPARTMENT

AOC #: 99
Issue #: 99(Rev 99)
Expiry date: 31-12-20xx

XYZ AIRLINES LIMITED

Operator Address:

XYZ Airlines Limited
99th Floor
XYZ Building
99 XYZ District
Hong Kong

Telephone: (852) 1234 5678

Fax: (852) 1234 5678

E-mail: info@xyzairlines.com

OPERATIONAL POINTS OF CONTACT

Contact details at which operational management can be contacted without undue delay are listed at page 2.

Pursuant to the Air Navigation (Hong Kong) Order 1995 (CAP 448C), this certificate certifies that XYZ Airlines Limited is competent to perform the public transport of passengers and cargo, as defined in the attached operations specifications, in accordance with the operations manual and CAP 448C.

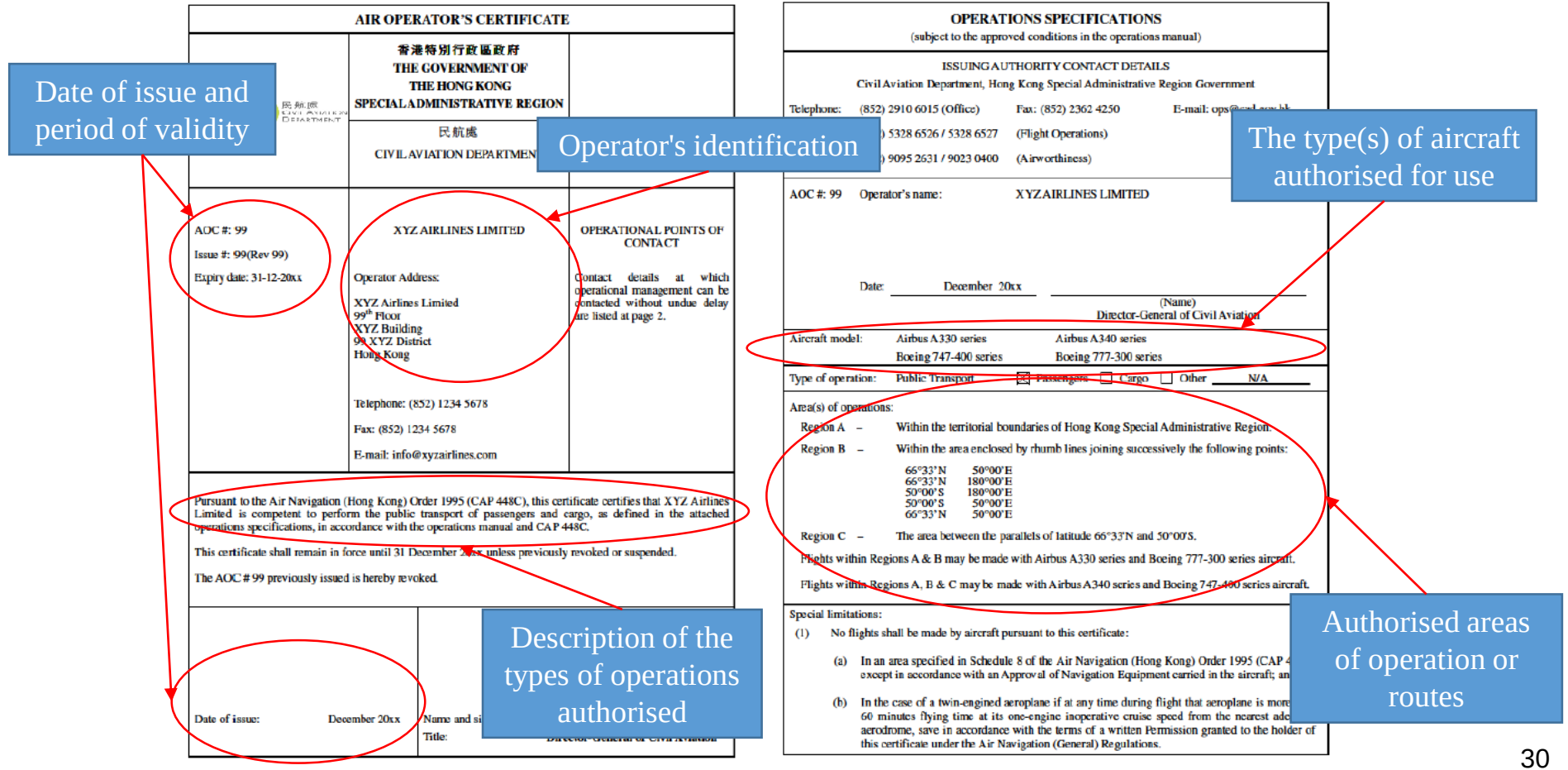
This certificate shall remain in force until 31 December 20xx unless previously revoked or suspended.

The AOC # 99 previously issued is hereby revoked.

Date of issue: December 20xx

Name and signature: (Name)
Title: Director-General of Civil Aviation

Air operator certificate (AOC)



Types of AOC

AOC can be granted for the following operations:

- Aerial surveying
- Aerial spotting
- Agricultural operations
- Aerial photography
- Aerial advertising
- Fire fighting
- Air ambulance or aeromedical
- Flight Training
- Charter
- Public transport

} Airlines

The AOC process

The certification process may vary between States, but can generally be divided into steps:

1. Pre-application
2. Formal application
3. Document evaluation in both administrative and technical areas
4. Operational inspections
5. Decision on application and award of AOC and operations specifications (ops spec)

Operations manual

- An operator shall provide an operation manual.
- The operations manual must be kept up to date.
- The State of the Operator is required to review, indicate acceptance or approval of the operations manual .

AOC requirements

The AOC is issued to the operator dependent upon the operator demonstrating:

- Sufficient personnel with the required experience for the type of operations requested
- Airworthy aircraft, suitable for the type of operations requested
- Acceptable systems for the training of crew and the operation of the aircraft (Operations Manual)
- A quality system to ensure that all applicable regulations are followed
- The appointment of key accountable staff
- Carriers liability insurance
- Proof that the operator has sufficient finances to fund the operation
- The operator has sufficient or arrangements for the supply of sufficient ground infrastructure, to support its operations into the ports requested
- The certificate is held by a legal person who resides in the country or region of application

The continue validity of an AOC shall depend upon the operator maintaining the above requirements.

Engineering operations

- Aircraft maintenance involves inspect, overhaul, repair and components replacement of aircraft, to ensure that the aircraft and its systems remain airworthy throughout its design life or Aircraft Life Extension.
- The airline's engineering operations however is more than just about aircraft maintenance:
  - To meet continuing airworthiness
  - Restore efficiency, safety and reliability to design levels when deterioration has occurred.
  - Maintain design level efficiency, safety and reliability of equipment.
  - To collect information for design and reliability improvements.
  - To accomplish aircraft maintenance at safe level at minimum cost.
  - To uphold aircraft resell value.

Aircraft maintenance programme

- Maintenance is actions and all activities involved in keeping a system and its equipment in working order and up to standards.
- A maintenance schedule is a detailed plan of what is to be maintained on an aircraft and how often.
- A maintenance programme is the maintenance schedule plus the procedures and policies, and tools (reliability programme for example) designed for continuous review and planning of maintenance activities and schedule, and analyses of the statistical data collected.
- A maintenance programme allow aircraft maintenance to be accomplish at safe level and at minimum cost.
- Via an established maintenance programme, operator could make more efficient maintenance and minimise maintenance cost.

Maintenance program

- An aircraft shall not fly unless it has been maintained in accordance with an approved maintenance program (approved by the state/country of registration).
- The airworthiness requirement of Hong Kong on continuing airworthiness and maintenance of aircraft can be found in the following CAD documents:
  - Hong Kong Aviation Requirements HKAR-1 Sub-section 1.6
  - CAD 452 – Approval of Aircraft Maintenance Schedules
  - CAD 418 – Condition Monitored Maintenance: An explanatory handbook
- In other states, similar documents can be found and obtained from the state's civil aviation authority.
- The two key elements of a maintenance program are:
  - Maintenance Schedule
  - Reliability programme

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Airports

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Airports

Each time a pilot operates an airplane, the flight normally begins and ends at an airfield, aerodrome or airport.

Airfields

- The earliest aircraft take-off and landing sites were grassy fields.
    - The plane could approach at any angle that provided a favourable wind direction.
- A slight improvement was the dirt-only field, which eliminated the drag from grass but only functioned well in dry conditions.
- Finally, concrete surfaces allow landings, rain or shine, day or night.
- An airstrip or airfield is a kind of airport that consists only of a runway with perhaps fuelling equipment. They are generally in remote locations.

Airports

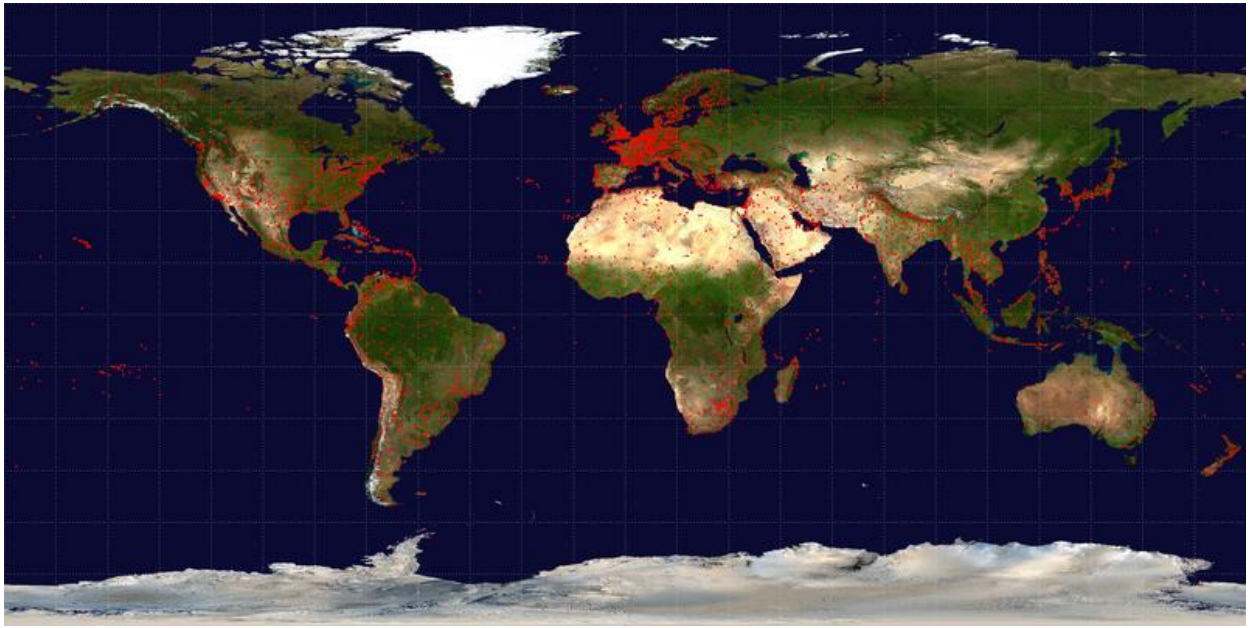
- Increased aircraft traffic during World War I led to the construction of landing fields.
- Aircraft had to approach these from certain directions.
  - ➢ Development of aids for directing the approach and landing slope.
- Following the war, some of these military airfields added civil facilities for handling passenger and cargo traffic.
  - One of the earliest such fields was Paris – Le Bourget Airport at Le Bourget, near Paris.
- In general, an airport is a complex of runways and buildings for the take-off, landing, and maintenance of civil aircraft, with facilities for passengers, cargo, and navigation tower to provide air traffic control.

Airports (cont'd)

Aerodrome encompasses those airports and airfields that don't quite meet the status or certification requirements to be airports.

Airport statistics

- Below map represents the locations of the world commercial airports as listed by the International Air Transport Association.
- The World Fact Book states that as of 2016 there were 41,820 airports in the world.



Aerodrome certificate

- ICAO Annex 14 sets out the international Standards And Recommended Practices (SARPs) for aerodrome design and operations.
- Harmonisation of the standards and practices allows:
  - Aerodromes around the global to be designed and operated to the same standards and practices.
  - Pilots and airlines to follow the same standards and practices at aerodromes around the world.
  - The highest possible level of safety to be maintained for the aerodrome operators, airlines and pilots, aerodrome workers and the travelling public.
- Annex 14 is split into 2 volumes:
  - **Vol. 1 - Aerodrome Design & Operations**
  - Vol. 2 -Heliports

ICAO Annex 14 Volume I - Aerodrome design and operations

- Chapter 1 – General (Definitions, Applicability, Certification of Aerodromes, Safety Management System & Reference codes)
- Chapter 2 – Aerodrome data
- Chapter 3 – Physical characteristics
- Chapter 4 – Obstacle restriction and removal
- Chapter 5 – Visual aids for navigation
- Chapter 6 – Visual aids for denoting obstacles
- Chapter 7 – Visual aids for denoting restricted use areas
- Chapter 8 – Electrical systems
- Chapter 9 – Aerodrome operational services, equipment and installations
- Chapter 10 – Aerodrome maintenance

Chapter 1. General

1.1 Definitions

1.2 Applicability

1.3 Common reference Systems

1.4 Certification of aerodromes

- Aerodromes used for international operations are to be certified by the State responsible:
  - According to Annex 14 specifications.
  - Through an appropriate regulatory framework (regulatory body, laws and rules), that has established certification criteria and requires a manual with pertinent aerodrome information.
  - Has a SMS in operation.

1.5 Safety Management

1.6 Airport Design

1.7 Reference Codes

ICAO aerodrome reference code

Reference field length

Wingspan and main gear wheel track

Aerodrome Reference Code				
Code Element 1		Code Element 2		
Code number	Aeroplane reference field length	Code letter	Wing span	Outer main gear wheel span
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1200 m up to but not including 1800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

Aeroplane reference field length is defined as the minimum field length required for take-off at maximum certificated take-off mass, at sea level, in ISA conditions in still air and with zero runway slope as documented in the AFM or equivalent document.

Minimum runway width

Code number	Code letter					
	A	B	C	D	E	F
1	18 m	18 m	23 m	–	–	–
2	23 m	23 m	30 m	–	–	–
3	30 m	30 m	30 m	45 m	–	–
4	–	–	45 m	45 m	45 m	60 m

Example:

- B767-300ER: Aerodrome reference field length is over 2,700m which corresponds to code number 4. The wingspan is 47.6m with an outer main gear wheel span of 10.8m which corresponds to code letter D.

➢ Minimum runway width is 45m.

Aerodrome certificate

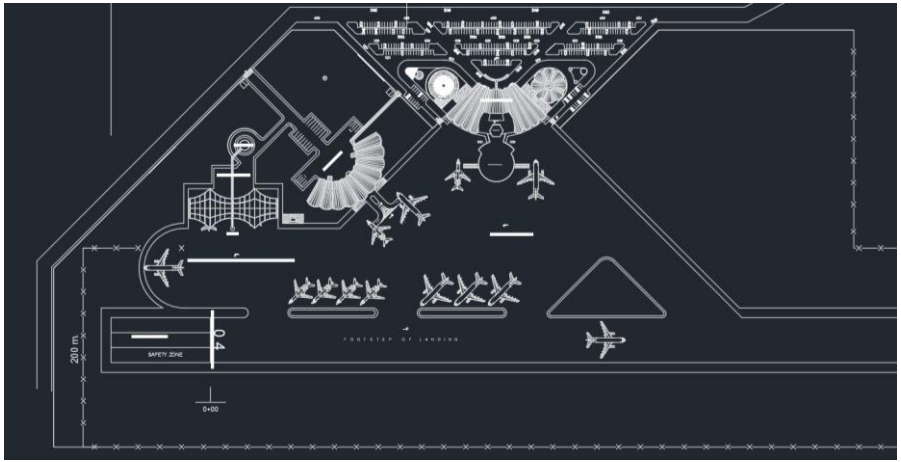
- Aerodrome's operator certificate is based on ability of the airport's operator to meet the required regulations and demonstrate compliance with Acceptable Means of Compliance (AMC) and Guidance Material (GM), and approved Aerodrome Manual on all the following items:
  - Physical characteristics (ICAO Annex 14 Chapter 3)
  - Obstacle restriction and removal (ICAO Annex 14 Chapter 4)
  - Visual aids for navigation (ICAO Annex 14 Chapter 5)
  - Visual aids for denoting obstacles (ICAO Annex 14 Chapter 6)
  - Visual aids for denoting restricted use areas (ICAO Annex 14 Chapter 7)
  - Electrical systems (ICAO Annex 14 Chapter 8)
  - Aerodrome operational services, equipment and installations (ICAO Annex 14 Chapter 9)
  - Aerodrome maintenance (ICAO Annex 14 Chapter 10)
- **Aerodrome Manual** contains the main information on the airport's location, facilities, services, equipment, operational processes, business organisation and management and the safety management system.

Types of civil aviation airports

Commercial service airports	• Publicly owned airports • Have at least 2,500 passenger boarding each calendar year • Receive scheduled passenger service
Cargo service airports	• Airports that are serviced by scheduled cargo air transports • Airport may be both a commercial passenger service and a cargo service airport • The existence of cargo only service airport is not known
General aviation airports	• The remaining airports, airfields
Reliever airports	• Airports designated to relieve congestion at commercial service airports
Heliports	

Types of civil aviation airports (cont'd)

- Commercial service airports can be further categorised by:
  - Passenger traffic
  - Hub size
  - Towered and non-towered



Towered and un-towered airports

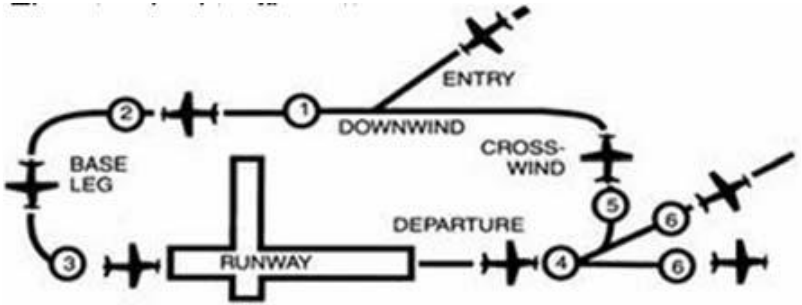
Towered and non-towered airports are categorised based on air navigation and air traffic control requirement.

Towered airport

- A towered airport has an operating control tower.
- Two things distinguish a towered airport:
    1) The presence of air traffic controllers
    2) Maintain two-way radio communication
- Air traffic control (ATC) is responsible for providing for the safe, orderly, and speedy flow of air traffic at airports where the type of operations and/or volume of traffic requires such a service.
- Pilots operating from a controlled airport are required to maintain two-way radio communication with air traffic controllers, and to acknowledge and comply with their instructions.
- At towered airports, pilots follow the instructions given by the air traffic controllers, and it's important to have full understanding of airport signage and lighting systems.

Un-towered airports

- An uncontrolled airport does not have an operating control tower. Two-way radio communications are not required.
- Instead of receiving instructions from a tower controller, pilots follow recommended procedures.
- Inside controlled airspace, take-off and landing on non-towered airports will require communication and clearances from a remote air traffic control unit.
- Pilots may be able to obtain those clearances by radio, by phone, or through a local flight service station.



Primary and non-primary airports

Categorisations based on passenger traffic demand

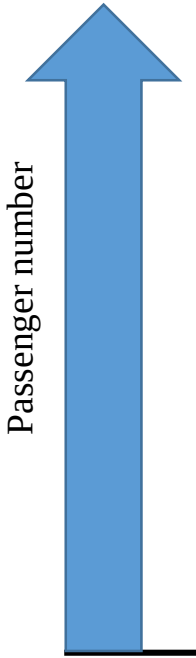
Primary & Non-primary

- Primary airports are commercial service airports that have more than 10,000 passenger boarding each year.
- Non-primary airports are airports that have at least 10,000 passenger boarding each calendar year on schedule and non-scheduled services.

Hub classification

- Large hub
- Medium hub
- Small hub
- Non-hub

Primary and non-primary airports (cont'd)



Airport classifications		Hub type: Percentage of annual passenger boardings	Common name
Commercial service: Publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service	Primary: Have more than 10,000 passenger boardings each year	Large: 1% or more	Large hub
		Medium: At least 0.25% but less than 1%	Medium hub
		Small: At least 0.05% but less than 0.25%	Small hub
		Non-hub: More than 10,000 but less than 0.05%	Non-hub primary
	Non-primary	Non-hub: At least 2,500 and no more than 10,000	Non-primary commercial service
Non-primary (Except commercial service)		Not applicable	Reliever

The busiest airports - movements

Rank	City (Airport)	Take-off and Landings 2017	% Change
1	ATLANTA GA, US (ATL)	879 560	-2.1
2	CHICAGO IL, US (ORD)	867 049	-0.1
3	LOS ANGELES CA, US (LAX)	700 362	0.5
4	DALLAS/FORT WORTH TX, US (DFW)	654 344	-2.7
5	BEIJING, CN (PEK)	597 259	-1.5
6	DENVER CO, US (DEN)	574 966	1.7
7	CHARLOTTE NC, US (CLT)	553 817	1.5
8	LAS VEGAS NV, US (LAS)	542 994	0.3
9	AMSTERDAM, NL (AMS)	514 625	3.6
10	SHANGHAI, CN (PVG)	496 774	3.5
11	PARIS, FR (CDG)	482 676	0.7
12	LONDON, GB (LHR)	475 915	0.2
13	FRANKFURT, DE (FRA)	475 537	2.7
14	TORONTO ON, CA (YYZ)	465 555	2.0
15	GUANGZHOU, CN (CAN)	465 295	6.9
16	ISTANBUL, TR (IST)	460 785	-1.2
17	SAN FRANCISCO CA, US (SFO)	460 343	2.2
18	TOKYO, JP (HND)	453 126	1.0
19	HOUSTON TX, US (IAH)	450 383	-4.3
20	MEXICO CITY, MX (MEX)	449 664	0.3

The busiest airports - passengers

Rank	City (Airport)	Enplaning and deplaning 2017	% Change
1	ATLANTA GA, US (ATL)	103 902 992	-0.3
2	BEIJING, CN (PEK)	95 786 442	1.5
3	DUBAI, AE (DXB)	88 242 099	5.5
4	TOKYO, JP (HND)	85 408 975	6.5
5	LOS ANGELES CA, US (LAX)	84 557 968	4.5
6	CHICAGO IL, US (ORD)	79 828 183	2.4
7	LONDON, GB (LHR)	78 014 598	3.0
8	HONG KONG, HK (HKG)	72 664 075	3.4
9	SHANGHAI, CN (PVG)	70 001 237	6.1
10	PARIS, FR (CDG)	69 471 442	5.4
11	AMSTERDAM, NL (AMS)	68 515 425	7.7
12	DALLAS/FORT WORTH TX, US (DFW)	67 092 194	2.3
13	GUANGZHOU, CN (CAN)	65 887 473	10.3
14	FRANKFURT, DE (FRA)	64 500 386	6.1
15	ISTANBUL, TR (IST)	64 119 374	6.1
16	NEW DELHI, IN (DEL)	63 451 503	14.1
17	JAKARTA, ID (CGK)	63 015 620	8.3
18	SINGAPORE, SG (SIN)	62 220 000	6.0
19	INCHEON, KR (ICN)	62 157 834	7.5
20	DENVER CO, US (DEN)	61 379 396	5.3

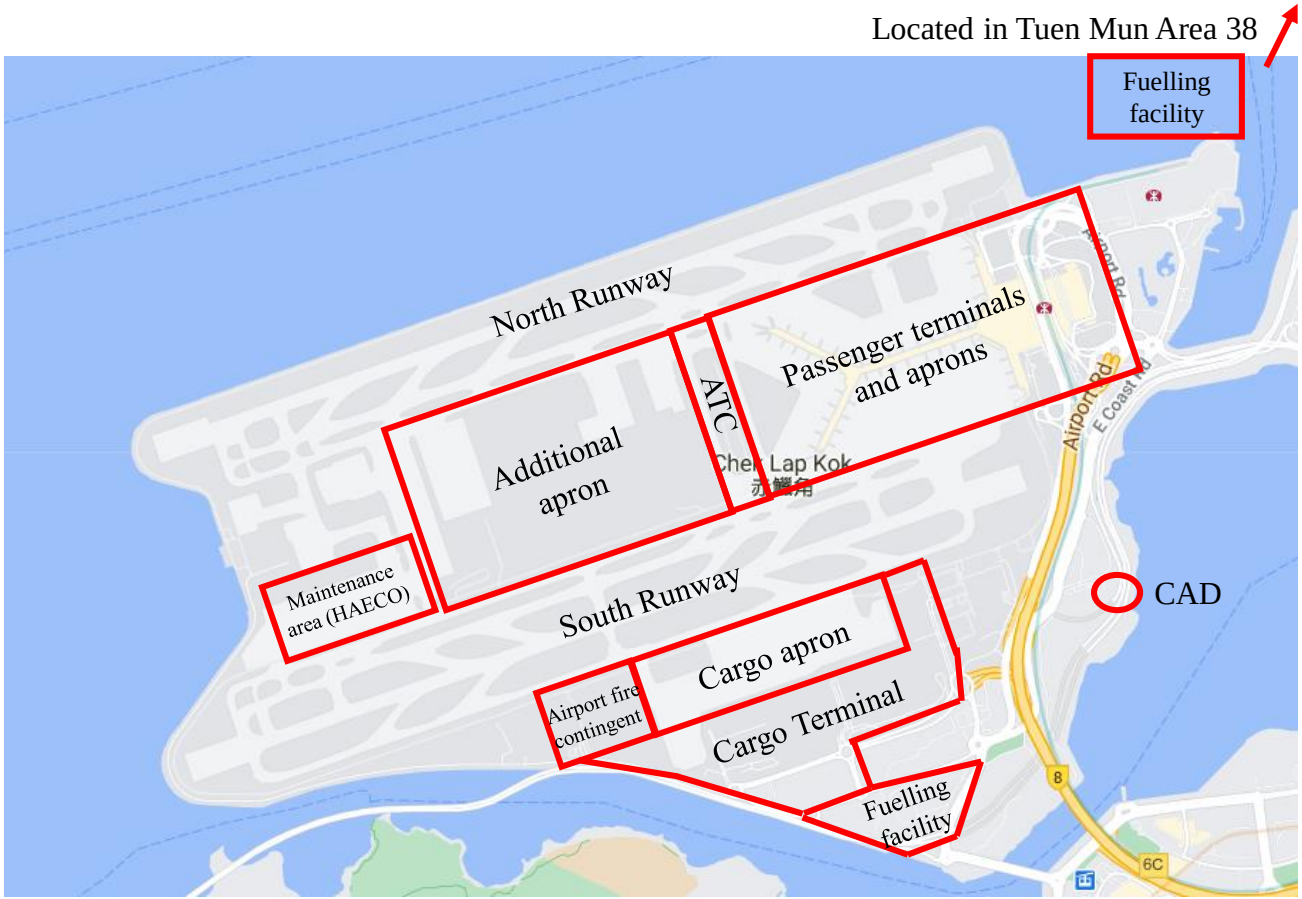
The busiest airports - cargo

Rank	City (Airport)	Loaded and unloaded 2017	% Change
1	HONG KONG, HK (HKG)	5 049 898	9.4
2	MEMPHIS TN, US (MEM)	4 336 752	0.3
3	SHANGHAI, CN (PVG)	3 824 280	11.2
4	INCHEON, KR (ICN)	2 921 691	7.6
5	ANCHORAGE AK, US (ANC)	2 713 230	6.7
6	DUBAI, AE (DXB)	2 654 494	2.4
7	LOUISVILLE KY, US (SDF)	2 602 695	6.8
8	TOKYO, JP (NRT)	2 336 427	7.9
9	TAIPEI, TW (TPE)	2 269 585	8.2
10	PARIS, FR (CDG)	2 195 229	2.8
11	FRANKFURT, DE (FRA)	2 194 056	3.8
12	SINGAPORE, SG (SIN)	2 164 700	7.9
13	LOS ANGELES CA, US (LAX)	2 158 324	8.1
14	MIAMI FL, US (MIA)	2 071 722	2.9
15	BEIJING, CN (PEK)	2 029 584	4.5
16	DOHA, QA (DOH)	2 020 942	15.0
17	LONDON, GB (LHR)	1 794 276	9.4
18	GUANGZHOU, CN (CAN)	1 780 423	7.8
19	AMSTERDAM, NL (AMS)	1 778 382	4.9
20	CHICAGO IL, US (ORD)	1 721 807	12.6

Hong Kong International Airport (HKIA)

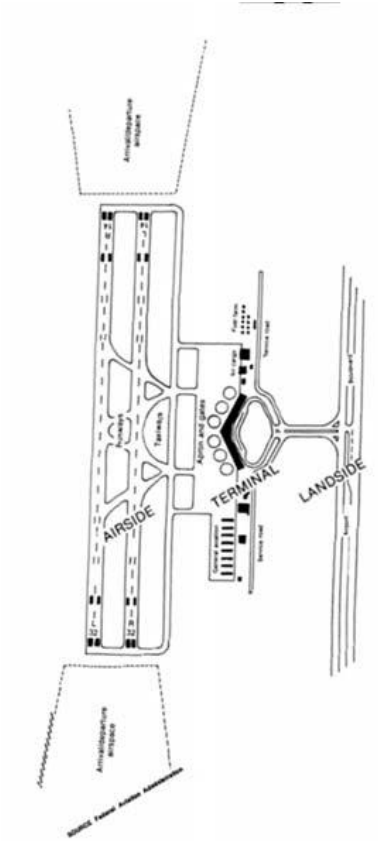
- Over 100 airlines, 1000 passenger and cargo flights per day.
- 960 of which are scheduled passenger and all-cargo flights between Hong Kong and around 180 destinations worldwide, including about 45 mainland cities.
- About 350 non-scheduled passenger and cargo flights each week. About 70% of these flights are operated with wide-bodied jets.
- The Civil Aviation Department (CAD) is responsible for the provision of air traffic control services, certification of Hong Kong registered aircraft, monitoring of airlines on their compliance with bilateral Air Services Agreements, the regulation of general civil aviation activities and overseeing the safety and security of airport operations.
- The Airport Authority Hong Kong (AAHK) ensures the operations of the HKIA comply with the safety and security requirements of CAD in order to obtain an aerodrome license from CAD for operating the Airport.

Hong Kong International Airport (HKIA) (cont'd)



Anatomy of airports

- An airport is a complex transportation hub serving aircraft, passengers, cargo, and surface vehicles.
- It is customary to classify the several components of an airport in three major categories:
  - Airside facilities
  - Landside facilities
  - The terminal buildings
- The terminal building serves as the interchange between the landside and airside facilities.



The Hong Kong Polytechnic University
香港理工大學

Flight Operations

Opening Minds • Shaping the Future
啟迪思維 • 成就未來

Flight operations

- Every flight is physically operated by the flight crew.
- However, a great deal of support, preparation and coordination is required for any flight. The major elements that require coordination for any flight include:
  - The aircraft
  - Cockpit and cabin crews
  - Flight planning
  - Maintenance personnel
  - Ground service personnel
  - Flight monitoring

Anatomy of an airline

- An airline's most important assets are its airplanes and its people. An airline can have the best planes in the world, but without the employees, an airline can't do anything.
- One of the most basic costs is the price of buying the airplanes. A Boeing 737, a short-haul passenger jet aircraft, costs around $90 million. A large long-haul passenger jet aircraft like an A380 can cost around $400 million.

AIRBUS AIRCRAFT
2018 AVERAGE LIST PRICES (USD millions)

A220-100	81
A220-300	91.5
A318	77.4
A319	92.3
A320	101.0
A321	118.3
A319neo	101.5
A320neo	110.6
A321neo	129.5
A330-200	238.5
A330-800 (neo)	259.9
A330-200 Freighter	241.7
A330-300	264.2
A330-900 (neo)	296.4
A350-800	280.6
A350-900	317.4
A350-1000	366.5
A380	445.6

Airplane Families	Current Price $ in millions average
737 Family	
737-700	89.1
737-800	106.1
737-900ER	112.6
737 MAX 7	99.7
737 MAX 8	121.6
737 MAX 200	124.8
737 MAX 9	128.9
737 MAX 10	134.9
747 Family	
747-8	418.4
747-8 Freighter	419.2
767 Family	
767-2C	*
767-300ER	217.9
767-300 Freighter	220.3
777 Family	
777-200ER	306.6
777-200LR	346.9
777-300ER	375.5
777 Freighter	352.3
777-8	410.2
777-9	442.2
787 Family	
787-8	248.3
787-9	292.5
787-10	338.4

The people

- Airlines are most often represented in public by front line employees, such as pilots and flight attendants, but there are many more working behind the scenes.
- Line personnel - pilots and flight attendants, reservation clerks etc.
- Operations - scheduling aircraft and flight crews, maintain guidelines to meet FAA standards, and training.
- Maintenance - about 10% of an airline's work force is dedicated to aircraft maintenance.
- Sales and marketing – responsible for advertising, cargo sales, reservations, customer service and food service.
- Airline also employs specialists and subcontractors to perform particular duties. This includes lawyers, accountants, and public-relations specialists.
- Subcontractors are companies whom airlines farm work out to, e.g. cleaning, fuelling, security, food services and sometimes maintenance.

Flight operations

Flight crew comprise of both cabin crew and cockpit crew.

Cockpit crew

- Modern airliners are designed to be operated by two pilots: the captain and the first officer.
- Older aircraft may also require a flight engineer to manage the systems.
- The captain has the ultimate responsibility for the safe and efficient conduct of the flight.
- In emergency circumstances, the captain may deviate from a procedure or regulation under his or her command authority – captain's emergency authority.

Cabin crew

- Primarily responsible for passenger safety during the flight.
- Other duties include providing customer service and assistance with boarding.
- Cabin crew receive specialised training in aircraft emergencies, evacuation procedures, medical issues and health hazards, care of special needs passengers, flight regulations and meal service, or marketing background.
- The number of cabin crew assigned to a given flight vary with the seats available on the aircraft, and their working agreement.

Portable Breathing Equipment (PBE) smoke hoods

First Aid/CPR/AED

Flight crew regulations

- In order to ensure high level of safety and reliability, the aviation industry is a tightly regulated industry.
- Regulated by the country's aviation regulatory body and the aviation regulatory bodies of the countries that they operate in, and oversee by ICAO.

Flight crew standards and regulations

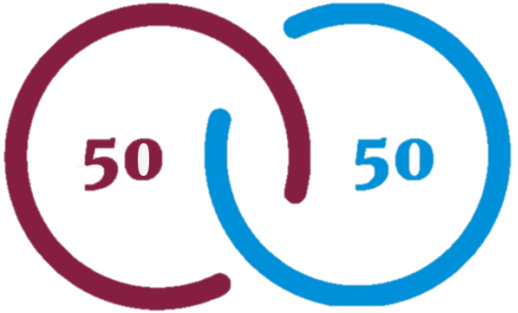
- Majority of the aviation accidents are caused by human error.
- Airlines and regulators have developed standards and detailed procedures to be carried out by the crew under normal, abnormal and emergency conditions, which are detailed in flight crew operating manuals.
- The flight standards department establishes crew member proficiency and currency.

Flight operations officer

- The flight operations department of an airline is responsible for the preparation and coordination, and the safe and efficient movement of flights from origins to their destinations.
- A flight could not be successful without the back stage support of the flight operation officer.

Fight dispatcher

- Flight operations officer, or the dispatcher, works in the airline's operations centre:
  - Coordinate and prepare the aircraft for the scheduled flight.
  - Monitor the flight on its journey and the aircraft's performance, the weather and anything that might affect flight performance and safety.
- Flight operations officer share 50/50 responsibility with the captain for the safety of each flight they dispatch.
- For each flight, the flight dispatcher develops the flight plan with the pilots to maximise the payload while minimising the operating cost, and develop contingency plan in the event of an emergency.



Aircraft maintenance engineers (AME)

- A licensed person who carries out and certifies aircraft maintenance.
- AME ensure the aircraft is fit for its mission.
- In Hong Kong, HKAR-66 is a set of CAD requirements for the qualification of aircraft maintenance staff by the issue of an aircraft maintenance license.
- The license authorise the holder to perform certain roles within line and/or base maintenance. There are three levels within the license:
    - Category A - Line Maintenance Certifying Mechanic
    - Category B1 - Line Maintenance Certifying Engineer (Mechanical)
    - Category B2 - Line Maintenance Certifying Engineer (Avionic)
    - Category B3 - Simple Light Airplane Maintenance Certifying Engineer
    - Category C - Base Maintenance Certifying Engineer

Flight rules 1

- Visual Flight Rules (VFR) are the rules that govern the operation of aircraft in VMC (meteorological conditions in which flight solely by visual reference is possible).
- VFR are detailed in ICAO:
  - Annex 2: Rules of the Air, Chapter 4: Visual Flight Rules

Altitude band	Airspace class	Flight visibility	Distance from cloud
At and above 3 050 m (10 000 ft) AMSL	A*** B C D E F G	8 km	1 500 m horizontally 300 m (1 000 ft) vertically
Below 3 050 m (10 000 ft) AMSL and above 900 m (3 000 ft) AMSL, or above 300 m (1 000 ft) above terrain, whichever is the higher	A***B C D E F G	5 km	1 500 m horizontally 300 m (1 000 ft) vertically
At and below 900 m (3 000 ft) AMSL, or 300 m (1 000 ft) above terrain, whichever is the higher	A***B C D E	5 km	1 500 m horizontally 300 m (1 000 ft) vertically
	F G	5 km**	Clear of cloud and with the surface in sight

* When the height of the transition altitude is lower than 3 050 m (10 000 ft) AMSL, FL 100 should be used in lieu of 10 000 ft.

** When so prescribed by the appropriate ATS authority:

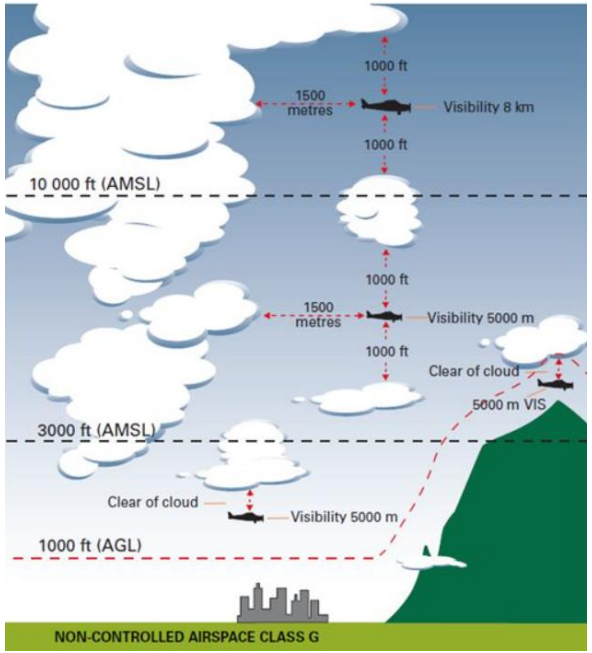
a) flight visibilities reduced to not less than 1 500 m may be permitted for flights operating:

1) at speeds that, in the prevailing visibility, will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision; or

2) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low volume traffic and for aerial work at low levels.

b) HELICOPTERS may be permitted to operate *in less than 1 500 m* flight visibility, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision.

***The VMC minima in Class A airspace are included for guidance to pilots and do not imply acceptance of VFR flights in Class A airspace.

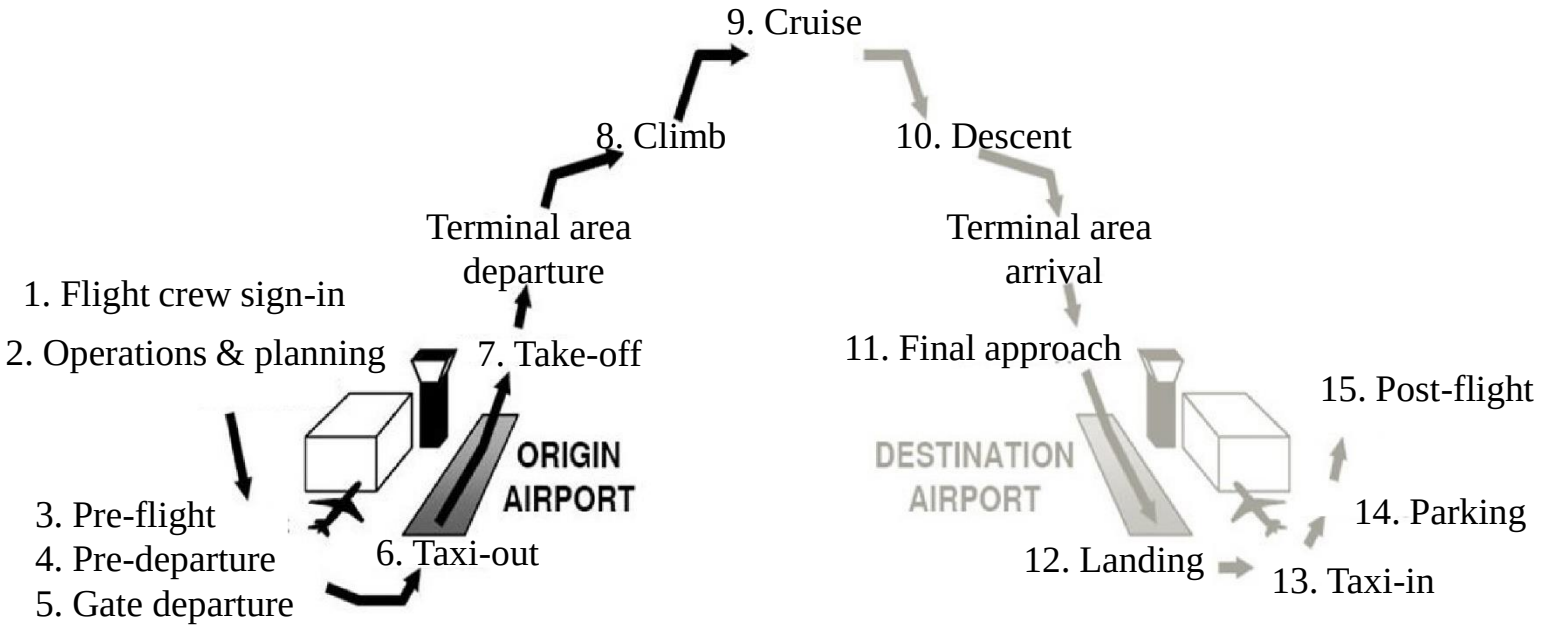


Flight rules 2

- Instrument Flight Rules (IFR) are rules which allow properly equipped aircraft to be flown under instrument meteorological conditions (IMC).
- IFR are detailed in ICAO Annex 2: Rules of the Air, Chapter 5: Instrument Flight Rules.
- It dictate how aircraft are to be operated when the pilot is unable to navigate using visual references under visual flight rules. The aircraft must be fitted with the necessary instrumentation and certified by the regulatory authority, and the pilot must hold an instrument rating.
- IFR flights must submit a flight plan to the ATC to allow aircraft to be separated in controlled airspace.

Category	Ceiling		Visibility
Visual Flight Rules (green sky symbol)	Greater than 3,000 feet AGL	and	Greater than 5 miles
Marginal Visual Flight Rules (blue sky symbol)	1,000 to 3,000 feet AGL	and / or	3 to 5 miles
Instrument Flight Rules (red sky symbol)	500 to below 1,000 feet AGL	and / or	1 mile to less than 3 miles
Low Instrument Flight Rules (magenta sky symbol)	Below 500 feet AGL	and / or	Less than a mile

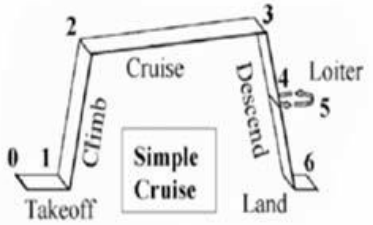
Flight phases of flight crew

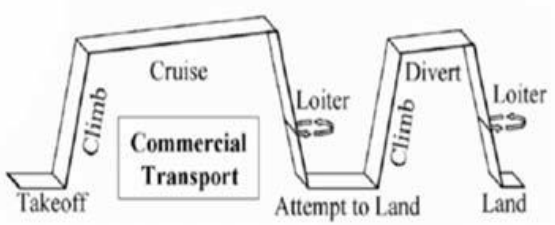


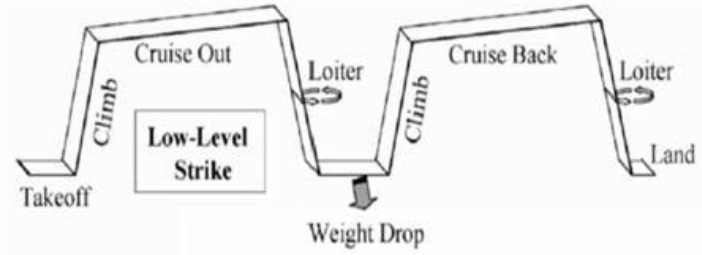
- The figure shows a typical phases for the flight crew on a revenue flight.
- The Sterile Cockpit Rule normally applies below 10,000 feet, which requiring pilots to refrain from non-essential activities during critical phases of flight.

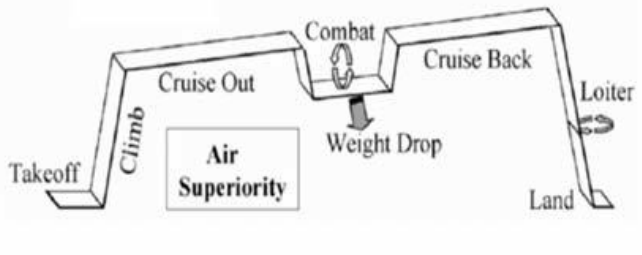
Other flight profiles

- An aircraft is operated within its designed usage. Within this limits, flight profile varies depending on the mission type and flight phase.
- Each flight phase has its own distinct flight profile, and hence manoeuvre, motion and crew actions.









Flight crew sign-in

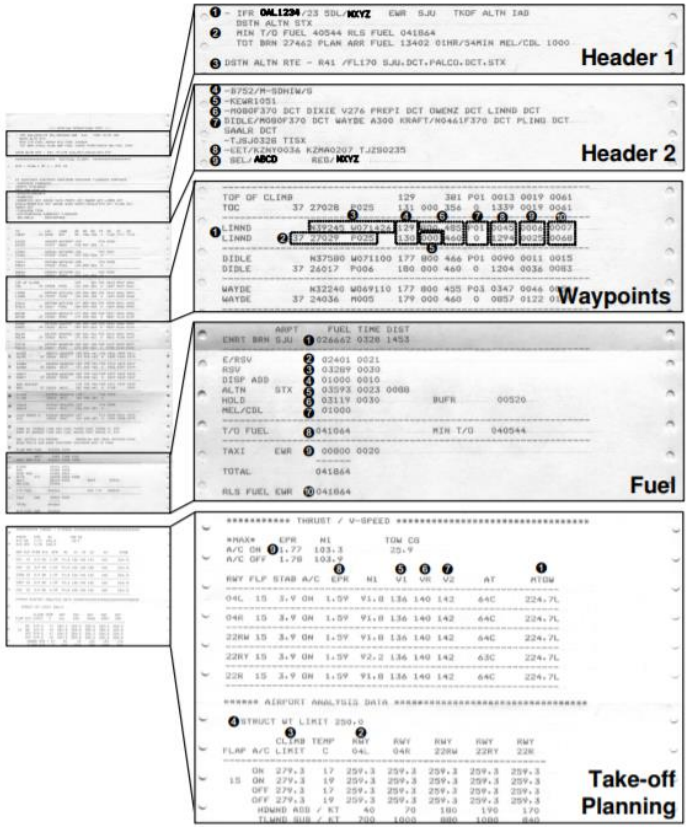
- Crew members sign in at the station at least one hour prior to departure to complete flight planning, publication and any administrative responsibilities.
- The captain is ultimately responsible, accountable for pre-flight duties.

Operations and planning

- Before the flight crew sign-in, the airline's dispatch officers are already at work on planning the flight – to produce a **flight plan**.
- Flight planning involves:
  - Select the optimal routing
  - Generate a flight plan which takes into account the aircraft type, weather conditions during the entire flight, aircraft weight and balance and loads, and other constraints and limitations.
- Evaluate the take-off and landing performance, fuel requirement.
- The flight plan is made available to the cockpit crew and sent to ATC hours before the flight is scheduled to take-off.

What is a flight plan?

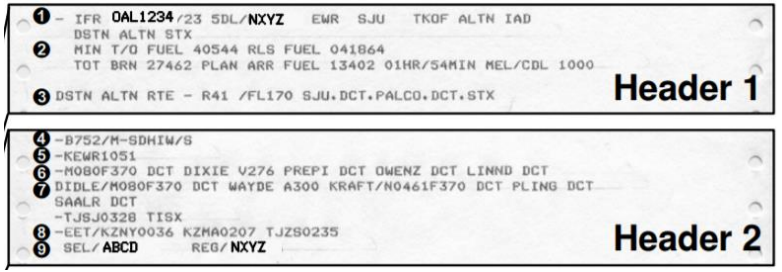
- Flight plan details various aspects of the flight:
  - E.g. flight rule, routing, weather, alternate airport options, fuel requirements, take-off performance and loads, which are subjected to last minute changes.
- The flight plan gives ATC of the enroute flight information region (FIR) advanced notice of the flight's expected time of transit.
- A flight plan of commercial flight can be viewed in 4 sections:
  - Header
  - Waypoints
  - Fuel
  - Take off performance



Flight plan

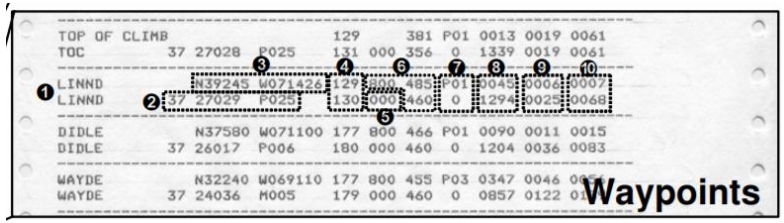
Headers

- Contain the flight plan summary and information concerning aircraft type and registration, the field routing, planned cruise speed and altitude, and enroute ATC sectors to be traversed.



Waypoints

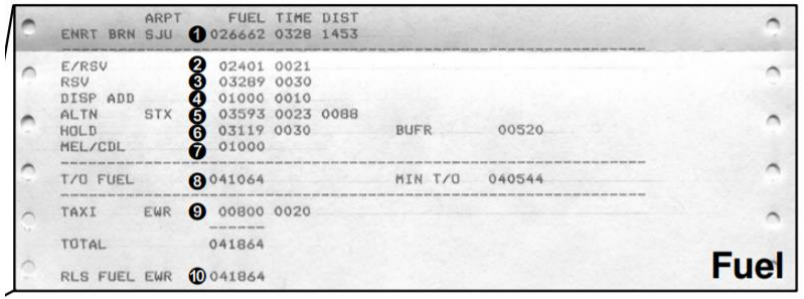
- Contain specific information corresponding to each waypoint in the filed route including wind, turbulence and weather forecasts, temperature deviation from standard, course heading, terrain elevation data, cumulative flight time and fuel burnt etc.



Flight plan (cont'd)

Fuel

- One of the key purpose of flight plan is to determine the fuel load.
- It is critical to finalise the fuel quantity required as early as possible.
- Considerations for fuel quantity include:
  - Fuel to destination plus reserve
  - Regular reserve
  - Fuel to get to alternate
  - Holding and taxi fuels
  - MEL/CDL fuel

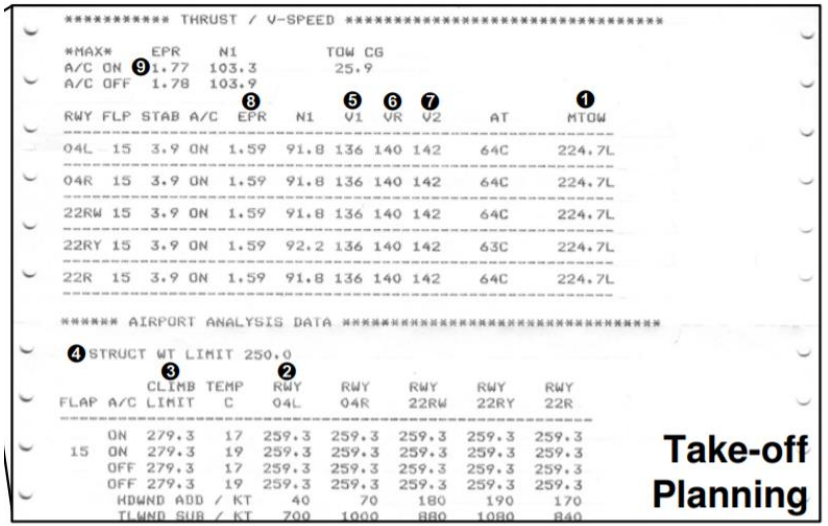


- The aircraft's weight is limited by the maximum take-off weight and is constrained by:
  - The runway-limited weight is derived from take-off runway length.
  - The climb-limited weight is based on the ability of the aircraft to climb at minimum angles with and without all engines operating normally.
  - The maximum landing weight is limited by landing runway length available and/or the ability of the aircraft to execute an aborted landing while still meeting minimum climb gradient requirements.

Flight plan (cont'd)

Take-off Planning

- Take-off and climb is the 2nd most accident prone stage of flight – accounts for 17% of all fatal accidents.
- Take-off performance must be evaluated once the load is determined by considering the available runway, local weather and atmospheric conditions.
- Take-off performance data is normally computed by flight operations.
- Adjustment may be needed to deal with changing weather and runway condition.



********** THRUST / V-SPEED **********

	EPR	N1	TOW CG
MAX			
A/C ON	❾1.77	103.3	25.9
A/C OFF	1.78	103.9	

RWY	FLP	STAB	A/C	❽EPR	N1	❺V1	❻VR	❼V2	AT	❶MTOW
04L	15	3.9	ON	1.59	91.8	136	140	142	64C	224.7L
04R	15	3.9	ON	1.59	91.8	136	140	142	64C	224.7L
22RW	15	3.9	ON	1.59	91.8	136	140	142	64C	224.7L
22RY	15	3.9	ON	1.59	92.2	136	140	142	63C	224.7L
22R	15	3.9	ON	1.59	91.8	136	140	142	64C	224.7L

****** AIRPORT ANALYSIS DATA ******

❹STRUCT WT LIMIT 250.0

FLAP	A/C	❸CLIMB LIMIT	TEMP C	❷RWY 04L	RWY 04R	RWY 22RW	RWY 22RY	RWY 22R
	ON	279.3	17	259.3	259.3	259.3	259.3	259.3
15	ON	279.3	19	259.3	259.3	259.3	259.3	259.3
	OFF	279.3	17	259.3	259.3	259.3	259.3	259.3
	OFF	279.3	19	259.3	259.3	259.3	259.3	259.3
	HDWND ADD / KT			40	70	180	190	170
	TLWND SUB / KT			700	1000	880	1080	840

Take-off Planning

Flight plan approval

- The flight plan must be agreed by flight operation officer (dispatcher) and the captain.
- Receive ATC route clearance on the filed routing.
- Changes to the filed routing by ATC must be addressed.
  - Include re-evaluating the fuel quantity, weight, take-off performance, and reprogrammed into the flight management system.
- Despite ATC route clearance is received prior to take-off, before transitioning through airspace boundaries, the flight crew is required to contact the ATC at the transitioning flight information region (FIR) to inform of its arrival and reaffirm clearance.

Pre-flight

- The crew must determine the airworthiness of the aircraft and address any open issues before departure.
- Pre-flight typically describes the interior and exterior inspections of the aircraft, and any activities performed by the flight crew to check that the aircraft is in a safe operation state prior to departure.
- This phase involves:
  - Exterior walk-around examination, interior cockpit set-up and systems and avionic checks.
  - Check fuel slip and verify the fuel quantity, fuel type and distribution with flight plan and on-board sensors.
- Pre-flight also includes verification that all required manuals and paperwork are onboard and complete.
- Minimum Equipment List (MEL) identifies the components which may be inoperative on a given aircraft while still maintaining legality for dispatch as well as the deferral rules – maintenance or fixes can be deferred up to a prescribe number of flight hours or days.
- Pre-flight inspections are outlined in a checklist.

Flight management system

- Modern aircraft have extensive auto-flight and performance optimisation capabilities.
  - ➢ Flight Management System (FMS).
- Automation has been the solution for reducing pilot workload and improving situation awareness issues, which were found to be contributing factors in some aircraft accidents and incidents.
- The flight crew have the options of a range of flight modes from full manual mode control by the pilots to full automated flight mode managed by the FMS.
- During pre-flight, the flight crew initiates the auto-flight program, programming the flight path route data into the FMS to enable the desire level of automation for each flight phase.

Appropriate amount of automation and manual control improves flight safety. While over reliance on automation can risks degradation in basic manual flying skills.

Aircraft Communication And Reporting System (ACARS)

- Allow the aircraft to be in continuous contact with the dispatch during the entire flight.
- A digital datalink system for transmission of short messages or voice recordings between aircraft and ground stations via VHF airband radio or satellite.
- Some ACARS messages are downlinked from the aircraft automatically during every flight. These include:
  - Out-time
  - Off-time
  - On-time
  - In-time
  - Engine log
- FMS flight plan can be uplinked to the aircraft

  FMS via ACARS during pre-flight.

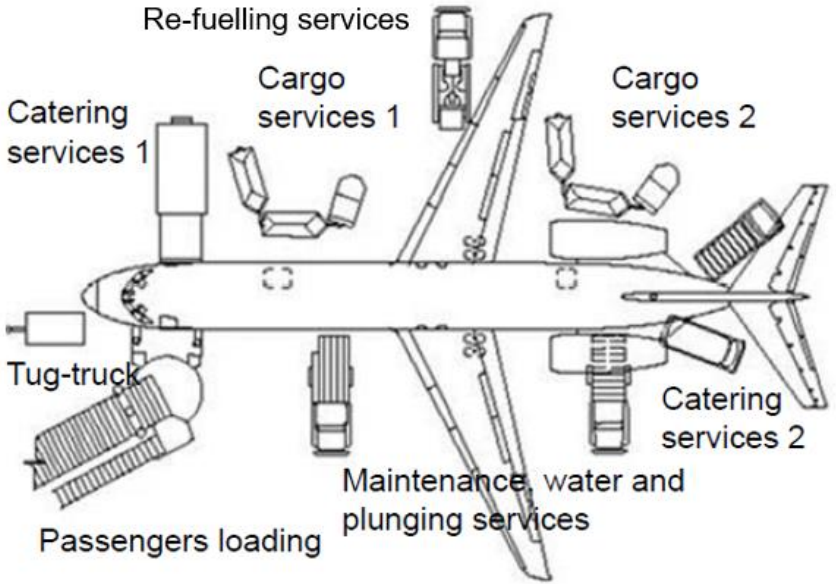
Centre console

```
FLIGHT 1234 /08 JFK -PUJ
PDC
OAL1234 XPNDR 1557
B752/W      P1300  350

KJFK SHIPP LINND BETNY
KUPEC A554 FLORI***WDPC
@ICAO FLORI/N0462F370 N***

KENNEDY 9 DEPARTURE
CANARSIE CLIMB
MAINT 5000 EXP REQSTD ALT 10MIN AFT DEP
DEPARTURE FREQUENCY 135.9
CONTACT GROUND CONTROL 121.9
ADVISE ON INITIAL CONTACT YOU HAVE ATIS
END
```

Sample ACARS output: pre-departure clearance

At the gate

- The captain, lead gate officer and ground crew chief coordinate to ensure all pre-departure requirements are met.
- The senior flight attendants coordinates boarding activities and cabin safety requirements.



Pre-departure

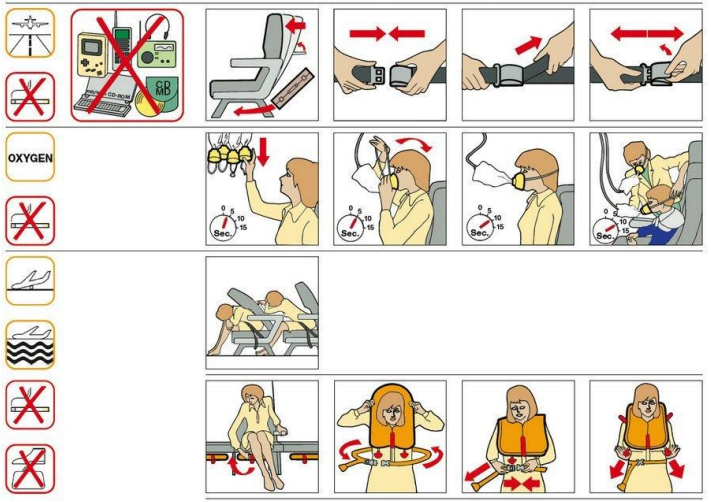
- As departure time approaches, the crew contacts ATC for routing clearance, and to address any changes to the filed routing made by the ATC including:
  - Reprogramming entries to flight computer
  - Re-evaluate take-off performance using updated weather and atmospheric conditions.
- Possible adjustment to departure time as a result of current traffic and local weather conditions.
- Delayed departure time may result in a delayed boarding, gate hold after completion of boarding, and hold away from gate.

Departure

- Once boarding is completed, closing of cabin doors is coordinated by lead flight attendant and gate officers. Air-bridges are then retracted away from the aircraft.
- Once cargo and baggage loading is complete, the ground crew closes the cargo doors, and detaches any external aircraft support equipment.
- Tow truck is then connected to the aircraft for push back, wheel chocks removed, park brake released and engines ignition.
- Upon final checks, the flight crew requests push-back clearance from ground control.
- Once the pushback is completed, the tug-truck is disconnected, and the bypass pin is removed. To complete the pushback, the ground handler shows the bypass pin to the pilots.
- Holding time will be allowed and communicated with ATC and ground control if de-icing and anti-icing is required.

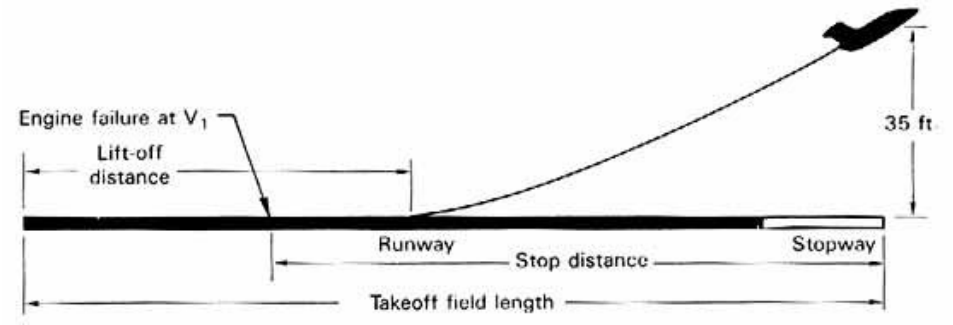
Taxi-out

- All movement must be authorised by ground control. After leaving the gate (push-back), the pilots contact the ground control to get taxi clearance to the designated or desired runway.
- Flight crew must complete the final take-off checklist, and completes passenger briefing and safety demonstration and/or video, and be secured at their stations before take-off.
- “Position and hold” allows the aircraft to taxi into position and hold on the departure runway while waiting for take-off clearance.
- When holding is not required, the aircraft is allowed to taxi on to the departure runway and take-off without holding.



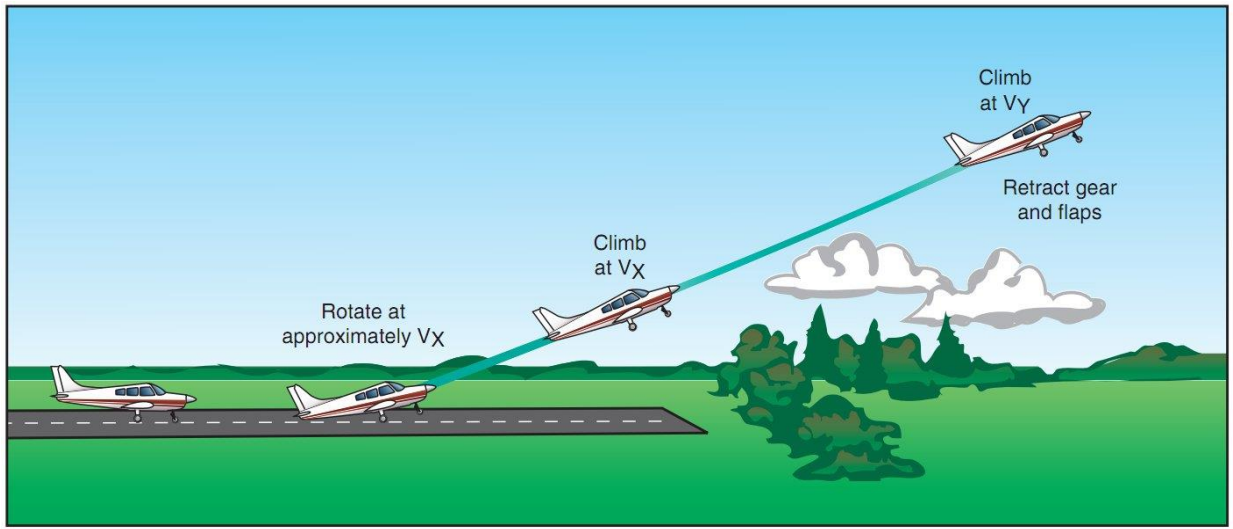
Take-off

- During take-off roll, the cockpit crew monitors the aircraft's roll down the runway, engine parameters, and cockpit and exterior conditions.
- The pilot-not-flying will call out each important speed as it is being reached as part of the normal procedure.
- Should an engine failure occur before the V1 speed is reached, the take-off is aborted and aircraft is stopped on the runway.
- Depending on the type of failure, evacuation and fire and rescue crew can be called for.
- In an regular problem-free take-off, the pilot precedes with normal climb out which includes retracting landing gears, flaps and slats.



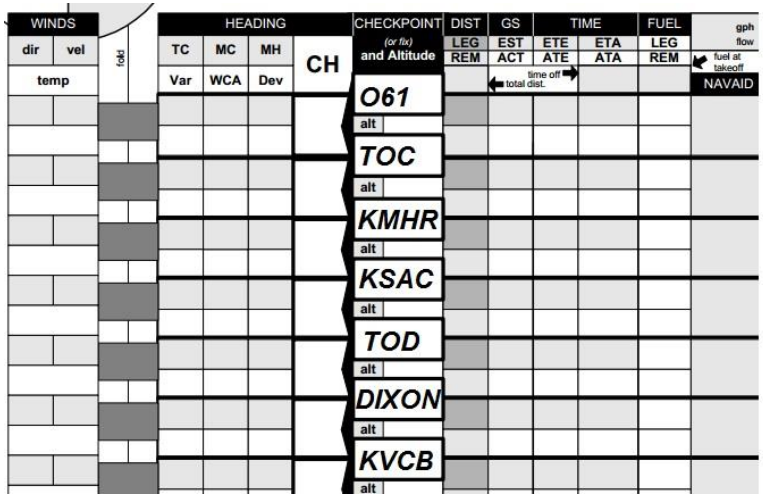
Climb

- The climb profile is determined by ATC and airspace requirements.
- As the aircraft climbs through 18,000 feet, the crew sets their altitude referencing from local barometric pressure setting to the standard atmospheric pressure reference so that all aircraft at high altitudes are using a common pressure reference.



Cruise

- As cruise altitude is being reached, the crew establishes the power setting and Mach target.
- During cruise, the crew maintain a time-fuel log to compare planned time and fuel burn performance. Potential time-fuel variation include winds in flight is greater or less than forecast, different cruise altitude and speed than planned, fuel leak and other mechanical problems.



Enroute

- Transitioning through airspace boundaries require advance notification and entry to different flight information region (FIR) also require clearance.
  - Normally done in advance via the filed flight plan process, and communications between aircraft and ATCs as it approaches each boundary.
- Deviation from the planned routing is always possible & is enabled through coordination with ATC.
- At any phase of flight, the crew must remain alert and prepared the appropriate contingency plan as the aircraft moves along the route.

Descent / Approach

- Descent takes place with about 30 to 40 minutes remaining from the destination. The flight crew at this time will begin preparation for landing.
- Similar to climb, the descent profile is determined by both ATC and airspace limitations.
- Communication between the destination station begins.
- To obtaining up-to-date weather information, visibility, holding delays, expected approach and runway procedures are the major considerations in planning an approach.
    - Allow the crew to set up the navigation equipment for the expected approach and arrival.
- As the aircraft descends below the transition level (FL180), the altimeters are set to the local barometric setting.

Approach / Landing

- In flight operations, approach and landing is the phases of flight where the pilot aligns and guides the aircraft towards the landing strip to bring the aircraft from air to the ground.
- Landing is the phase of flight where most aircraft accidents occur – 47% of all fatal accidents.
- Safe landing require accurate altitude, descent rate and speed indications, alignment with the landing strip, considerations for weather and wind conditions, and good visibility.

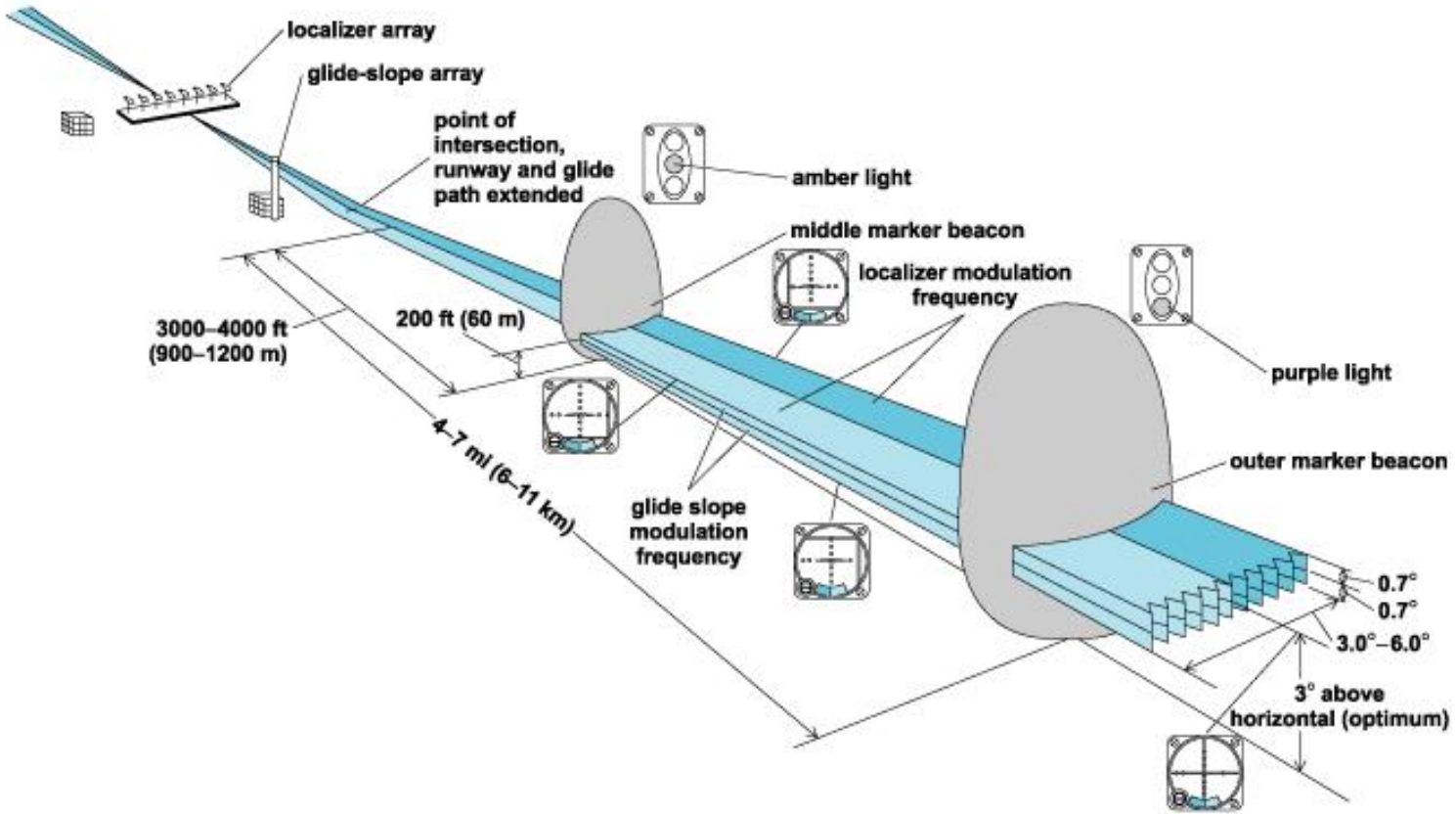
Visual approach / Landing

- Although visual approach is the first type of approach normally taught to any pilots, this type of approach may be hazardous and careful consideration should be given before flying a visual approach in preference to an instrument approach, especially on large aircraft.
- During VFR conditions, pilots exercising visual approach are encouraged to use all available NAVAIDs as back-up.
- Many carriers encourages their crews to manually operate the flight controls when appropriate for the purpose of maintain proficiency.

Instrument approach / Landing

- Many major runways at large airports utilise the Instrument Landing System (ILS) to provide guidance to pilots during approach and landing.
  - Consist of telecommunication aids to the pilot to enable him to approach the runway and make a successful landing under conditions of poor visibility even when no ground reference data is visible.
- Most aircraft are equipped to meet the requirements of a variety of precision approach and landing procedures such as CAT I, CAT II and CAT III Instrument Landing System (ILS).
  - Category I: Decision height (DH) 200ft. above runway threshold elevation and a lower RVR greater than 550 meters
  - Category II permits a DH of not lower than 100ft. and an RVR not less than 300 m;
  - Category IIIA permits a DH below 100ft. and an RVR not below 200 m;
  - Category IIIB permits a DH below 50ft. and an RVR not less than 50 m;
  - Category IIIC is a full auto-land with roll out guidance along the runway centreline and no DH or RVR limitations apply. This category is not currently available routinely primarily because of problems which arise with ground manoeuvring after landing.

ILS approach / Landing



Instrument approach

- Precision approach is a IFR procedure where both lateral (localiser) and vertical (guide slope) guidance are provided by the local navigation aid (NAVAID) of the runway to pilot during instrument conditions.
- Non-precision approach is a IFR procedure where lateral track information is provided by the local navigation aid or satellite, vertical guidance is received through barometric referencing or other means not directly associated with the specific runway.
- Precision approaches provide for operations in much lower ceiling (minimum) and visibility conditions due to precise altitude guidance.
- Runway wind condition is a major consideration for the flight crew during the final approach and landing. Maximum cross wind limitations ranges from 25 to 30 knots, and can be reduced further depending on runway, visibility and weather conditions.

Landing

- After touchdown, the flight crew uses spoilers, reverse thrust, air brake, and wheel braking (applied at low speeds < 60 knots) to decelerate the aircraft to taxi-speed, and vacate the runway as soon as possible.
- The crew reports any notable unpleasant conditions to the ATC terminal controller.
- Contact ground control for taxi movement and clearance.
- Contact ground crew to confirm arrival gate or apron assignment, and dis-embarkment arrangement.

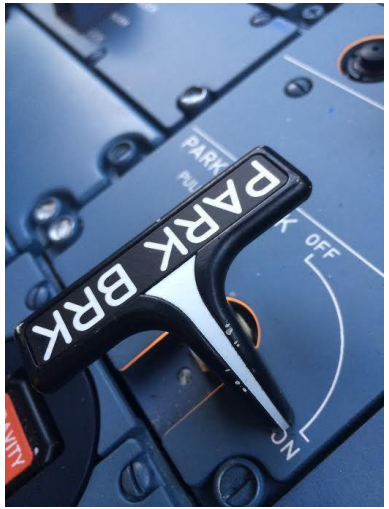



Taxi-in

- Movement along the taxi-way must obtain clearance from ATC ground control.
- Pilot must be diligent during ground operations. Special consideration must be given during night-time and poor weather and poor visibility conditions.
    - The most fatal aircraft accident in history occurred when an aircraft in taxi collided with an aircraft in the take-off phase.
- Once clearance to gate is received, the captain taxis to the ramp area where he/she will acquire the “marshaller”, who uses light wands to signal and guide the pilot and aircraft into the parking position.
    - In some cases, tug truck is required to bring the aircraft into the parking position.

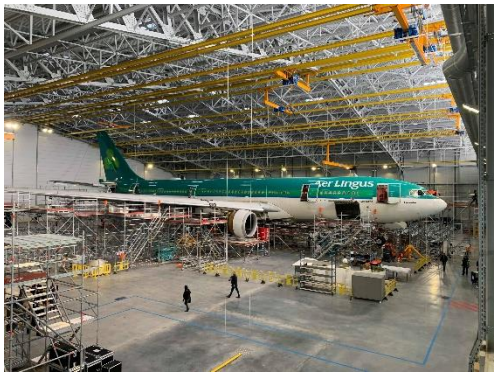
Parking

- Once park brake is on. The air-bridges or stair are moved into position for dis-embarkment.
- Setting the park-brake and opening a cabin door trigger the “IN” event (In-time), which is used to determine the on-time arrival report card, flight and airline performance data and scheduling adjustment requirement.



Post-flight

- Debrief reports are required in any notable incidents such as significant mechanical failures, illness, injuries or death onboard, misconducts, overweight or heavy landing, fuel dumping, emergency, ATC violations etc. – mandatory incident reporting.
- Once all cockpit and cabin duties are fulfilled, the crew begins preparation for the nest flight leg.
- If this is the last leg of the day, the flight crew is released from duty. Maintenance personnel performs the planned checks and line maintenance on the aircraft, to prepare the aircraft for the next day's schedule.
- If depot maintenance is required, the aircraft is towed to the appropriate maintenance hangar or apron area.



Flight crew

- Cockpit crews require licensing by their State's authorities, including some level of commercial transport certification as well as individual qualifications in specific aircraft for larger types (type-ratings).
- Crews must complete the training regimen established by their airline before meeting the qualification requirements for operating that carrier's aircraft.
- Improved simulator technology has significantly reduced the utilisation of actual aircraft during flight training.
    - The simulators can safely replicate a wide variety of environmental, flight and mechanical conditions in order to achieve flight crew proficiency in both normal and abnormal procedures.

Crew duty

- Over 20,000 cabin crew and 10,000 cockpit crew, duty assignment can be an extremely complicated job.
- Cockpit and cabin crews are assigned duty to given flight by a variety of means.
- The objectives of a Flight Time Limitation (FLT) Scheme are to ensure that crew members are adequately rested at the beginning of each flight duty period (FDP).
    - The duration and timing of individual duty periods will enable them to operate to a satisfactory level of efficiency and safety in all normal and abnormal situations.
    - Operators are required by law to take all reasonable steps to ensure that the provisions of their approved FTL Scheme are complied with.
    - Operators must ensure that all crew rosters include sufficient physiological rest so as to avoid the onset of crew fatigue.

Day	EMIRATES
1	DXB-KWI-DXB
2	OFF
3	DXB-SEZ
4	SEZ-DXB
5	OFF
6	OFF
7	DXB-DOH-DXB
8	DXB-CAI-DXB
9	OFF
10	DXB-BAH-DXB
11	DXB-GLA
12	GLA-
13	DXB
14	OFF
15	DXB-DAR
16	DAR-DXB
17	OFF
18	OFF
19	OFF
20	OFF
21	DXB-IAH
22	IAH
23	IAH-
24	DXB
25	OFF
26	OFF
27	DXB-JNB
28	JNB-
29	DXB
30	OFF
31	DXB-DEL

Flight safety

- Keys in preventing aircraft inflight accidents:
  - Good visibility
  - Sufficient aircraft separation
  - Respecting minimum flight altitude
- Two key operational rules that flight crews, airports and ATC must comply with when carrying out air transport operation:
  - Take-off and landing minimums
  - Vertical separation minimums

Take-off and landing minimums

- Aerodrome operating minima (AOM) are criteria used by pilots to determine whether they may land or take off from any runway.
- AOM consist of two parts:
  - One relating to the cloud base
  - One relating to the visibility and/or Runway Visual Range (RVR)
- The international standards for AOM are defined in ICAO Doc 8168 - Procedures for Air Navigation Services (PANS-OPS).
- In case of different requirements by some State (e.g. the U.S.), pilots must determine the standards applied at airports where they intend to operate and make due allowance for any differences.

Take-off

- AOM are defined as:

"The limits of usability of an aerodrome for:

a) Take-off, expressed in terms of RVR and/or visibility and, if necessary, cloud conditions;

b) Landing in precision approach and landing operations, expressed in terms of visibility and/or RVR and Decision Altitude/Height (DA/H) as appropriate to the category of the operation;

c) Landing in approach and landing operations with vertical guidance, expressed in terms of visibility and/or RVR and DA/H;

d) Landing in Non-Precision Approach and landing operations, expressed in terms of visibility and/or RVR, Minimum Descent Altitude/Height (MDA/H) and, if necessary, cloud conditions."

Approach and landing

- Landing minima consist of both visibility and/or RVR, and cloud base elements.
- An instrument approach may not be continued beyond the outer marker fix in the case of a precision approach, or below 1,000 ft. above the aerodrome in the case of a non-precision approach, unless the reported visibility or RVR is above the specified minimum.
- An instrument approach may not be continued beyond the DH/DA or MDH/MDA unless the required visual references for the runway are distinctly visible and identifiable.
- Where a landing is to be made on a runway other than the runway to which the approach is being flown, appropriate circling approach minima (MDH and visibility) apply.

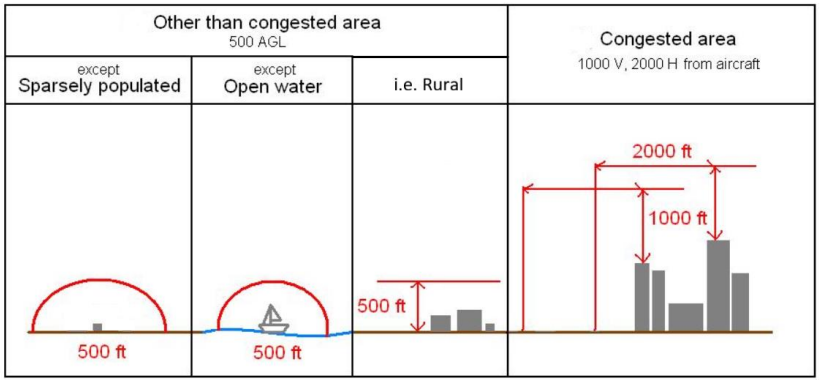
Landing minima

Category	Ceiling		Visibility
Visual Flight Rules (green sky symbol)	Greater than 3,000 feet AGL	and	Greater than 5 miles
Marginal Visual Flight Rules (blue sky symbol)	1,000 to 3,000 feet AGL	and / or	3 to 5 miles
Instrument Flight Rules (red sky symbol)	500 to below 1,000 feet AGL	and / or	1 mile to less than 3 miles
Low Instrument Flight Rules (magenta sky symbol)	Below 500 feet AGL	and / or	Less than a mile

Flight minimum altitudes

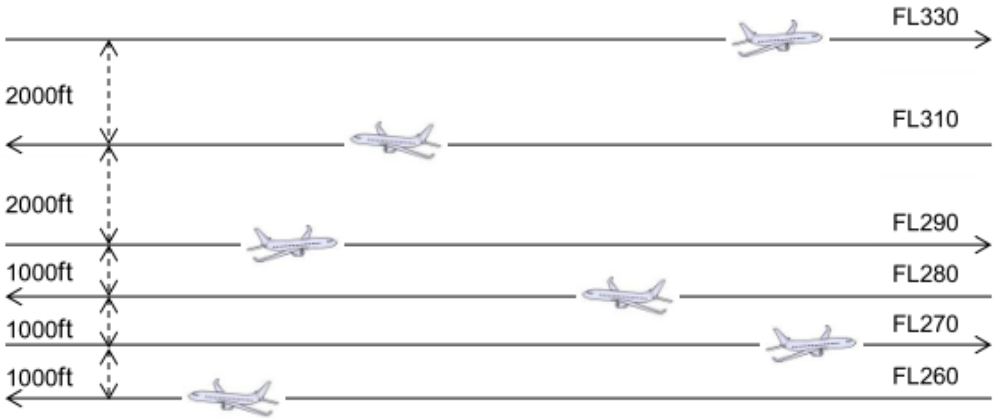
- An operator is required to establish minimum flight altitudes along the routes that it services.
  - The minimum flight altitude shall not be less than the minimum flight altitudes established by the State flown over.
- The minimum flight altitudes are usually considered to be not less than 1000 ft. above terrain and adjacent to the flight path.
- This provides a safety buffer region around a particular route that a pilot might fly, which allows for errors in the air. Flying at or above this altitude, a pilot complies with terrain clearance requirements on that particular flight leg.

	Minimum Safe Altitudes - 14 CFR 91.119
Congested Area	At least 1,000 feet above highest obstacle within 2,000 feet of the aircraft
Uncongested Area	At least 500 feet above the surface, and no closer than 500 feet to any person, vessel, vehicle, or structure
Anywhere	Altitude allowing for emergency landing without undue hazard to persons or property on the ground



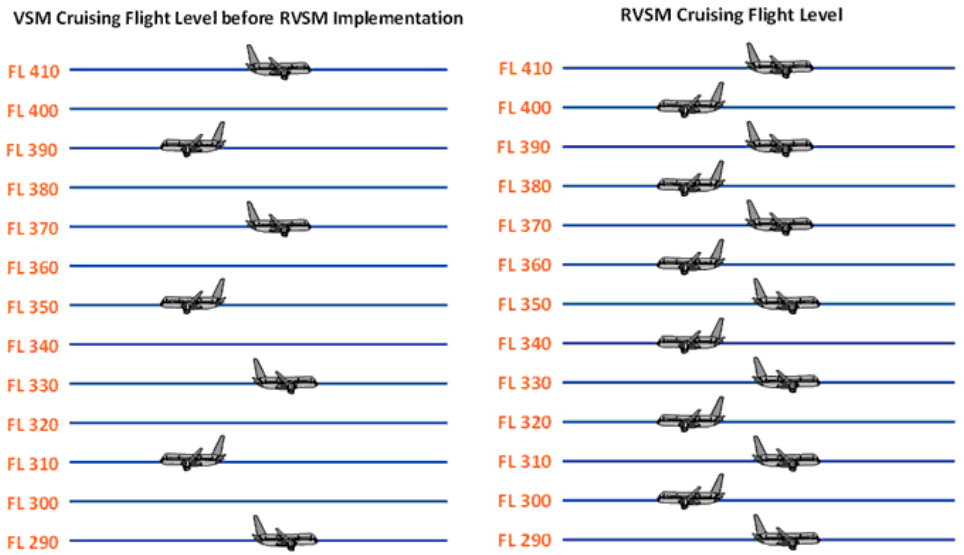
Vertical separation minima (VSM)

- Before 1997, the minimum vertical separation between airplanes between FL 290 (29,000 ft.) and FL410 (41,000 ft.), inclusive, was 2,000 feet (or between 8,850 and 12,500 m from 600 m to 300 m).
  - This large separation was necessary because of the relatively large errors in barometric altimeters at high altitudes.
- To accommodate for the continuous increase in air traffic, solution to overcome the limitation in airspace capacity was required.



Reduced vertical separation minima (RVSM)

- RVSM is the reduction of the standard vertical separation required between aircraft flying between FL290 and FL410 from 2,000 feet to 1,000 feet.
    - Increase the number of aircraft that can fly in a fixed volume of airspace.
- Accurate altitude determination by satellite global positioning systems makes it possible to reduce the VSM for properly equipped airplanes.



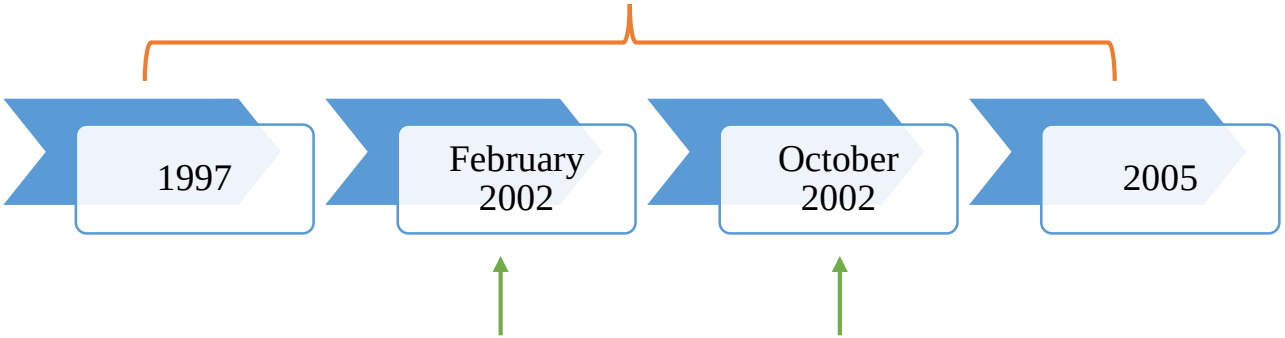
RVSM qualified aircraft

Application and reliability of RVSM relies on the accuracy of altitude measuring equipment. An operator shall ensure that aircraft operated in RVSM airspace are equipped with:

- Two independent altitude measurement systems
- An altitude alerting system
- An automatic altitude control system
- A secondary surveillance radar transponder with altitude reporting system
- A program in place to assure continued airworthiness of RVSM critical systems
- Flight crews, dispatchers, and flight operations must be properly trained
- Operational procedures, checklists, etc. must be established and published in the ops manual and AFM.

RVSM implementation

RVSM was implemented in all of Europe, North Africa, Southeast Asia, North America, South America, and over the North Atlantic, South Atlantic, and Pacific Oceans.



The States of the ICAO Asia/Pacific Region within the Western Pacific/South China Sea (WPAC/SCS) area, which includes Hong Kong, implemented RVSM operations for ATC flight level assignment using a modified single alternate flight level orientation scheme (FLOS), with a complementary flight level allocation scheme (FLAS).

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