# EASA ATPL

## HANDBOOK

Hédi Ben Farhat

BravoFox

# EASA ATPL Handbook

Free Sample

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# Preface

Please keep in mind that **this book assumes that you already have a PPL**. From that base, **there's everything here that you will need** to complete your lessons and <u>succeed in taking your ATPL</u>.

**This is a collection of notes, tips and schematics** to remember the very essential knowledge <u>before taken an ATPL exam or going for a job interview</u>.

### Who am I?

I'm not native English speaker so there might be some grammatical mistakes.

I was born in 1987 in north France, and I still live in France near Grenoble (French Alps). I used to work as IT Team leader, in small and large companies before creating my own company.

Academic curriculum:

- Electronic highschool diploma,
- Bachelor degree in Electronic,
- University degree in IT Networking and Telecommunication,
- Master degree in Engineering General IT

### Regarding aviation:

I started my career in aviation on a computer, like many I guess, doing simulated flights. At first on 'Flight Simulator 95'. Then, I've used many simulators and logged many many hours on them. I've jump into the "real aviation" world a soon as the "real" money came in. PPL in 2014, with about 200 hours of flight at the time I'm writing this book.

I've done volunteer work for a year in a local aviation club as board member.

I volunteered in another non-profit organisation, also as financial manager: The "Grenoble Air Show", which involved the French "Patrouille de France" and gathered more than 10 000 people in 2016 and 2018.

### How did I write this book?

Step by step, one module after another.

1. I read the ATPL books ⇒Taken some key notes and tips from the books,
2. I used 'Aviation-Exam' ⇒ Added and removed some notes to keep it as close as possible to the ATPL Exam,
3. I drew the illustrations in the book,
4. I kept improving the book until I got a solid and regular 90% on Aviation-Exam

### How to use the book ?

The texts written with **bold characters** are most of the time seen in questions. The <u>underlined texts</u> are seen in the correct answers. *Some useful tips and mnemonics are written in italic.*

I strongly recommend buying the CRP5-W flight computer and learn how to use it. Instead of the classic CRP5, the CRP5-W will save you a lot of time for all triangle of velocities questions.

Finally, **I would like to thank my dear Emeline, my family and especially my dog** for their support during this whole period of studying the ATPL.

# AIR LAW

## 1. ICAO

### 1.1 COMMISSIONS (TRIMMED)

### 1.2 SECRETARIAT (TRIMMED)

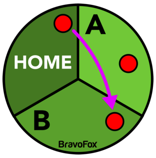
### 1.3 SARPS – INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

**SARPS are listed in the annexes** to the Chicago Convention.

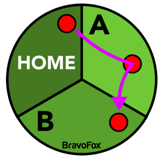
1. Personnel licensing
2. Rules of the Air
3. Meteorological Services for International Air Navigation
4. Aeronautical Charts
5. Units of Measurement to be used in Air and Ground Operations
6. Operation of Aircraft
7. Aircraft Nationality and Registration Marks
8. Airworthiness of Aircraft
9. Facilitation
10. Aeronautical Telecommunications
11. Air Traffic Services
12. Search and Rescue
13. Aircraft Accident Investigations
14. Aerodromes
15. Aeronautical Information Services
16. Environmental Protection
17. Security - Safeguarding International Civil Aviation against Acts of Unlawful Interference
18. The Safe Transport of Dangerous Goods by Air

#### 1.3.1 THE CONVENTIONS (TRIMMED)

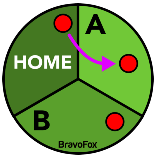
## 2. FREEDOMS OF THE AIR



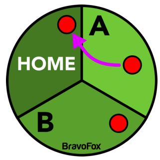

1: The right to fly over a foreign country without landing.



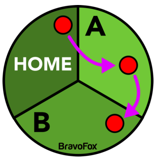

2: The right to refuel or carry out maintenance in a foreign country without embarking or disembarking passengers or cargo.



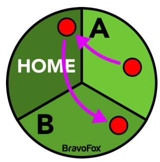

3: The right to fly from one's own country to another country.




4: The right to fly from another country to one's own.

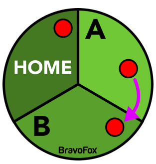



5: The right to fly between two foreign countries on a flight originating or ending in one's own country.

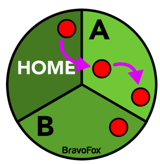



6: The right to fly from a foreign country to another while stopping in one's own country for non-technical reasons.

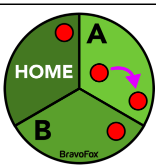
Modified 6th: The right to fly between two places in a foreign country while stopping in one's own country for non-technical reasons.




7: The right to fly between two foreign countries, where the flights do not touch one's own country.




8: The right to fly inside a foreign country, continuing to one's own country.




9: The right to fly within a foreign country without continuing to one's own country.

## 3. CERTIFICATE OF AIRWORTHINESS

Is applicable to aeroplane **>5700kg MTOM**, intended for the carriage of **Passengers, Cargo** or **Mail** in international air navigation.

**State of registry:** Established or renewed the Certificate of Airworthiness

**State of design**: ensure there exists a continuing structural integrity program.

It must be onboard for **any flight operation**.

**When an aircraft has sustained damage:**

- State of Registry judge if the aircraft is longer or not **airworthy.**
- State of Registry give permission (or not) to **fly to an airport for reparation.**
- In another Contacting State, the authorities can prevent the aircraft from resuming its flight on condition they advise the State of Registry.

## 4. HIGH SEAS

The rules established under the Convention on International Civil Aviation apply.

**Air Navigation Service over high seas** are provided by a contracting state who accepted the responsibility.

## 5. AIRCRAFT MARK

| | |
|---|---|
| F-GTPT | F ⇒ Common mark (ICAO ⇐ **I**nternational **T**elecommunication **U**nion) |
| | GTPT ⇒ Registration mark ⇒ State of registry or common mark registering authority |
| | Vertical ≥ 30cm |
| | Under the wing ≥ 50cm, on the left half of the lower surface of the wing structure |

1. **ITU** *allocate* common mark to **ICAO**
2. **ICAO** *assigns* the common mark to the **State of registry** or **Common Mark Registering Authority**
3. **State of Registry** *assigns* the registration mark.

**Forbidden:** XXX, SOS, PAN, TTT, Q**, five-letter combinations used in the International Code of Signals.

## 6. CERTIFICATE OF REGISTRATION

Contains:

- Nationality or Common mark
- Registration mark
- Manufacturer's designation of the aircraft
- Serial number of the aircraft
- Name and address of the owner
- A certificate mentioning that the aircraft has been entered on the register of the State
- Dated signature of the registering officer

# 7. AIRCRAFT CLASSIFICATION

## 7.1 PRIORITY (TRIMMED)

# 8. FLIGHT CREW LICENSING

## 8.1 ROLES (TRIMMED)

## 8.2 LICENCES (TRIMMED)

## 8.3 THEORICAL KNOWLEDGE (TRIMMED)

## 8.4 CREDITING OF FLIGHT TIME (TRIMMED)

## 8.5 RECENT EXPERIENCE (TRIMMED)

## 8.6 AGED 60 OR MORE IN COMMERCIAL AIR TRANSPORT (CAT) (TRIMMED)

## 8.7 MEDICAL / PART-MED (TRIMMED)

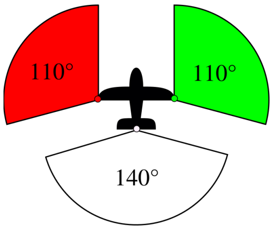
# 9. RULES OF AIR

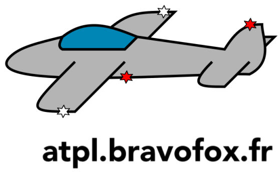
## 9.1 RIGHT OF WAY

**Airborne:** Has **Right of way**: those on your right. Maintaining Heading and Speed.

**On ground:** Landing>Taking-off>Towed>Other vehicles

## 9.2 LIGHTS & OVERTAKES




**Anti-collision**: always

**Red Beacon**: when engine running

**Nav**: from Sunset until Sunrise

## 9.3 FLIGHT PLAN

**Needed if:** Controlled flight, IFR, International

**Sent:**

- **60min** prior departure
- **10min** prior the first point if submitted in flight
- **3h** prior EOBT if **AFTM**
- **30min** if **controlled / change.**

**Contain:**

- Aircraft identification
- Flight Rules (I/V/Y/Z) Y=I, V Z=V, I
- Equipment
- Departure Aerodrome
- EOBT – Estimated Of Blocks Time
- Cruise speed (TAS or Mach number)
- Cruise level
- Route
- Destination Aerodrome
- EET – Estimated Elapsed Time
- Alternate Aerodrome
- Fuel endurance
- POB (including dead body)
- Emergency and survival equipment

**Closing flight plan**: Within 30min after ETA.
**Arrival report** contain:

- Aircraft identification
- Departure Aerodrome
- Destination Aerodrome
- Arrival Aerodrome
- Time of arrival

**RPL** – Repetitive Flight Plan:

Used in IFR same day(s) consecutive week minimum 10 occasions or 10 consecutive days.

**Notify ATC** if

- +30min delay EOBT controlled flight (1h if uncontrolled)
- TAS ±5% or Mach number ±0.01 regard to the FPL.
- Error >2min at reporting point
- If EOBT +1h flight plan should be amended or cancelled.
- Landed at an airfield other than original destination (Notify original destination within 30min of the original ETA)

## 9.4 COMMUNICATION FAILURES (TRIMMED)

### 9.4.1 TOWER VISUAL SIGNAL (TRIMMED)

## 9.5 UNLAWFUL INTERFERENCE (TRIMMED)

## 9.6 INTERCEPTING (TRIMMED)

### 9.6.1 PHRASEOLOGY (TRIMMED)

### 9.6.2 SIGNALS (TRIMMED)

## 9.7 FLIGHT LEVEL

| | IFR | | VFR | |
|---|---|---|---|---|
| ≤FL290 | 20 | 30 | 25 | 35 |
| | 40 | 50 | 45 | 55 |
| | **20 × k** | **10 + 20 × k** | **5 + 20 × k** | **15 + 20 × k** |
| >FL290 | 310 | 290 | 320 | 300 |
| | 350 | 330 | 360 | 340 |
| | **310 + 40 × k** | **290 + 40 × k** | **320 + 40 × k** | **300 + 40 × k** |

## 9.8 RVSM

**RVSM** – Reduced Vertical Separation Minima.

Between **FL290 and FL410, need A/TCAS, VFR not permitted**.

| | IFR | |
|---|---|---|
| ≥FL290 ≤FL410 | 300 | 290 |
| | 320 | 310 |
| | **300 + 20 × k** | **290 + 20 × k** |

**SSR transponder tolerances:**

±200ft RVSM

±300ft non-RVSM

±200ft non-RVSM (including any exception)

## 9.9 VMC (TRIMMED)

## 9.10 SPECIAL VFR (TRIMMED)

## 9.11 IFR (TRIMMED)

## 9.12 DISTRESS AND URGENCY (TRIMMED)

## 9.13 SQUAWK CODES (TRIMMED)

## 9.14 INCURSION INTO AN RESTRICTED/PROHIBITED/DANGER AREA(TRIMMED)

## 9.15 NARCOTICS/DRUGS/ALCOHOL (TRIMMED)

# 10. PROCEDURES FOR AIR NAVIGATION (PANS)

## 10.1 AIRCRAFT CATEGORIES (TRIMMED)

## 10.2 DEPARTURE (TRIMMED)

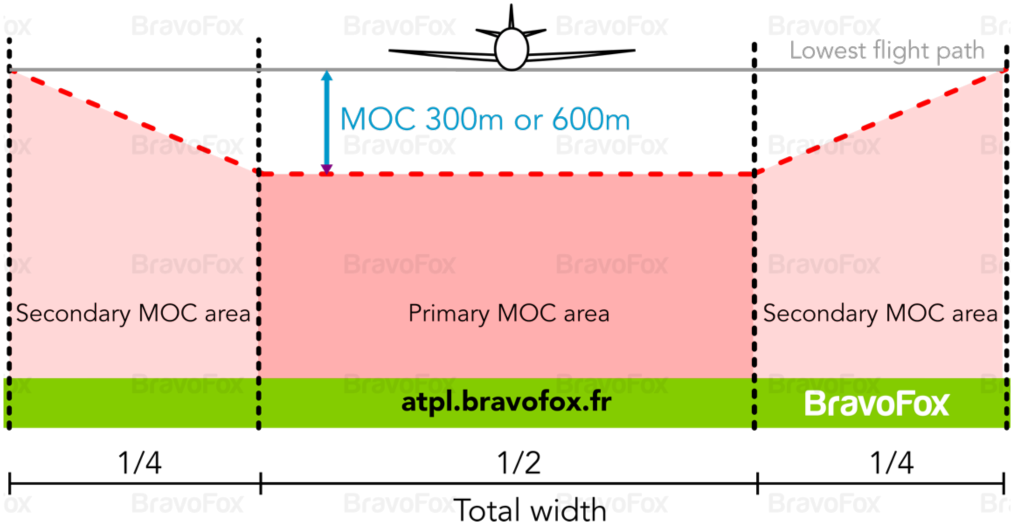
## 10.3 APPROACH (TRIMMED)

### 10.3.1 PRECISION CAT I/II/III (TRIMMED)

### 10.3.2 NON-PRECISION (TRIMMED)

### 10.3.3 PROCEDURE SEGMENTS (TRIMMED)

### 10.3.4 OBSTACLE CLEARANCE ALTITUDE/HEIGHT

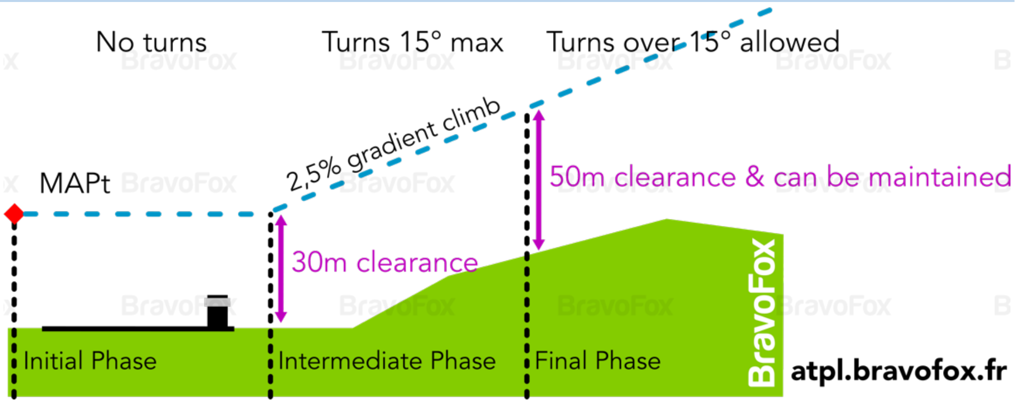



**MOC** - Minimum Obstacle Clearance

Secondary area reducing to 0 from IF to FAF (Intermediate).

For non-precision, **MOC on final** = 75m with FAF, 90m without FAF

### 10.3.5 MISSED APPROACH SEGMENT



### 10.3.6 STRAIGHT-IN APPROACH

**Track <30°** from runway centre line.

### 10.3.7 VISUAL APPROACH

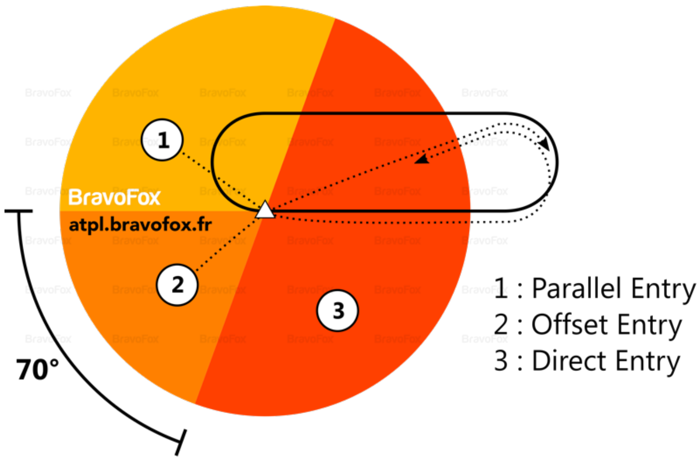
Completing the IFR procedure visually. ATC still responsible for separation.

### 10.3.8 TRACK REVERSAL AND RACETRACK (TRIMMED)

### 10.3.9 FIX ACCURACY/BEARING ERROR/TRACK GUIDANCE ACCURACY (TRIMMED)

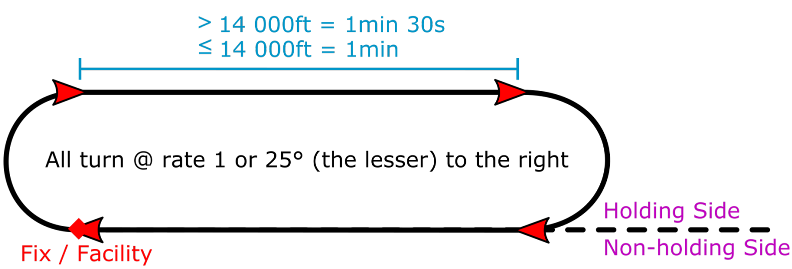
## 10.4 VISUAL MANOEUVRING CIRCLING (VM(C)) APPROACH (TRIMMED)

## 10.5 HOLDING PROCEDURES




Entry determined by **magnetic heading** (5° tolerance).

**Flight level** must be established **5NM prior the fix**.



#### 10.5.1 SPEED (TRIMMED)
#### 10.5.2 MISCELLANEOUS (TRIMMED)
### 10.6 ALTIMETER SETTING (TRIMMED)
### 10.7 PARALLEL RUNWAY OPERATION (TRIMMED)
### 10.8 SSR/ACAS (TRIMMED)
#### 10.8.1 SSR (TRIMMED)
#### 10.8.2 ACAS (TRIMMED)

## 11. AIR TRAFFIC SERVICES
### 11.1 AIRSPACES (TRIMMED)
### 11.2 PROHIBITED/RESTRICTED/DANGER AREA (TRIMMED)
### 11.3 AIRWAYS (TRIMMED)
### 11.4 RNP (TRIMMED)
### 11.5 AIREP (TRIMMED)
### 11.6 ATS (TRIMMED)
### 11.7 EMERGENCY PHASES

**Triggered** by ATC or FIC.

#### 11.7.1 INCERFA

Uncertainty exists as to the safety of an aircraft and its occupants.

Triggered when:

- No communication has been received from an aircraft within 30min after a time communication should have been received.
- An aircraft fails to arrive within 30min of the ETA.

#### 11.7.2 ALERFA

Apprehension exists as to the safety of an aircraft and its occupants.

Triggered when:

- Following INCERFA, subsequent attempts to establish communication have failed.
- Cleared to land and fails to land within five minutes of the estimated time of landing and no comms with the aircraft.
- Information has been received which indicates that the operating efficiency of the aircraft has been impaired.
- An aircraft is known or believed to be subject of unlawful interference.

#### 11.7.3 DETRESFA

There is a reasonable certainty than an aircraft and its occupants are threatened by grave and imminent danger and require immediate assistance.

Triggered when:

- Following ALERFA, subsequent attempts to establish communication have failed.
- The fuel on board is considered exhausted, or to be insufficient to enable the aircraft to reach safety
- Information is received which indicate that the operating efficiency of the aircraft has been impaired to the extent that a forced landing is likely.
- Information is received or it reasonably certain that the aircraft is about to make or has made a forced landing.

### 11.8 ATIS/METAR/SPECI (TRIMMED)

## 12. AIR TRAFFIC MANAGEMENT

### 12.1 EXPECTED APPROACH TIME (TRIMMED)

### 12.2 AIR TRAFFIC INCIDENT REPORT (TRIMMED)

### 12.3 WAKE TURBULENCE (TRIMMED)

### 12.4 SRA (TRIMMED)

### 12.5 SEPARATIONS (TRIMMED)

#### 12.5.1 APPROACH (TRIMMED)

#### 12.5.2 VERTICAL (TRIMMED)

#### 12.5.3 COMPOSITE (TRIMMED)

#### 12.5.4 LONGITUDINAL, TIME BASED (TRIMMED)

#### 12.5.5 LONGITUDINAL, MACH NUMBER TECHNIQUE (TRIMMED)

#### 12.5.6 LONGITUDINAL, DISTANCE BASED (USING DME) (TRIMMED)

#### 12.5.7 LONGITUDINAL, TRACK (TRIMMED)

#### 12.5.8 DEPARTING AIRCRAFT (TRIMMED)

## 13. AIS – AERONAUTICAL INFORMATION SERVICE

AIRAC – Aeronautical Information Regulation And Control. Distributed 42 days in advance with the objective of reaching recipient 28 days in advance. Amended every 28 days.

Integrated Aeronautical Information Package = AIP + NOTAM + PIB + AIC + Checklists + Summaries

### 13.1 AIC

AIC – Aeronautical Information Circular. Colour coded.

| Colours |
|---|
| Administrative |
| ATC |
| Safety |
| Danger area map |
| Maps/charts |

## 13.2 AIP – Aeronautical Information Publication

| | |
|---|---|
| GEN | Regulations and requirement<br>Tables and codes<br>Services<br>Charges<br>Location indicators |
| ENR | Rules and procedures<br>ATS Airspace<br>ATS Routes<br>Nav aids<br>Navigation warning<br>En-route charts<br>Comm. Failure |
| AD | Aerodromes |

## 13.3 Sup AIP

Contain temporary change of long duration (3 months or longer).

## 13.4 PIB – Pre-flight Information Bulletin

Contain: Active NOTAM/SNOWTAM/ASHTAM + Local information + Predefined maps

## 13.5 NOTAM

**NOTAM** – Notice to Airmen. Short-term.

**Triggered by:**

Long duration work on aerodrome

Work or reparation on the fuel feeding area

Strong solar radiations

Epidemics outbreak that requires the passengers for new vaccine

Change in aerodrome designation signs

## 13.6 ASHTAM

| |
|---|
| Eruption in progress, ashes over FL250<br>Eruption likely, expect ashes over FL250 |
| Eruption in progress, ashes not expected over FL250<br>Eruption likely, ashes not expected over FL250 |
| Volcano active |
| Volcanic activity considered to have ceased |

## 13.7 SNOWTAM

**Friction is measured** on each third of the runway.

| Friction coefficient | Friction |
|---|---|
| ≥ 0.4 | 5 - Good |
| 0.36 - 0.39 | 4 – Medium / Good |
| 0.30 - 0.35 | 3 – Medium |
| 0.26 - 0.29 | 2 – Medium / Poor |
| ≤ 0.25 | 1 – Poor |
| 9 | Unreliable |

| Frozen water deposit | |
|---|---|
| Ice/Slush snow | Water saturated snow<br>*(Your feet will get wet)* |
| Dry snow | Fall apart<br>*(Can't make snowball)* |
| Wet snow | Stick together<br>*(To make snowball)* |
| Compacted snow | Compacted snow<br>*(The snowball)* |

## 13.8 WET RUNWAY REPORT

| | |
|---|---|
| Damp | Surface show change of colour due to moisture |
| Wet | Surface soaked but no standing water |
| Water patches | Patches of standing water are visible |
| Flooded | Extensive standing water is visible |

# 14. AERODROMES

## 14.1 AERODROME REFERENCE CODE (TRIMMED)

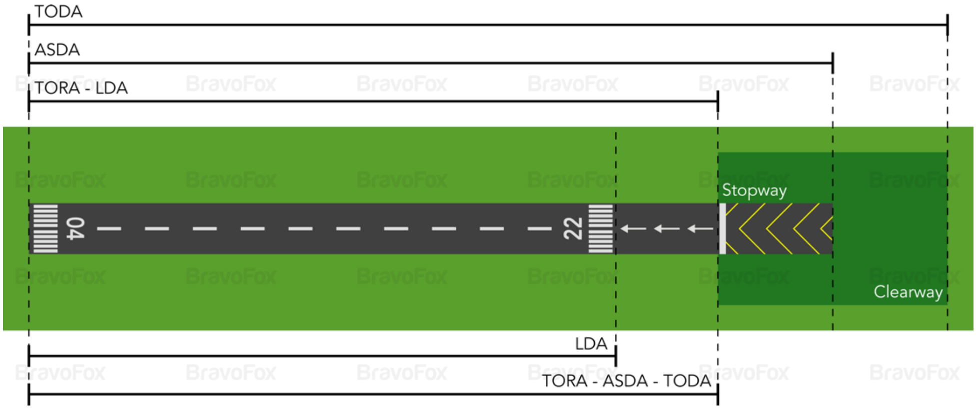
### 14.1.1 RUNWAY WIDTH (TRIMMED)

### 14.1.2 TAXIWAYS (TRIMMED)

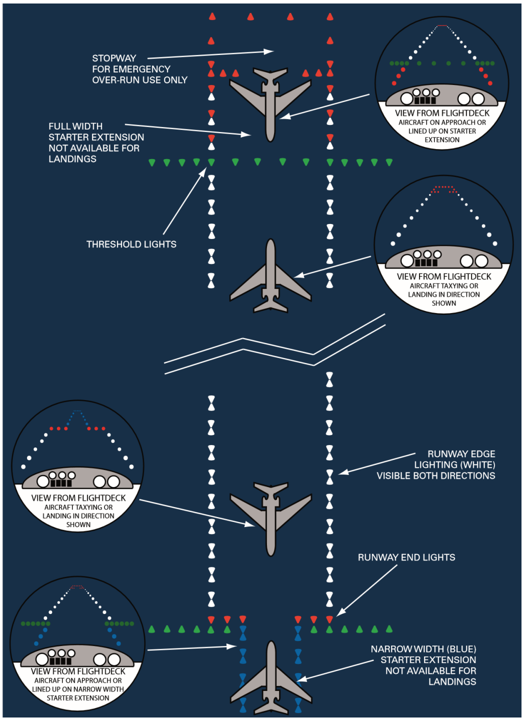
### 14.1.3 MARKING (TRIMMED)

## 14.2 APPROACH LIGHTING SYSTEM (TRIMMED)

## 14.3 Runways




### 14.3.1 Lighting

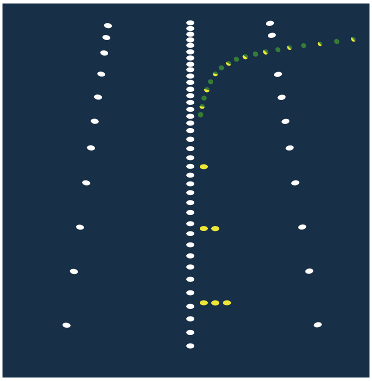



**Exit:** Blue.

**Centreline:** White from the threshold to 900m from the runway end, the following 600m is lit with alternate white and red lights, and the final 300 m lit by red.

**Touchdown Zone (TDZ):** Two row of white barrettes.

**Rapid exit**: 6 yellow lights (3, 2, 1) spaced 100m.



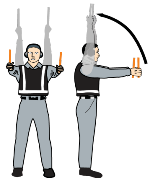
## 14.4 Signals (Trimmed)

### 14.4.1 Ground Signals (Trimmed)

### 14.4.2 Stand Marks (Trimmed)

## 14.4.3 Marshalling signals to pilot

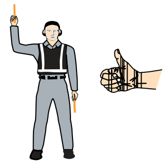
Movement unobstructed



Identify gate

Proceed to the next signalman

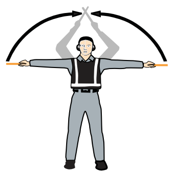
Straight ahead



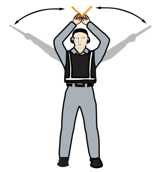
Affirmative/All clear

Turn left

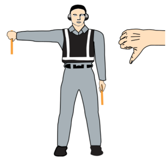
Turn right



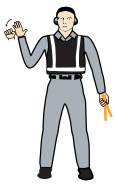
Normal stop



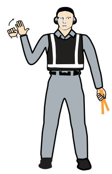
Emergency stop



Negative



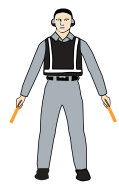
Set brake



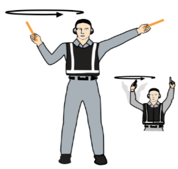
Release brake

Chocks inserted

Chocks removed

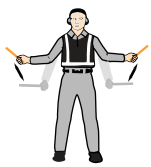


Hold position

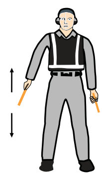


Start engine

Cut engine

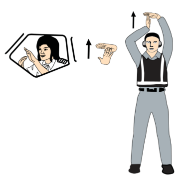


Slow down

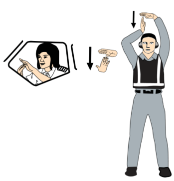


Slow down engine on

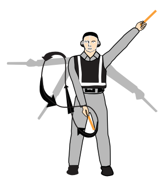
Do not touch control



Connect ground power



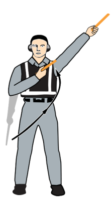
Disconnect ground power



Fire

Dispatch aircraft

Establish com. via interphone



Open/close stairs

#### 14.4.4 Signals by pilot to marshaller (Trimmed)

### 14.5 Firefighting & emergency vehicles (Trimmed)

## 15. Facilitation

### 15.1 CMC – Crew Member Certificates (Trimmed)

### 15.2 General declaration (Trimmed)

### 15.3 Cargo Manifest and air waybill (Trimmed)

### 15.4 Unladen cargo in wrong stateoperator. (Trimmed)

### 15.5 Inadmissible person (Trimmed)

## 16. Security

Objective is to safeguard international civil aviation operations against acts of unlawful interference.

Security committee of the airport assists establishing security at the airport.

An "aircraft security check" is an inspection of the interior including cargo hold to detect prohibited articles and unlawful interferences with the aircraft.

### 16.1 Some measures

All baggage must be screen again if mixed with unchecked ones.

Flight deck door closed and locked when all external doors are closed.

Pilot-in-command must be notified of number of law enforcement officers carrying a weapon and their seat location.

Pilot-in-command and operator must be informed when passengers are obliged to travel because they have been the subject of judicial or administrative proceedings.

Additional security measures for unaccompanied baggage.

Keywords:

Security control – introduction
Access control – entry
Screening – technical means

### 16.2 Specific security measures

For deportees, inadmissible persons, and persons in lawful custody

### 16.3 National security program

Measures are the discretion of the contracting state and apply to:

All international civil air transport.

Domestic flight at the discretion of each member state

Regards to:

Cabin baggage

Checked baggage

Cargo and other goods

Access control

Airport design.

# 17. Aircraft Accident and Incident Investigation (Trimmed)

# 18. SAR – Search And Rescue

## 18.1 Signals air-ground (Trimmed)

## 18.2 Signals ground-air (Trimmed)

## 18.3 Procedures (Trimmed)

# AIRFRAME, SYSTEMS, ELECTRICS, POWER PLANT

## 1. SYS. DESIGN, LOADS, STRESSES, MAINTENANCE

### 1.1 FORCES

Tension – Shear – Compression

**Buckling**: Multiple force.

### 1.2 LOADS

**CTST**: Compressive, Tensile, Shear, Torsional

**Stress** is due to cycle loads. $Stress = Force/Area$

**Strain**: deformation due to load/stress.

Plastic deformation ⇒ Permanent deformation, damage

Elastic deformation ⇒ Return to initial state.

**Fatigue:** if a material is continually loaded and unloaded it will eventually break even though the load remains the same.

### 1.3 SYSTEM DESIGN

**Fail safe**: Redundant adjacent components.

**Safe life**: Replacement after a given life hours and/or landings.

**Hard-Time**: Based on the number of cycles or time in use.

**Damage tolerant**: Damage are considered.

**On condition**: Monitoring critical parameters.

### 1.4 CORROSION

Incorrect metallic bonding = Corrosion at skin joints.

### 1.5 RELATIONSHIP BETWEEN PROBABILITY AND SEVERITY OF FAILURE CONDITION (TRIMMED)

## 2. AIRFRAME

### 2.1 WING (TRIMMED)

### 2.2 STRUCTURE (TRIMMED)

### 2.3 BONDING METALLIC PARTS (TRIMMED)

### 2.4 CONTROL SURFACE (TRIMMED)

# 3. HYDRAULICS

$$Force\ (N) = Area \times Pressure \qquad Pressure = \frac{Force}{Area} = \frac{Force \times Displacement}{Area \times Displacement} = \frac{Energy}{Volume}$$

$$Area_1 \times Displacement_1 = Area_2 \times Displacement_2$$

## 3.1 FLUID

**Small aircraft**: Mineral oil commonly used.

**Large aircraft**: Synthetic oil, phosphate ester based. Purple or green.

**Incompressible** and **irritating for eyes and skin**.

Lubricating oil lubricates, seals, cool, cleans and prevent corrosion.

## 3.2 USUAL HYDRAULIC SYSTEM

In large transport aircraft: **3000psi, 3 hydraulic systems.** (High pressure and small flow)

**Open centre system**: Constant low-pressure flow from the pump to the reservoir.

**Closed system**: Constant pressure is maintained in the part of the system that leads to the selector valves.

## 3.3 PUMP

**Axial pistons pumps** = **constant pressure pump** = **variable displacement pump**: Produce high pressure, can be off-loaded. Often used due to their ability to produce high pressure when required, can be off-loaded to reduce power consumption. Quantity dependent on system demand.

**Constant displacement pump = constant volume = variable pressure.**

**Pressure regulator** used with constant delivery pump.

**Hand pump** are connected to the bottom of the reservoir.

**Oil is kept under pressure** to prevent cavitation.

**Overheat detectors** are usually installed at the pump.

## 3.4 RESERVOIR

Store the fluid.

Where the fluid can purge itself of air.

Where fluid temperature is measured.

Provide expansion chamber for temperature variation.

## 3.5 SHUTTLE VALVE

Enable alternate system to operate the same actuator.

## 3.6 SELECTOR VALVE

Direct system pressure to either side of the piston of an actuator.

## 3.7 NON-RETURN VALVE (NRV)

Allow fuel to flow in one direction. Like diode in electronics.

Also called "Check valve".

## 3.8 PRESSURE RELIEF VALVE

Will open when oil pressure exceeds one value in order to lower the pressure.

If **not seated properly** = leakage = low oil pressure.

### 3.9 HYDRAULIC FUSES

Prevent total system loss of a leaking hydraulic line.

### 3.10 SAFETY COMPONENTS

Filters, Pressure relief valves, By-passes, Shut-off valve

### 3.11 ACCUMULATOR

= **Energy** storage

Damp fluid pressure fluctuations/surges.

Alternate source of pressure.

### 3.12 WARNING LIGHTS/INDICATORS

**Low pressure**: measured in the system

**Low level**: measured in the reservoir

**Overheat detector**: measured at the pumps

**Pump low pressure**: may be caused by pump failure or drive shaft failure.

**Pop out indicator**: warn of an impending by-pass situation.

**Loss of hydraulic pressure** is indicated in the cockpit by master caution light, dedicated amber light and loss of pressure reading for the affected system.

### 3.13 FAILURES

**Internal leakage**: Increase fluid temperature.

**External leakage**: Fluid loss.

## 4. FLIGHT CONTROLS

### 4.1 FLY-BY-WIRE (TRIMMED)

### 4.2 FLY-BY WIRE TRIMMING(TRIMMED)

### 4.3 RUDDER LIMITER (TRIMMED)

## 5. ELECTRICS

### 5.1 GENERAL (TRIMMED)

### 5.2 LOGIC GATE (TRIMMED)

### 5.3 BATTERY (TRIMMED)

### 5.4 FUSES/BREAKER (TRIMMED)

### 5.5 RECTIFIER/INVERTER (TRIMMED)

### 5.6 GENERATOR (TRIMMED)

### 5.7 MOTORS WINDING (TRIMMED)

### 5.8 ELECTRICAL BONDING (TRIMMED)

### 5.9 SCHEMA (TRIMMED)

# 6. PROTECTION AND DETECTION SYSTEMS

## 6.1 FIRE DETECTION

**Loop fire detector**: when temperature increase ⇒ resistance decrease ⇒ Current increase

Detect low resistance and low capacity ⇒ Loop is faulty

**Gaseous fire loop** detector system tested by heating up the sensor.

**Bimetal strip detectors** of an engine fire detection system are arranged in parallel, close during a fire. *(To close the electrical circuit).*

**Tested** via a test circuit that carries out a continuity check.

## 6.2 FIRE EXTINGUISHER

**Power plant fire extinguisher**: operated by an electrically fired cartridge.

**Toilet fire extinguisher**: automatically activated by heat detector.

**Fire handle pulled**: halt fuel, arm extinguishing system, pneumatic supply closes, disable thrust reverser, deactivation of the electric generator, engine fire warning switch ready. **Extinguishing agent used,** only a light is shown on the flight deck.

**Fire agent is directed** to the low-pressure end of the outside of the engine compressor.

## 6.3 SMOKE DETECTOR

Ion detectors and photoelectric cell (optical detector).

**Labyrinth optical detector:** Light reflects towards the photosensitive cell and the labyrinth has a shielding function.

## 6.4 PROTECTIVE BREATHING EQUIPMENT

PBE protects the members of the crew against fumes and noxious gases.

**Smoke hoods** are available for the crew and must last for 15 minutes.

## 6.5 DITCHING CONTROL

The purpose of a ditching control is to **close the outflow valve.**

## 6.6 RAIN PROTECTION

**Rain repellent** should never be sprayed onto the windshield unless the rainfall is very heavy.

# 7. LANDING GEAR

## 7.1 OLEO-PNEUMATIC (TRIMMED)

# 8. WHEELS

## 8.1 STEERING (TRIMMED)

## 8.2 TYRES (TRIMMED)

## 8.3 BRAKES (TRIMMED)

# 9. PRESSURISATION AND AIR CONDITIONING, BLEED (TRIMMED)

# 10. ANTI-ICING & DE-ICING

## 10.1 ICE DETECTOR (TRIMMED)

## 10.2 WINDSCREEN (TRIMMED)

## 10.3 ANTI-ICING (TRIMMED)

## 10.4 PNEUMATIC DE-ICING (TRIMMED)

# 11. OXYGEN SYSTEMS

**Supplementary oxygen**: In case of depressurization.

**First aid oxygen**: For medical assistance.

**Protective oxygen**: Avoiding NOx.

Oxygen + Oil/Grease ⇒ **Burn or Explosion.**

## 11.1 CHEMICAL OXYGEN GENERATOR

Often used to supply passenger oxygen. Supply mixture of oxygen and cabin air. ⇒ **Do not use when smoke in cabin.**

Disadvantages compare to gaseous: Flow cannot be limited / Less capacity

If the automatic passenger mask presentation fails, it is possible to retrieve an individual mask by opening the mask storage compartment with a sharp pointed object.

**Maximum cabin altitude: 8 000ft; Warning at 10 000ft; Masks released at 15 000ft max.**

## 11.2 PROTECTED BREATHING EQUIPMENT

**PBE**: Above 32000ft or when demanded manually, 100% oxygen is supplied.

Emergency mode provides continuous flow, 100% oxygen, under positive pressure.

Smoke in cockpit: Set oxygen regulator to 100%.

Typically, flight deck oxygen is stored **in gaseous states. Oxygen regulators** used are diluter-demand type.

# 12. FUEL SYSTEM

Fuel is kept under pressure to prevent vapour lock.

## 12.1 FUEL

| | |
|---|---|
| 100LL | b"L"ue |
| 100 | 100% ⇒ Success ⇒ Green |
| 80 | 80% ⇒ you could do better ⇒ Red |

**Freezing point**: JET A (-40°C) > JET A-1 (-47°C) > JET B (-60°C)

**Flashing point**: JET A = JET A-1 > JET B

## 12.2 PISTON ENGINE

MOGAS = Risk of carburettor icing.

AVGAS used for **reciprocating piston engines**.

## 12.3 TURBINE ENGINE

**LP fuel pumps in tanks** are electrical centrifugal low pressure, 20 to 100psi, submerged to cool the pump/heat the fuel and priming.

**High pressure (HP) pumps** are driven by the engine.

**Fuel heaters** are located on the engines. Tanks are not heated.

## 12.4 FUEL FLOW

Measure quantity of movement. **F. Pressure** measured between the booster pump and the engine outlet or at the outlet of the HP filter.

## 12.5 FUEL LEVEL

Small plane: Measure fuel level.

Large plane: Capacitive dielectric measure fuel mass.

$$C_{capacitance} = e_{dielectric\ permittivity} \times a_{area} \div d_{distance}$$

**Compensated capacitance** fuel gauging system compensate for the varying density with local temperature.

**Fuel tanks** used on most modern transport aircraft are integral tanks, fitted with **baffle check valves** to prevent fuel movement to the wing tip. **Unusable fuel** is sometimes minimised by the incorporation of tank sump pads.

The function of a **feed box** in the fuel tank is to increase the fuel level at the boost pump location and prevent cavitation.

**Magnetic drip stick** fuel system measurement can be done with the indication from the indicator and using the documentation.

During fuelling, **automatic fuelling shut off valves** shut off the fuel supply system when the fuel has reached a predetermined volume or mass.

# 13. Piston Engines

## 13.1 General (Trimmed)
## 13.2 Components (Trimmed)
## 13.3 Magnetic ignition (Trimmed)
## 13.4 Fuel (Trimmed)
## 13.5 Mixture (Trimmed)
## 13.6 Carburettor (Trimmed)
## 13.7 Cooling (Trimmed)
## 13.8 Injection (Trimmed)
## 13.9 Oil (Trimmed)

# 14. TURBINE ENGINES

## 14.1 GENERAL

Theorical **constant pression** combustion. **Nosiest part** is the jet efflux.

**EPR (Engine Pressure Ratio):** Jet pipe total/turbine outlet pressure (EXHAUST) to compressor inlet total pressure (INTAKE).

**EGT (Exhaust Gas Temperature)** typically measured at the HP turbine outlet. (between gas generator turbine and free power turbine in free turbine).

**The bypass ratio** is the ratio of bypass air mass flow to HP compressor mass flow. Bypass ratio decreases exhaust gas flow velocity and increase mass flow. The design of a fan or bypass engine spinner is such that rain/hail can be deflected into the bypass duct.

**Specific fuel consumption** is fuel per hour per unit of trust.

**The propulsive efficiency** of a turbo jet is the ratio of: propelling nozzle thrust to energy supplied to the nozzle.

**Ram air** increase efficiency of the engine.

A **free turbine** in a turbine engine does not drive a compressor.

The internal geometry of a turbofan intake for a subsonic commercial aeroplane is **divergent in order to reduce airflow velocity and increase static pressure in front of the fan.**

## 14.2 TRUST

$$T = m_{bypass}(V_{JB} - V_A) + m_{core}(V_{JE} - V_A) = m_{bypass}(V_{JB} - V_A) + A(P_J - P_0)$$

$T : Trust\ (N)$

$m_{bypass} : mass\ through\ bypass\ duct$

$m_{core} : mass\ through\ engine\ core$

$V_{JB} : Velocity\ of\ the\ air\ leaving\ bypass\ duct$

$V_{JE} : Velocity\ of\ the\ air\ leaving\ the\ jet\ nozzle$

$V_A : Velocity\ of\ the\ aircraft$

$A : Exhaust\ cross\ sectional\ area$

$P_J : Static\ exhaust\ pressure$

$P_0 : Static\ ambiant\ pressure$

Example:

- Mass air flow 50kg/s
- TAS 90 m/s
- Exhaust nozzle gas velocity 150m/s
- Exhaust nozzle static pressure 1050 hPa
- Ambient static pressure 100 hPa
- Cross-sectional area of the nozzle 0.10m$^2$

Net engine thrust equals:

$1hPa = 100Pa = 100N/m^2$

$50 \times (150 - 90) + 0.1 \times (105000 - 100000) = 3500N$

### 14.3 CONVERGENT/DIVERGENT DUCT (TRIMMED)
### 14.4 COMPRESSOR (TRIMMED)
### 14.5 COMPRESSORS PRESSURE RATIO

| | Compressor type | Pressure ratio | Number of stages |
|---|---|---|---|
| A | Axial | 1.2 : 1 | One stage |
| C | Centrifugal | 5 : 1 | |
| C | Centrifugal | 12 : 1 | Total stage |
| A | Axial | 35 : 1 | |

**Centrifugal compressor** is more robust and technologically less complicated.

**Axial compressors** are vulnerable to foreign object damage, expensive to manufacture.

### 14.6 COMBUSTION CHAMBER (TRIMMED)
### 14.7 TURBINE (IMPULSE/REACTION) (TRIMMED)
### 14.8 LUBRICATION (TRIMMED)
### 14.9 FUEL HEATER/OIL COOLER. (TRIMMED)
### 14.10 FADEC (TRIMMED)
### 14.11 STARTING TROUBLES (TRIMMED)
### 14.12 FLEX TAKE-OFF (TRIMMED)
### 14.13 FLAT-RATED TURBOFAN (TRIMMED)
### 14.14 REVERSE (TRIMMED)
### 14.15 ACCESSORY UNITS (TRIMMED)
### 14.16 MAINTENANCE/PREVENTION (TRIMMED)

## 15. APU (TRIMMED)

## 16. PROPELLER
### 16.1 TURBOPROP (TRIMMED)
### 16.2 AUTO-FEATHER (TRIMMED)

# INSTRUMENTATION

## 1. SENSORS AND INSTRUMENTS

### 1.1 PRESSURE GAUGE

$$1bar = 100\,000\ Pa = 100\ kPa = 10^5 N/m^2 = 14{,}5038PSI \approx 15PSI$$

**Aneroid capsule**: measures Absolute pressure, Manifold pressure, Air intake pressure, LP fuel pump pressure

**Bellows sensor:** measures Manifold pressure, Cabin differential.

**Bourdon tube:** measures Hydraulic pressure.

**Manifold pressure gauge** measures absolute pressure in air intake near the inlet valve.

**From lowest to highest pressure**: Aneroid capsule < Bellows < Bourdon tube *(Alphabetical order)*

### 1.2 TEMPERATURE SENSING

$E = k \times T_h$ $E: Electromotive\ force - k: Constant - T_h: Hot\ junction\ temperature$

$°K = °C + 273$

$°F = (°C \times 1.8) + 32$

In transport category airplane, temperatures are measured with resistance thermometers, thermocouple thermometers.

**Mercury thermometer:** From -37°C to 356°C

**Bimetallic strip thermometer:** From -50°C to 400°C.

- Indicates temperature change by mechanical displacement.

**Thermocouple thermometer:** From -200°C to 2000°C.

- Two dissimilar metal conductors joined together at one end.
- Temp rise at hot junction ⇒ Voltage increase.
- Also called alumel/chromel system.
- No power supply, power for gauge lighting only.

**Resistance thermometer:**

- Also called ratiometer-type.
- Independent of the supply voltage.
- Very accurate.

**CHT** Cylinder Head Temperature: Temperature within the hottest cylinder. Measured with thermocouple.

**EGT** Exhaust Gas Temperature: Temperature outlet of the HP stage of the turbine. Measured with thermocouple.

If **CSD** Constant Speed Drive **temperature is in the red arc** pilot must disconnect it, the generator is not available for the rest of flight.

#### 1.2.1 TEMPERATURE INDICATOR COLOURED SEGMENT

| | | | |
|---|---|---|---|
| Normal | Special conditions | Abnormal/Caution/Exceptional | Danger/Out of limits |
| Normal | | Abnormal/Caution/Exceptional | |

**Red pointer** moves and remain positioned at the maximum value reached.

### 1.3 FUEL GAUGE (TRIMMED)
### 1.4 FUEL FLOWMETERS (TRIMMED)
### 1.5 SYNCHROSCOPE (TRIMMED)
### 1.6 ENGINE VIBRATION MONITORING (TRIMMED)
### 1.7 TACHOMETER (TRIMMED)
### 1.8 THRUST MEASUREMENT (TRIMMED)
### 1.9 ENGINE TORQUEMETER (TRIMMED)

## 2. MEASUREMENT OF AIR DATA PARAMETERS

### 2.1 PRESSURE MEASUREMENT

$P_D = P_T - P_S$ $(Dynamic\ pressure = Total\ pressure - Static\ pressure)$

$1013{,}25\ hPa = 14.5\ psi = 29.92\ inHg$

Position error = Disturbed airflow = Pressure error ⇒ Varies with AoA/speed.

**Non compensated static** at high speed ⇒ lower pressure = higher altitude.

**Sideslip** to the left ⇒ the wind coming from the left.

If **alternate static source** is used in light non-pressurized aeroplane, it tends to over-read (lower pressure due to aerodynamic suction).

### 2.2 TEMPERATURE MEASUREMENT

$0°C = 273.15°K$ $+1000ft \equiv -2°C$

$TAT = RAT = SAT + RAMrise(kinetic\ heat) \times Kr$

$OAT = SAT = RAT \div (1 + 0.2M^2 \times Kr) \rightarrow approximately: RAT \div (1 + 0.2M^2)$

**SAT** is an absolute temperature expressed in °C.

### 2.3 ANGLE OF ATTACK MEASUREMENT

**AoA vane** feeds its output to the ADC (Air Data Computer)

**Signal varying with** angular position and/or probe differential pressure.

**Indicate angular position** of a vane detector (wind vane) or a conical slotted probe.

Protected from **icing** by electric heating.

### 2.4 ALTIMETER (TRIMMED)
### 2.5 VERTICAL SPEED INDICATOR

$1m/s \approx 200ft/min$

$ROD\ (ft/min) = \theta \times 100 \times GS\ (kts) \div 60$ $3°or\ 5\% \rightarrow GS \times 5$

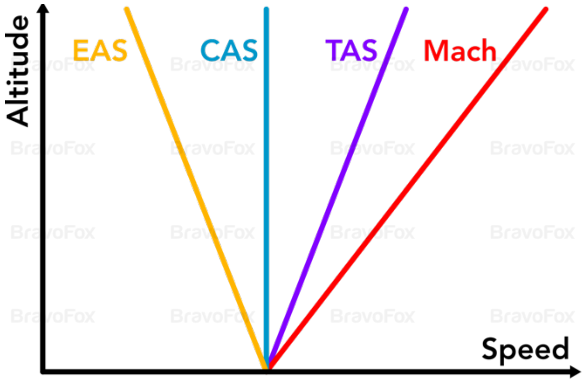
**Fed** by static pressure.

**Measures** difference between instantaneous static pressure and previous static pressure.

**Errors:** Blocked static – Instrument – Time lag – Position.

**Can be improved** by adding a correction based on an accelerometer sensor.

## 2.6 AIRSPEED INDICATOR




Static pressure in the case – Dynamic pressure in the aneroid.

**PUDSOD**: Pitot blocked Under read in Descend – Static blocked Over read in Descend.

Flying toward colder air is like descending. Warmer like climbing.

**White arc:** From $V_{S0}$ to $V_{FE}$.
**Green arc**: From $V_{S1}$ to $V_{NO}$.
**Yellow arc**: From $V_{NO}$ to $V_{NE}$.

$V_{YSE}$ the **blue line on twin-engine** is best single-engine rate of climb.
$V_{FE}$ max speed with the flaps extended for each approved flap position.
$V_{LE}$ max speed landing gear extended – $V_{LO}$ max speed landing gear operation.
$V_{NO}$ not to be exceeded except in still air and with caution.
$V_{MO}$ **expressed** in CAS or EAS.
$V_{NE}$ must not be exceeded.

A second, **striped needle** indicates maximum operating speed ($V_{MO}$).

ASI provided with a **moving red and white hatched pointer**. This pointer indicates maximum speed in $V_{MO}$ operation versus altitude.

**Compressibility error** must be considered for aeroplane with TAS > 200kts.

**Parallax** is a reading error.

**To be as accurate as possible, ASI** must be calibrated according to the **Saint-Venant** formula, considering the air compressibility.

| SPEED | Instrument | | Calibrated | | Equivalent | | True |
|---|---|---|---|---|---|---|---|
| | ⇘ | | ⇗ ⇘ | | ⇗ ⇘ | | ⇗ |
| | | Position | | Compressibility | | Density | |

*ICET – Ice Tea / PCD – Pretty Cold Drink*

## 2.7 MACHMETER

$M_{Number} = TAS/LSS$

$LSS = 38.95 \times \sqrt{K^\circ}$

$K^\circ = C^\circ + 273$

Mach indicator is based on the computation of:

$(P_T - P_S) \div P_S \rightarrow \boldsymbol{CAS\ is\ constant\ at\ constant\ M_N\ if\ OAT\ changes}$.

The striped **barber arrow indicating $V_{MO}/M_{MO}$** uses data from an aneroid capsule.

Machmeter is subject to position error.

## 2.8 ADC – AIR DATA COMPUTER

**Input**: Static pressure, Total Pressure, TAT

**Output**: Barometric/pressure altitude, Mach number, CAS, TAS, SAT

**Advantages**: position/pressure error correction, density error correction, remote data transmission.

ADC transforms air data measurements and **supplies data** to EFIS, transponder, Auto Flight Control System, servo motors in instruments, TCAS.

**ADIRU**: Is an Air Data Computer which is integrated with an Inertial Reference Unit.

# 3. MAGNETISM – DIRECT READING COMPASS AND FLUX VALVE

## 3.1 EARTH'S MAGNETIC FIELD (TRIMMED)

## 3.2 AIRCRAFT MAGNETIC FIELD (TRIMMED)

## 3.3 FLUX VALVE (TRIMMED)

## 3.4 DIRECT READING MAGNETIC COMPASS (TRIMMED)

# 4. GYROSCOPIC INSTRUMENTS

## 4.1 GYROSCOPE (TRIMMED)

### 4.1.1 WANDERS (TRIMMED)

### 4.1.2 INSTRUMENTS (TRIMMED)

## 4.2 RATE OF TURN INDICATOR / TURN CO-ORDINATOR – BALANCE (SLIP) INDICATOR (TRIMMED)

## 4.3 ATTITUDE INDICATOR (TRIMMED)

## 4.4 DIRECTIONAL GYROSCOPE (TRIMMED)

## 4.5 REMOTE READING COMPASS SYSTEM (TRIMMED)

## 4.6 SOLID-STATE SYSTEMS – AHRS (TRIMMED)

# 5. INERTIAL NAVIGATION AND REFERENCE SYSTEMS

$$distance = \int speed = \iint acceleration$$

**"NAV"**: Normal operation, must be selected prior to movement of the aircraft. **"ATT"**: Provide attitude and heading.

The principle of the **Schuler pendulum** is used in the design of a stabilised platform inertial system.

**Shuler Tuning** is applicable to both gyro-stabilised platform (INS) and 'strapdown' (IRS) systems.

**Schuler oscillation**: 84 minutes.

IRS more modern and reliable than INS. IRS rigidly fixed to the aircraft chassis.

**IRS/INS can be aligned** in ALIGN or NAV mode. (In NAV mode a light indicate alignment completed).

**ADC provide TAS input** ⇒ required to provide Wind/V read out. If **ADC/CADC failure** ⇒ INS no longer provide wind direction and speed.

## 5.1 INS: INERTIAL NAVIGATION SYSTEMS (STABILIZED INERTIAL PLATFORM)

3 rate gyros + 2 accelerometers mounted on the same platform. **The platform** is free from aircraft trihedron.

**Rate integrating gyro** is used in inertial attitude unit and inertial navigation unit.

**Alignment**: **Levelled** via gravity then **North aligned** by inputs from horizontal accelerometers + the east gyro.

Accept 10° of error in initial longitude input.

**Output data from Platform**: accelerations north/south, east/west, attitude and true heading.

**Output data from INS Computer** to the platform: rate corrections to the gyros (to keep the platform levelled).

**Great circle track** = Desired track.

**Acceleration measured** in the trihedron are free from the aircraft trihedron.

**"ALIGN":** The unit aligns on the local geographic trihedron.

**Lateral error** increase over time, 1.5 NM/hour or more. **Vertical error** increase exponentially.

## 5.2 IRS: INERTIAL REFERENCE SYSTEMS (STRAPPED-DOWN)

3 Lasers gyros and 3 accelerometers mounted in direction of the aircraft axis, no spin up time and insensitive to gravitational (g) forces.

**Laser gyro** is much more cumbersome than conventional gyro, measure angular rate about its sensitive axis.

**Ring laser gyro** is a device which measures angular movements with a laser generating two light waves (frequency difference).

**Lock-in phenomena in ring laser gyro**: Dither is needed to measure very low rates of rotation when this phenomenon is experienced.

**IRS automatically detects latitude**: input latitude entered by the pilot is compared.

**Acceleration measured** in the trihedron are fixed to the aircraft trihedron (aircraft axes).

**Output**: Heading (true/magnetic), Track (true/magnetic), Drift angle, Attitude, Rate of attitude change, GS, Present position (lat., long.).

**"ALIGN"**: measure Earth rotation and local gravitation to position the reference trihedron.

**Alignment time:** Equator, 5 minutes – up to 70N/S, 10 minutes – 70 to 78N/S, 17 minutes.

## 6. TRIMS – YAW DAMPER – FLIGHT ENVELOPE PROTECTION

### 6.1 TRIM SYSTEMS (TRIMMED)

### 6.2 YAW DAMPER (TRIMMED)

### 6.3 FEP: FLIGHT ENVELOPE PROTECTION (TRIMMED)

## 7. AUTOTHROTTLE – AUTOMATIC THRUST CONTROL SYSTEM

## 8. AUTOMATIC FLIGHT CONTROL SYSTEMS

### 8.1 AUTOPILOT SYSTEM (TRIMMED)

### 8.2 FLIGHT DIRECTOR (TRIMMED)

### 8.3 AUTOLAND (TRIMMED)

## 9. COMMUNICATION SYSTEMS

### 9.1 VOICE COMMUNICATION, DATALINK TRANSMISSION (TRIMMED)

### 9.2 FANS: FUTURE AIR NAVIGATION SYSTEMS (TRIMMED)

# 10. FLIGHT MANAGEMENT SYSTEMS

## 10.1 DESIGN

**Components**: CDU – Control and Display Unit, FCC – Flight Control Computer, FMC – Flight Management Computer.

**Provide**: LNAV, VNAV, aircraft position computation, fuel management, radio tuning, continuous automatic navigation guidance and performance management.

**Position is computed from**: GPS, IRS, DME, VOR, **LOC** (**but not LOCALIZER**, not NDB)

**Aid the flight crew** with navigation and in-flight performance optimization.

**Advanced FMS**: 4-D FMS.

**Dual FMC mode**: "independent mode" or master/slave synchronized.

## 10.2 NAVIGATION DATABASE, AIRCRAFT DATABASE

**Two major sections in database**: aeroplane performance and navigation.

**Database includes** airport, SID/STAR, navaids, waypoints, airways, magnetic variation.

**Database validity**: 28 days. **Database updated**: After FMS software update.

**Performance factor**: A percentage that must be applied to get a better fuel burn prediction. Can account for aircraft age.

## 10.3 OPERATIONS, LIMITATIONS

**FMS** constructs a four-dimensional flight plan.

**FMS provide guidance for non-precision approaches**: RNAV, VOR/DME, VOR/NDB, LOC.

**FMS multiple DME sensor non-precision approach**: ≤0.3NM.

**FMS Fuel management** should not be considered as an accurate and reliable source.

**FMS takes into account**: one engine inoperant, current wind.

**FMS vertical guidance computed** using ZFM, Fuel quantity, Cost index, Flight plan angle, Airspeed.

**FMS cross track (XTK)** is the abeam distance error, Left/Right from desired flight plan leg.

**FMS lateral offset**: flying along the flight plan leg with a constant right/left offset.

**Temperature compensation**: To provide compensated altitudes for temperatures different from ISA.

**Track between two fixes**: a great circle arc.

**Dead Reckoning mode (DR)** is a backup navigation mode to compute FMS position.

If **radio updating not available** a warning message is displayed on the EHSI and MCDU.

**Cost index**: Operating cost divided by fuel cost.

- **Zero CI** = minimum trip fuel/maximum range.
- **High CI** = high airspeed/high fuel trip.

## 10.4 MCDU: MULTIFUNCTION CONTROL DISPLAY UNIT

**CDU are used during pre-flight** to manually initialize the IRSs and the FMC with dispatch information.

**FMC/CDU initial start-up pages**: IDENT – POS INIT – RTE.

**PROGRESS** or **LEG** page displays: Time prediction, track, distance, speed, altitude constraint/prediction, remaining fuel prediction.

**Message priority**: Alerting > Advisory.

# 11. ALERTING SYSTEMS, PROXIMITY SYSTEMS

**FWS** – Flight Warning System: Only alert in case of failures.

**Warning message**: require immediate action.

**Caution message**: immediate awareness, subsequent action will be required.

**Advisory message**: any colour except red/amber, awareness require, crew action may be required.

Safe operation.

**Flight warning system priority**: Stall, Windshear, GPWS, TCAS *("SWAT" – A representing a mountain.)*

## 11.1 RADIO-ALTIMETER

**Radio altimeter uses:** two antennas, one for emission (directional) and another one for the reception. (**aerial=antenna**).

**Emit** SHF – Super High Frequency.

Frequency modulation. 4 200 – 4 400 MHz (centimetric/decimetric wavelength).

**Range**: 2500ft.

**Precision:** ±2ft between 0 and 500ft.

Height information is removed if **radio altimeter fails**.

**Provide data to**: GPWS, Automatic landing system, TCAS (No RA given below 400ft).

## 11.2 STALL PROTECTION

**Also known as** the stick pusher.

**Protect** of an impending stall without pilot actions requirement.

At **high AoA**, the system inhibits pitch up trim.

In **fly-by-wire aircraft**, when approaching a stall: Inhibits and limits pilot inputs.

## 11.3 ALERTING SYSTEMS

| | |
|---|---|
| Take-off Warning | **Triggers conditions**:<br>Stabiliser not in a safe position for take-off.<br>Longitudinal trim is not within the approved range for take-off.<br>Parking brake is still ON. |
| SWS<br>Stall Warning System | **Receive information from**: AoA sensor, configuration and compute them.<br>System is **inhibited** on ground.<br>**Impeding stall**: critical AoA is approached<br>⇒ Warning message/stick vibrations.<br>**Stall warning limit**: 5kts or 5% CAS whichever is greater. |
| Overspeed Warning | **Overspeed condition** triggers a warning message, **pilot should** reduce power and give a nose up input. |
| Altitude Alert System | **Triggers conditions**:<br>Approaching a preselected altitude<br>Deviating from selected altitude.<br>Altitude differs from a selected altitude |

11.4 GPWS: GROUND PROXIMITY WARNING SYSTEMS (TRIMMED)
11.5 ACAS/TCAS PRINCIPLES AND OPERATIONS (TRIMMED)

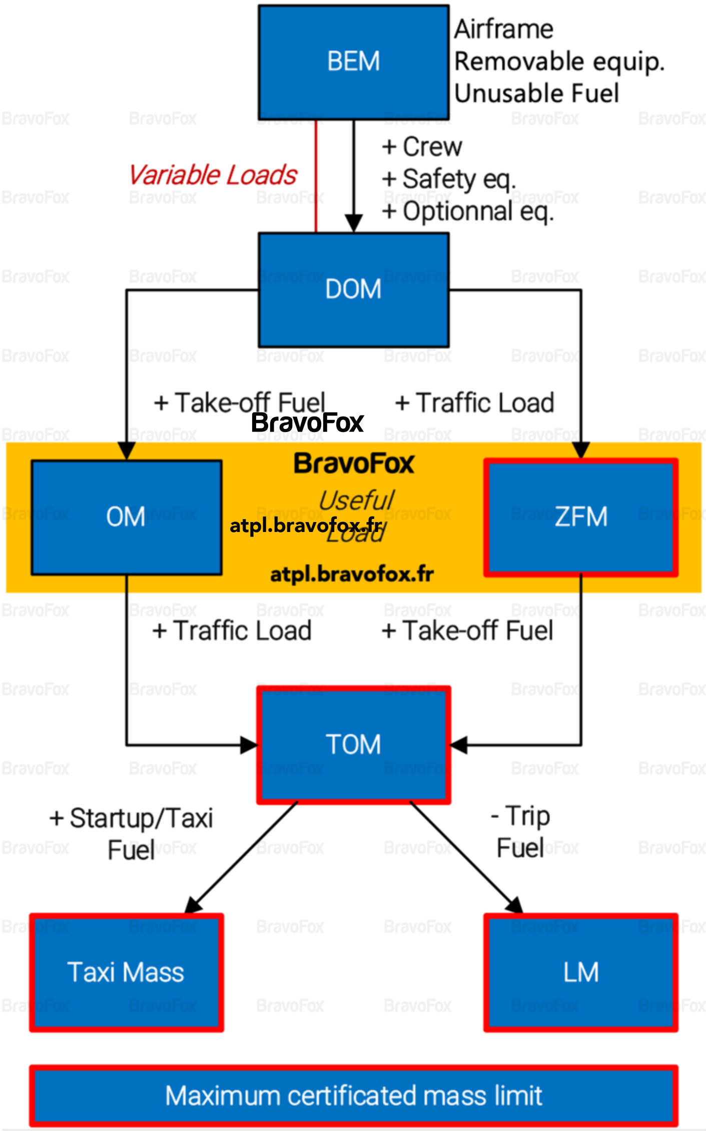
12. INTEGRATED INSTRUMENTS – ELECTRONIC DISPLAY
12.1 ELECTRONIC DISPLAY UNITS (TRIMMED)
12.2 EFIS: ELECTRONIC FLIGHT INSTRUMENT SYSTEMS (TRIMMED)
12.3 ENGINE PARAMETERS, CREW WARNING, AIRCRAFT SYSTEMS, PROCEDURE AND MISSION DISPLAY SYSTEMS (TRIMMED)

13. MAINTENANCE, MONITORING AND RECORDING SYSTEMS
13.1 CVR: COCKPIT VOICE RECORDER (TRIMMED)
13.2 FDR: FLIGHT DATA RECORDERS (TRIMMED)

14. DIGITAL CIRCUITS AND COMPUTERS
14.1 GENERAL (TRIMMED)
14.2 SOFTWARE (TRIMMED)

# MASS & BALANCE

## 1. TERMINOLOGY




BEM – Basic Empty Mass
DOM – Dry Operating Mass
OM – Operating Mass
ZFM – Zero Fuel Mass
TOM – Take-off Mass
LM – Landing Mass
UL – Useful Load
TF – Trip Fuel
TOF – Take-off Fuel
TL – Traffic Load
UL – Underload (Cargo)
Mxxx – Maximum x
Rxxx – Regulated x

### 1.1 MASS LIMITS (TRIMMED)

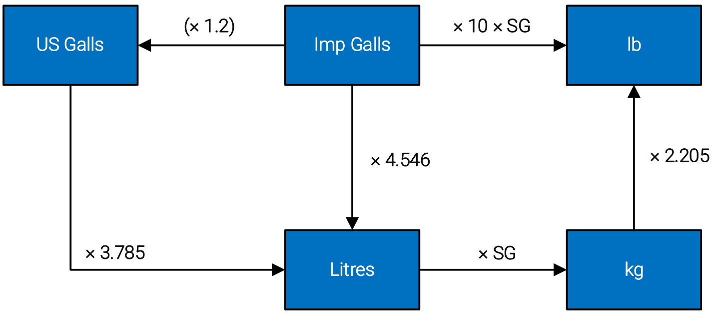
### 1.2 SPEEDS (TRIMMED)

# 2. PHYSICS

## 2.1 STALL SPEED

| Straight | In turn | Effect of weight |
|---|---|---|
| $V_{S1G} = \sqrt{\frac{L}{1/2\ \rho . C_{LMAX} . S}}$ | $V_{S\theta} = V_{S0°} \sqrt{\frac{1}{\cos\theta}} = V_{S0°}\sqrt{n}$ | $V_{SNEW} = V_{SOLD} \sqrt{\frac{New\ Weight}{Old\ Weight}}$ |

## 2.2 VOLUME/MASS




# 3. REGULATION

## 3.1 PASSENGERS (TRIMMED)

## 3.2 AIRCRAFT (TRIMMED)

### 3.2.1 MASS OF AN AIRCRAFT (TRIMMED)

### 3.2.2 FLEET MASS (TRIMMED)

## 3.3 LOAD FACTORS LIMIT (TRIMMED)

# 4. LOADING

## 4.1 MASSES STANDARDS (TRIMMED)

## 4.2 MASS CALCULATION (TRIMMED)

## 4.3 FUEL REQUIREMENTS (TRIMMED)

# 5. CARGO HANDLING

## 5.1 TYPES OF CARGO (TRIMMED)

## 5.2 FLOOR AREA/RUNNING LOAD LIMITATIONS (TRIMMED)

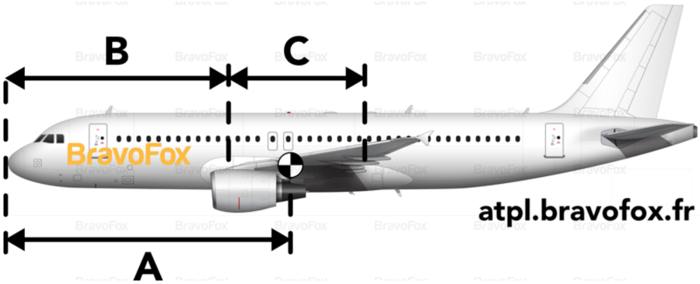
## 5.3 SECURING LOAD (TRIMMED)

# 6. CG POSITION & MOVEMENTS

## 6.1 DATUM (TRIMMED)

## 6.2 CG DETERMINATION (TRIMMED)

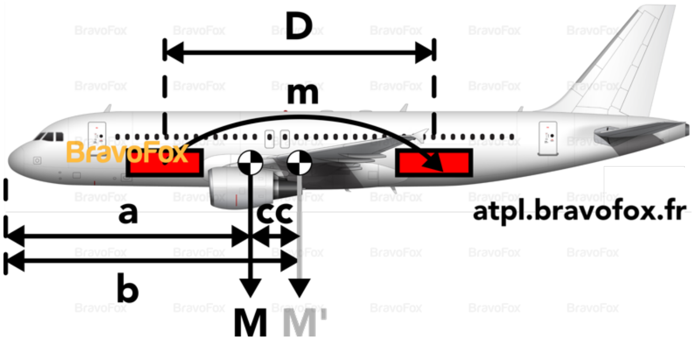
## 6.3 CG % MAC




$$\%MAC = \frac{A - B}{C} \times 100$$

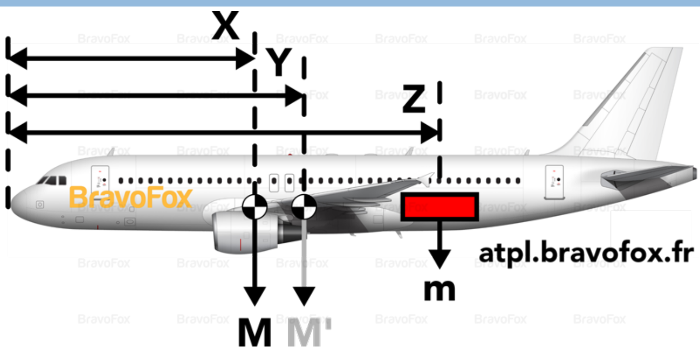
$A$ : *distance of CG from datum*
$B$ : *distance of MAC leading edge from datum*
$C$ : *length of MAC*

## 6.4 REPOSITIONING CG BY MOVING MASS




$$m \times D = M \times (b - a)$$
$$m \times D = M \times cc$$

## 6.5 REPOSITIONING CG BY ADDING OR REMOVING MASS




$$New\ Total\ Moment = Old\ Total\ Moment + Change\ Moment$$
$$(M + m) \times Y = (M \times X) + (m \times Z)$$
$$M' = M + m$$

## 6.6 EFFECT OF CG POSITION (TRIMMED)

# PERFORMANCE

## 1. GENERAL

The operational regulations regarding **scheduled performance are contained** in the EASA AIR OPS **document**.

### 1.1 DEFINITION

**AEO**: All Engine Operating
**OEI**: One Engine Inoperative
**FF**: Fuel Flow
**MAP**: Manifold Air Pressure
**MCP**: Maximum continuous power
**ROC**: Rate of Climb

$V_{NE}$: Structural limit.
$V_{MCG}$: Minimum control ground speed (in case of OEI)
$V_{MCA}$: Minimum control airspeed (in case of OEI)
$V_X$: Speed for best angle of climb
$V_Y$: Speed for best rate of climb
$V_R$: Rotation speed
$V_{S0}$: Stall speed in landing configuration
$V_{S1}$: Stall speed in a specific configuration
$V_{LO}$: Maximum speed for landing gear operation
$V_{LE}$: Maximum speed with landing gear extended

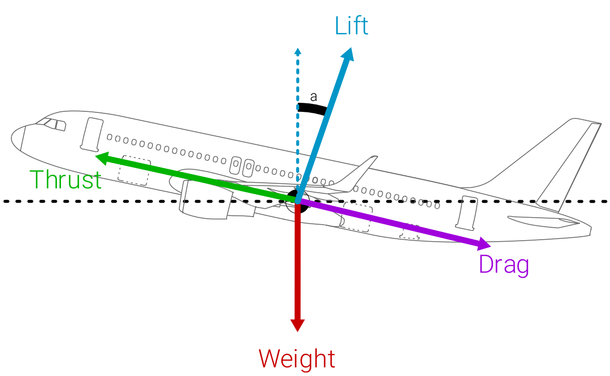
$C_L$: Coefficient of lift
$C_D$: Coefficient of drag

**Service ceiling**: Altitude where the climb reduces to 100ft/min.

**Absolute ceiling**: Maximum rate of climb = 0ft/min.

**Density altitude**: Used to determine aircraft performance.

### 1.2 FORCES




$$\cos a = \frac{W}{L}$$

$$Climb: T = D + L \sin a$$

$$Descend: D = T + W \sin a$$

$$Power\ required = TAS \times Drag$$

# 2. BASIC CALCULATION

## 2.1 SPEEDS – DISTANCES

$$NM \times TAS = NAM \times GS$$

$$NM \times TAS = NAM \times (TAS - HWC)$$

$NM: NM\ distance$

$NAM: Nautical\ Air\ Miles$

$HWC: HeadWind\ Component$

## 2.2 PRESSURE ALTITUDE

$$PA = Altitude + (1013 - QNH) \times 30$$

## 2.3 SPECIFIC CONSUMPTION – SPECIFIC RANGE

$$Specific\ Range = \frac{TAS}{Fuel\ Flow}$$

$TAS: NM/h$ $\quad F.F: Kg/h$

$$SFC = \frac{Fuel\ Flow}{Unit\ of\ power}$$

## 2.4 GRADIENT CALCULATION

Climb

$$Gradient\ \% = \frac{T - D}{W} \times 100$$

Descend

$$Gradient\ \% = \frac{D - T}{W} \times 100$$

## 2.5 RATE

$$RATE\ (ft/m) = GRADIENT\ (\%) * TAS(kt)$$

$$RATE = \frac{POWER\ AVAILABLE - POWER\ REQUIRE}{W}$$

## 2.6 LOAD FACTOR

$$n = \frac{L}{W} = \frac{1}{\cos\theta} \qquad \rightarrow Lift_\theta = L_{\theta^\circ} * \frac{1}{\cos\theta}$$

## 2.7 AERODYNAMIC

$$F = q \times C \times S \quad (N) \qquad q = \frac{1}{2}.\rho.V^2 \quad (N/m^2) \qquad \rightarrow F = \frac{1}{2}.\rho.V^2.C.S \quad (N)$$

$F : Lift\ or\ Drag - q : Dynamic\ pressure - C : Coefficient\ of\ Lift\ or\ Drag$

$S : Surface - \rho : Density - V : Speed$

## 2.8 LIFT/DRAG

Typical:

- Best ratio $C_L/C_D$ @ 4° AoA
- Stall @ 16° AoA

## 3. AIRCRAFT CLASSIFICATION

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

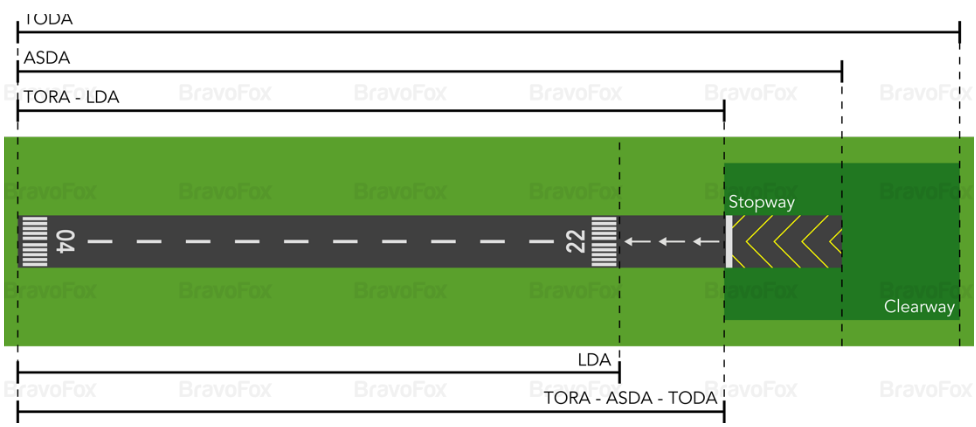
*A: CS-25* *B: CS-23*

## 4. RUNWAY

**Clearway**: An area beyond the runway, not less than 152m/500ft wide, under aerodrome authority.

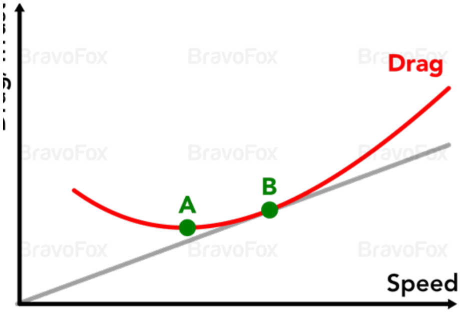
**TORA**: Take-Off Run Available
**ASDA**: Accelerate-Stop Distance Available
**TODA**: Take-off Distance Available
**LDA**: Landing Distance Available

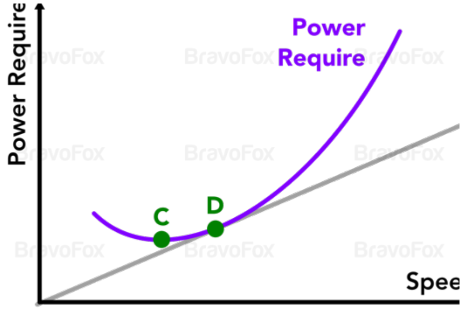
ASDA = TORA + Stopway
TODA = TORA + Clearway




**Wet runway** ⇒ Positive landing, full reverse and break ASAP.

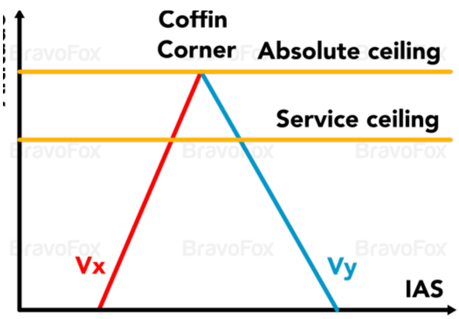
## 5. $V_X$ - $V_Y$ - $V_{MD}$ - $V_{MP}$

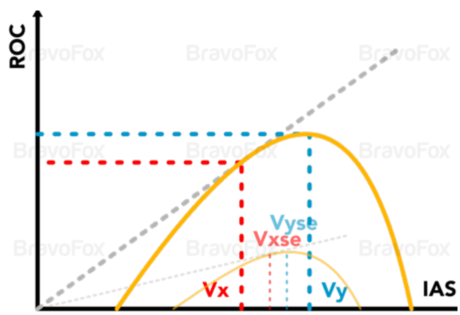



$$\textit{Power Require} = \textit{Drag} \times \textit{TAS}$$

| Jet aircraft | | Propeller aircraft | |
|---|---|---|---|
| A (=D) | B | C | D (=A) |
| $V_X$ | $V_Y$ | $V_X$ | $V_Y$ |
| Best endurance | Best range | Best endurance | Best range |
| $V_{MD}$ | 1.32 $V_{MD}$ | $V_{MP}$ | $V_{MD}$ |
| Max Lift/Drag | Max EAS/Drag | | Max Lift/Drag |



## 6. DRAG (TRIMMED)

## 7. BANK ANGLE ALLOWED (TRIMMED)

## 8. EFFECT OF CG POSITION (TRIMMED)

## 9. EFFECT OF WIND AND WEIGHT (TRIMMED)

## 10. CLASS B: (TRIMMED)

### 10.1 PERFORMANCES (TRIMMED)

### 10.2 RUNWAY REQUIREMENTS (TRIMMED)

### 10.3 MULTI-ENGINE (TRIMMED)

# 11. CLASS A: CS25

## 11.1 TAKE-OFF

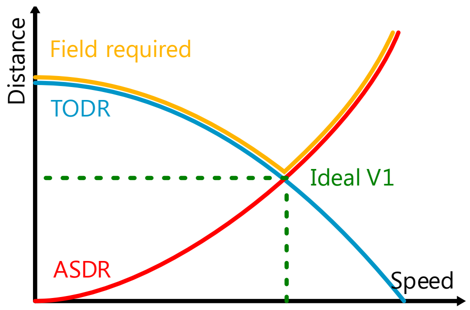
### 11.1.1 SPEEDS (TRIMMED)

### 11.1.2 LIMITATIONS

**PLTM – Performance Limited Take-off Mass:**

- Aerodrome distances available (Field Limit Mass)
- Climb requirements (Climb Limit Mass)
- Obstacle clearance (Obstacle Limit Mass)
- Brake energy limitations (VMBE)
- Tyre speed limitations (Tyre Speed Limit Mass)
- Runway strength limitation (ACN/PCN)
- Maximum structural take-off weight (MSTW)

### 11.1.3 $V_1$




| Stopway | Clearway | |
|---|---|---|
| ✗ | ✗ | **Balanced field:** <u>TODA=ASDA</u> ⇒ <u>Only one single $V_1$ value.</u> <u>The OEI take-off distance = rejected take-off to full stop distance.</u> |
| ✓ | ✗ | **Unbalanced field: $V_1 > V_{1balanced}$.** Allow for more mass due to the ASDA increment ⇒ $V_1$ increase. |
| ✗ | ✓ | **Unbalanced field: $V_1 < V_{1balanced}$.** Allow for more mass but $V_1$ need be lower to stop the aircraft ⇒ $V_1$ decrease. |

*If the question is about "balanced/unbalanced" look for ">…<" or "<…>"*

**Wet runway** ⇒ Need more runway to stop ⇒ <u>Lower</u> $V_1$

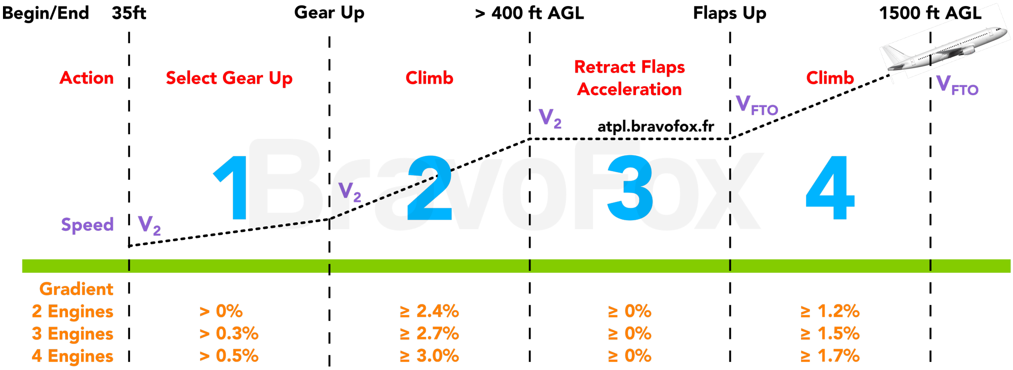
### 11.1.4 REDUCED / DE-RATED TAKE-OFF THRUST (TRIMMED)

### 11.1.5 OBSTACLE CLIMB CLEARANCE (TRIMMED)

### 11.1.6 CONTAMINATED RUNWAYS (TRIMMED)

### 11.1.7 RUNWAY REQUIREMENTS (TRIMMED)

### 11.1.8 Initial climb phases (CS-25)




1. Lift-off, accelerate to V2, positive rate ⇒ gear up
2. V2 until 400ft
3. Positive rate, acceleration, transition clean configuration
4. Climb at MCT, segment end at 1500ft.

### 11.1.9 ACN/PCN (Trimmed)

## 11.2 Climb (Trimmed)

### 11.2.1 Climb - Descend Profile / Crossover (Trimmed)

## 11.3 Cruise (Trimmed)

## 11.4 Cruise speed (Trimmed)

## 11.5 OEI – One Engine Inoperative (Trimmed)

## 11.6 Descend (Trimmed)

## 11.7 Approach / Landing (Trimmed)

### 11.7.1 Factor (Trimmed)

### 11.7.2 Hydroplaning (Trimmed)

### 11.7.3 Turnaround time (Trimmed)

# FLIGHT PLANNING & MONITORING

*I strongly recommend to study Mass & Balance, General Navigation and Instrument Navigation before this chapter as theses chapters cover almost all you need to know for Flight Planning & Monitoring.*

## 1. FLIGHT PLANNING

### 1.1 AIR LAW

**VFR flights shall not be flow over congested areas** of cities at height less than 300m/1000ft within a radius of 600m from the aircraft.

**Mountainous area** 600m/2000ft, radius 600m.

**Elsewhere** 150m above ground or water.

**MSA**: Minimum Sector Altitude, **provide 300m/1000ft obstacle clearance within 25NM/46km** on fixes/navaids associated with the approach procedure.

**MOC**: Minimum Obstacle Clearance

**"Normal" MOC** = 300m/1000ft

**Mountain 900-1500m** ⇒ MOC = 450m/1500ft

**Mountain >1500m** ⇒ MOC = 600m/2000ft

### 1.2 FLIGHT LEVEL

| | IFR | | VFR | |
|---|---|---|---|---|
| ≤FL290 | 20 | 30 | 25 | 35 |
| | 40 | 50 | 45 | 55 |
| | 20 × k | 10 + 20 × k | 5 + 20 × k | 15 + 20 × k |
| >FL290 non-RVSM | 310 | 290 | 320 | 300 |
| | 350 | 330 | 360 | 340 |
| | 310 + 40 × k | 290 + 40 × k | 320 + 40 × k | 300 + 40 × k |

### 1.3 ALTITUDE CORRECTION

$$Press_{correction} = (QNH - 1013) \times 30_{ft/hPa}$$

$$Altitude_{QNH} = Altitude_{indicated} + Press_{correction}$$

$$Temp_{correction} = ISA\ deviation \times 4 \div 1000 \times (Altitude_{QNH} - elevation)$$

$$Altitude_{true} = Altitude_{indicated} + Press_{correction} + Temp_{correction}$$

### 1.4 MAGNETIC/TRUE CONVERSION

| CH | + | DEV | = | MH | + | VAR | = | TH | - | CONV | = | GH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 220° | | 5°W | | 215° | | 10°E | | 225° | | 180° | | 45° |
| 220 | + | (-)5 | = | 215 | + | (+)10 | = | 225 | - | 180 | = | 45 |

# 2. FLIGHT PLANNING FOR IFR

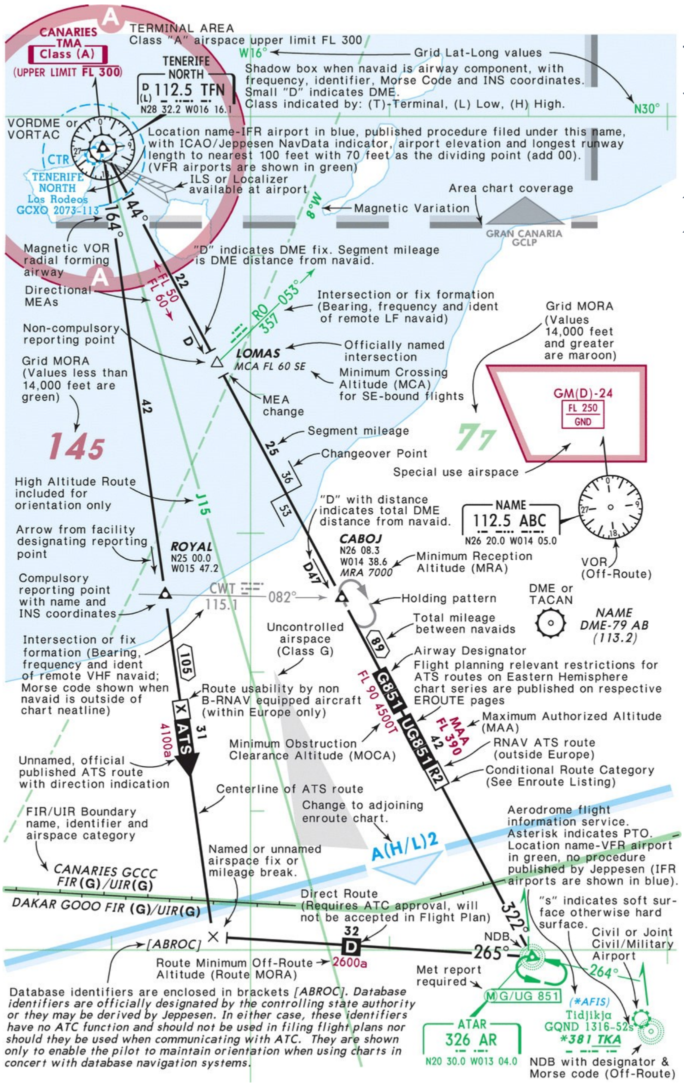
## 2.1 JEPPESEN CHART

MAA: Maximum Authorized Altitude.

MEA: Minimum Enroute Altitude, **provide acceptable coverage and fulfils obstacle clearance**.

MORA: Minimum Off-Route Altitude, **provide clearance 10NM either side of the route.**

MOCA: Minimum Obstruction Clearance Altitude.




MAA18000 ⇒ MAA 18000

7000 ⇒ MEA 7000ft

5000a ⇒ MORA 5000ft

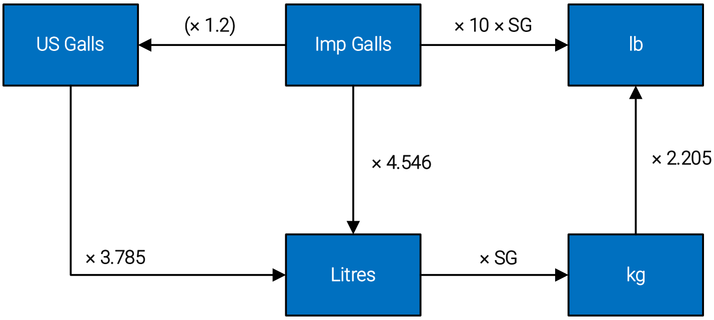
1600T ⇒ MOCA 1600ft

*XXXXa: a like area = MORA*

*XXXXT: T Track = MOCA*

# 3. FUEL PLANNING

## 3.1 VOLUME/MASS




## 3.2 FUEL REQUIREMENTS – TA-TRI-CO-AL-AD-FI-EX

| | TA-TRI-CO-AL-AD-FI-EX |
|---|---|
| **Taxi Fuel** | Only at departure. Is not part of the take-off fuel |
| **Trip Fuel** | Climb – Trip – Descent – Approach - Land |
| **Contingency Fuel** | The greater of<br>▪ 5% of the trip fuel / 3% of trip if **suitable* en-route alternate available.**<br>▪ 5min of Fuel @1500ft **above Destination** |
| **Alternate Fuel** | Used for missed approach (does not include missed approach at alternate) |
| **Additional Fuel** | **If no Dest. Alternate given**: 15min hold @1500ft **above Destination** |
| **Final Reserve** | **For emergency only**: It is prohibited to plan the usage of such fuel. |
| Reciprocating | 45min hold @1500ft **above Alternate** |
| Turbine | 30min hold @1500ft **above Alternate** |
| **Extra Fuel** | |

*3% Contingency is only possible if the alternate is within a circle of centre located on the route, at the greatest distance between 25% total or 20% total + 50 NM from destination, which radius equal 20% of total flight plan.

## 3.3 EXTRA FUEL

Based on MTOM

$$EXTRA_{FUEL} = MTOM - ZFM_{DOM+TL} - T/O_{FUEL}$$

Based on MLM

$$EXTRA_{FUEL} = MLM - ZFM_{DOM+TL} - LDG_{FUEL}$$

Take the lesser, if MLM is the limit then apply penalty on trip fuel.

Be aware of given limitations (MTOM/Fuel tank capacity).

### 3.4 SPECIFIC FUEL CALCULATION PROCEDURES (TRIMMED)
#### 3.4.1 RCF – REDUCED CONTINGENCY FUEL / DPP - DECISION POINT PROCEDURE (TRIMMED)
#### 3.4.2 PREDETERMINED POINT PROCEDURE / ISOLATED AERODROME (TRIMMED)
#### 3.4.3 FUEL TANKERING (TRIMMED)

## 4. PRE-FLIGHT PREPARATION
### 4.1 NOTAM (TRIMMED)
### 4.2 PLANNING MINIMA (TRIMMED)
### 4.3 METAR / TAF (TRIMMED)
### 4.4 SIGNIFICANT WEATHER (TRIMMED)
### 4.5 PET – POINT OF EQUAL TIME

**PET**: Equal time between departure and destination. Also called CP – Critical Point.

$$PET_{Distance} = Distance_{A\ to\ B} \times \frac{GS_{HOME}}{GS_{HOME} + GS_{OUT}} \qquad PET_{Time} = PET_{Distance} \times GS_{OUT}$$

**PET**: Move into the wind (Closer to destination if headwind).

### 4.6 PSR – POINT OF SAFE RETURN

**PSR**: The last point along the route which an aircraft can legally fly back to its departure aerodrome; having passed the PSR, the aircraft is committed to continue to its destination or some alternate aerodrome.

$$PSR_{Time} = Endurance \times \frac{GS_{HOME}}{GS_{HOME} + GS_{OUT}} \qquad PSR_{Distance} = PSR_{Time} \times GS_{OUT}$$

**PSR**: Is always closer to the departure if there is any wind.

## 5. FLIGHT PLAN
### 5.1 COMPUTER (TRIMMED)
### 5.2 INDIVIDUAL FLIGHT PLAN (TRIMMED)
### 5.3 RPL – REPETITIVE FLIGHT PLAN (TRIMMED)
### 5.4 SUBMISSION OF FLIGHT PLAN (TRIMMED)

## 6. FLIGHT MONITORING (TRIMMED)

# HUMAN PERFORMANCE & LIMITATIONS

## 1. BASIC CONCEPTS

**Competency**: A combination of Knowledge, Skill, Attitude *(KSA)*

**Skilled pilot**: Practices regularly, knows how to manage himself, knows how to keep resources in reserve for unexpected.

### 1.1 ACCIDENT STATISTICS

**The rate of accident** is approximately 1 accident per million airport movements.

In the last 3 decades 70-80% of aviation accidents seem related to the crew. Mainly caused by a lack of judgement. There is hardly ever a single cause responsible.

GPWS substantially **contributed to decrease hull accident** rates in the 1980s.

GPWS: Ground Proximity Warning System

### 1.2 FLIGHT SAFETY CONCEPTS

**Flight safety**: The theory, investigation and classification of incidents and accidents and their prevention.

In **Aviation Industry** everyone involved is responsible for flight safety.

In **complex organisations**, the safety manager and the safety review board are **responsible for safety**.

#### 1.2.1 TEM MODEL – THREAT ERROR MANAGEMENT

| Threats | **Environmental threats**: | **Organisational threats**: |
|---|---|---|
| | Weather | Operational pressure |
| | ATC | Aircraft |
| | Airport | Cabin |
| | Terrain | Maintenance |
| | Other | Ground |
| | | Dispatch |
| | | Documentation |

**Latent threat** is a threat which is not directly obvious or observably by the flight crew:

- Short turn-around schedules
- Cockpit design error *(737Max)*

**Errors**: Action or inaction during the flight course

| Errors | **Aircraft handling errors**: | **Procedural errors**: | **Communications errors**: |
|---|---|---|---|
| | Manual handling flight control | SOPs | Crew to external |
| | Automation | Checklists | Pilot to pilot |
| | Systems, radio, instruments | Callouts | |
| | Ground navigation | Briefings | |
| | | Documentation | |

**UAS**: Undesired aircraft states ⇒ Flight crew induced; safety margins are clearly reduced.

#### 1.2.2 SHELL MODEL (TRIMMED)

### 1.3 SAFETY CULTURE (TRIMMED)

# 2. BASIC OF FLIGHT PHYSIOLOGY / HEALTH MAINTENANCE

## 2.1 BASIC OF FLIGHT PHYSIOLOGY

### 2.1.1 ATMOSPHERE

**Standard atmosphere**: 78% nitrogen, 21% oxygen, 0,92% rare gases, 0,03% carbon dioxide.

**Below 70000ft**, Nitrogen composes a major part of the atmosphere.

**Percentage of oxygen** in the cabin air is the same as at sea level.

**Ozone-layer** is situated in the stratosphere. **Ozone in pressurized cabin** can be eliminated by ozone-converter.

**Pressure decrease** is non-linear, higher rate at low altitude.

**@18000ft >** 50% of sea level pressure – **@27000ft** > 33% SL – **@36000ft** > 25% SL *(9000/alt)*

**-2°C/1000ft** in the **troposphere**.

### 2.1.2 RADIATIONS

**Cosmic radiations** are:

- Normal solar activity
- Random solar activity (solar flare)
- Increase and decrease over cycle of 11 years

**Galactic radiations** are:

- Caused by galactic particle
- Steady and reasonably predictable

**Cosmic/Galactic radiation**: Highest intensity at high latitudes/altitude.

**Records of radiation** are normally kept for flight above 49000ft.

**Alpha radiation** can be blocked by a sheet of paper.

**Beta radiation** can pass 0.2 mm of paper/0.2 cm of water but can be stop completely.

**The average amount of cosmic radiation received per year** is about equal to the amount of background radiation.

More than 100 mSv (Sievert) of radiation **may have adverse effects on your health**.

### 2.1.3 HYPOTHERMIA

Internal body **temperature falls below 35°C** ⇒ Disorders associated with hypothermia appears.

Internal body **temperature falls below 32°C** ⇒ Mental disorders, and even coma.

**Shivering** makes it possible to combat the cold up to a certain extent, uses a lot of energy.

**Sleepiness occurs** associated with a feeling of contentment and apathy.

When suffer from hypothermia, demand for oxygen initially increase.

### 2.1.4 HYPOXIA

Is the lack of sufficient oxygen to meet the needs of the body tissues which require oxygen for oxidation of carbohydrates from food to produce energy.

**Symptoms**: euphoria, poor judgement, impaired judgement, memory disorder, fatigue, somnolence, dizziness, headache, breathlessness, impaired visual acuity, weakness, loss of touch, hyperventilation, tingling sensation in arms or legs, cyanosis (blue skin). Can lead to a hyperventilation.

**Can be caused by**: Low partial pressure of oxygen (critical value 55 mmHg), Carbon monoxide attached to haemoglobin, +Gz, Malfunction of the body cells to metabolize oxygen.

**Prevented** by using additional oxygen above 10000ft.

**100% oxygen at 40000ft** is equivalent to breathing ambient air at 10000ft.

**100% oxygen at 38000ft** is equivalent to breathing ambient air at 8000ft.

**100% oxygen at 33700ft** is equivalent to breathing ambient air at sea level.

**Climbing without oxygen**:

- **22000ft**: Loss of consciousness
- **20000ft**: Critical threshold
- **12000ft**: Short-term memory impairment starts
- **10000-12000ft**: Upward limit where healthy people are capable to compensate for oxygen lack
- **6000-7000ft**: Organism starts to compensate for the drop in partial $O_2$ pressure

**Rapid decompression time of useful consciousness**:

- 40000ft – TUC 15-20s (Need 100% oxygen under pressure)
- 35000ft – TUC 30-90s
- 30000ft – TUC 1-2min
- 25000ft – TUC 2-3min
- 20000ft – TUC 30min

### 2.1.5 ACCELERATIONS (TRIMMED)
### 2.1.6 LAWS AND PHENOMENA (TRIMMED)
### 2.1.7 DEHYDRATION (TRIMMED)
### 2.1.8 CARBON MONOXIDE – CO (TRIMMED)
### 2.1.9 RESPIRATORY/BREATHING (TRIMMED)
### 2.1.10 DECOMPRESSION SICKNESS (TRIMMED)
### 2.1.11 HYPERVENTILATION (TRIMMED)
### 2.1.12 BLOOD (TRIMMED)
## 2.2 MAN AND ENVIRONMENT: THE SENSORY SYSTEM (TRIMMED)
### 2.2.1 NERVOUS SYSTEM (TRIMMED)

## 2.2.2 EYES

70% of information processed by man enters via the **visual channel**.

**Vision** is processed at the cortex.

**Cornea** is the clear portion of the eye where the light passes through.

**Retina** is the light-sensitive inner lining of the eye containing photoreceptors.

**Fovea** is the area of best day vision and no night vision at all.

**Cones**: Central, colour vision.

**Rods**: Scotopic vision, night vision.

**Path of light**: Cornea – Iris/Pupil – Lens – Retina.

**AccoMmodation**: Change of the shape of the lens

Controlled by the functioning of the ciliary muscle around the lens

**aDAptation**: Adjustment of the eyes to high or low levels of illumination. Pupil dilatation

*accoMmodation for "Miles" / aDAptation for "Day"*

**Time to adapt**: Darkness to Light: 10s – Light to Darkness: 30minutes.

**Protect yourself from flash blindness in thunderstorm:**

Increase intensity of the cockpit light, looking inside cockpit, sunglasses, using blinds/curtains.

**Clear image** accomplished by crystalline lens.

**Colour vision** needs a considerable amount of light.

**Vision of relief**: Binocular vision at short distance – Proportion and perspective for further away.

**Vitamin A** is an essential in the build-up of rhodopsin (visual purple); without, night vision is degraded.

**Affect visual acuity**: Hypoxia, age, angular distance from the fovea, anaemia, smoking, CO poisoning.

**Hypoxia** can affect **night vision** at approximately 5000ft.

**During night**:

- **Rods** are responsible for night vision.
- Spend twice as much time with eyes remaining still during each saccade of the lookout scan.
- **Scanning** should be performed by slight eye movements to the side of the object.

**Contact lens**: Only acceptable for near-sighted

- Can cause: Irritation and runny eyes, itching or burning sensation.
- Damage to the cornea due to low humidity and hypoxia.
- Spare set of spectacles (glasses), approved by the AME, should be carried.

**Avoid sunglasses**: Yellow tinted, polarized, automatically tinted.

**Colour blindness**: may be subtle and only detected using specialised tests.

**Glaucoma** is a condition detected by pressure testing the eyeball. Disturbed light adaptation, Progressive narrowing of FoV, Insidious onset, intra-ocular pressure. Can lead to blindness.

**Cataract**: Clouding of the lens.

**Astigmatism**: mis-shaped cornea.

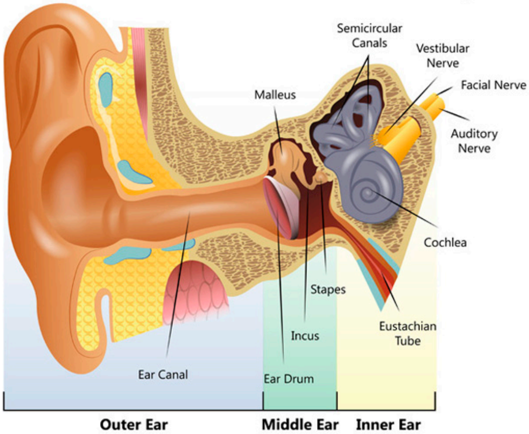
**Presbyopia** (loss of elasticity): far sighted linked with age.

**Myopia:** short sighted.

**Long-sighted**: Image is forming behind of the retina.

**Short-sighted**: Image is forming in front of the retina.

### 2.2.3 EARS




**Audible range**: 20 Hz – 20 kHz

**Group of tiny bones "Ossicles"** (anvil, hammer, stirrup, malleus, incus) are situated in the middle ear.

**Vestibular apparatus**:

- **Eustachian tube** equalize pressure
- **Otoliths** = Saccule & Utricle
- **Measure** linear/angular acceleration

**Semicircular canals** detects angular accelerations

**Sacculus & Utriculus** detects linear accelerations

**Cochlea** responsible for sound perception.

**Path of sound**: Pinna – External auditory canal – Ear drum – Ossicles – Oval window – Cochlea – Auditory nerve.

**Orientation in flight** is accomplished by: Eyes, Utriculus and sacculus, Semicircular canals, Seat-of-pants sense.

**NIHL – Noise-Induced Hearing Loss**: Damage of the sensitive membrane in the cochlea. (Wear of hair cells)

**Affect NIHL**: Exposition to heavy noise level (+85dB) and duration.

**Presbyacusis**: Gradual permanent loss of high tones. *(High age – High tones first)*

**Hearing tests** are carried out during pilot medicals to detect early sign of deafness.

**Conductive hearing loss can be caused by**: Damage to the ossicles in the middle ear, obstruction in the outer ear, ruptured tympanic membrane.

### 2.2.4 SICKNESS (TRIMMED)

### 2.2.5 ILLUSIONS (TRIMMED)

### 2.2.6 PRESSORECEPTORS (TRIMMED)

## 2.3 HEALTH AND HYGIENE (TRIMMED)

### 2.3.1 SLEEP (TRIMMED)

### 2.3.2 SMOKING (TRIMMED)

### 2.3.3 ALCOHOL (TRIMMED)

### 2.3.4 WEIGHT / BMI / EXERCISE (TRIMMED)

### 2.3.5 GENERAL CONSIDERATION (TRIMMED)

### 2.3.6 DISEASES (TRIMMED)

# 3. BASIC AVIATION PSYCHOLOGY

## 3.1 HUMAN INFORMATION PROCESSING (TRIMMED)

## 3.2 HUMAN ERROR AND RELIABILITY (TRIMMED)

## 3.3 BEHAVIOUR (TRIMMED)

## 3.4 ADVANCED COCKPIT AUTOMATION (TRIMMED)

## 3.5 DECISION MAKING

**Decision-making** is a voluntary and conscious process of selection from possible solutions to a problem.

The **DECIDE model**:

| | | |
|---|---|---|
| D | Detect the problem | Based on a prescriptive generic model, which seems most likely to come up with the solution. |
| E | Estimate the need to react to change | |
| C | Choose a solution | |
| I | Identify required action | Require the pilot to assess the impact of a deviation. |
| D | Do | |
| E | Evaluate de effect | |

The **amount of time available** has a large influence on the analysis of the situation.

**Adaptation to time constraint**: preparation of action and prioritisation of tasks.

Biases:

- **Frequency bias**: Personal experience tends to alter the perception
- **Confirmation bias**: Natural tendency to confirm our decision even if the facts contradict
- The group of which an individual belongs tends to influence the decision
- Easily tends to select data which meet expectation

**Assessment of a risk** is based on subjective perception and evaluation of situational factors.

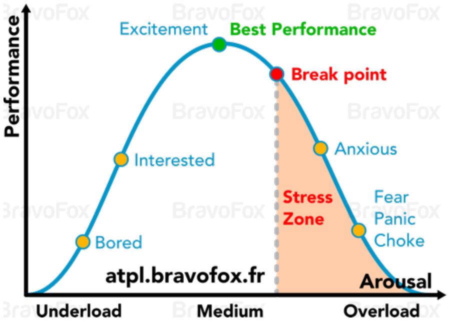
**Risky shift**: The tendency to both pilots to take more risk than any of them would on his own.

Assertiveness is the **most effective personality characteristics** for **decision making**.

## 3.6 AVOIDING AND MANAGING ERRORS (TRIMMED)

## 3.7 STRESS AND AROUSAL

**Arousal**: Degree of activation of the Central Nervous System.



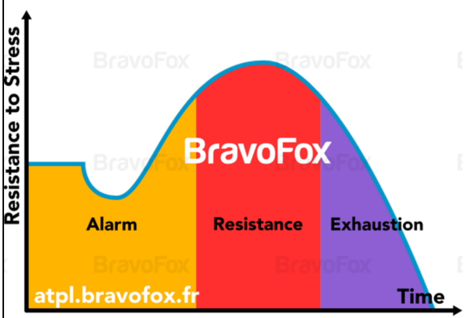

**Performance** is best before the breakpoint.

**Beyond break point**: Performance decrease but **arousal & stress** **still increase**.

**Can help to stay awake**: Isometric exercises

Active communication

The model of **General Adaptation Syndrome** (GAS)




**Alarm phase**: Prepare the body for action
Adrenaline produced ⇒ increased arousal
Increased heart rate
Decrease in stress resistance
Senses are sharpened
Brain activity accelerated.

**Resistance phase** of the stress reaction: Transformation of fat into sugar to produce energy. Psychosomatic disorder can occur if resistance phase last too long.

**Exhaustion phase**: The body eliminate waste products from the previous phases. Felling tired.

GAS is regulated by ANS (Autonomic Nervous System)

**Homeostasis**: Man's internal stress equilibrium.

**Sign of stress**: **Dry mouth**, dilated pupils, fast breathing, sweating (perspiration)

**To reduce stress**:

- **Psycho/Physio** stressors: Problem-focused coping *(solve your problem to decrease your stress)*
- **Psychological** stressors: Emotional/**Cognitive coping**: ignoring or rationalising the stress factor.

**Chronic stress** can lead psychological and physiological health problem.

Communication is the **first cockpit tool that suffer from stress**.

**Reversion habit** (return to an earlier behaviour) when too relaxed (not focused) or too stressed.

**Anxiety** is a form of stress, it can affect: attention, concentration, judgement, memory.

**Workload**: is acceptable if it requires about 60% of crew resource, depends on the pilot's expertise.

**Stress** can be positive; **fatigue** is always negative.

### Fatigue

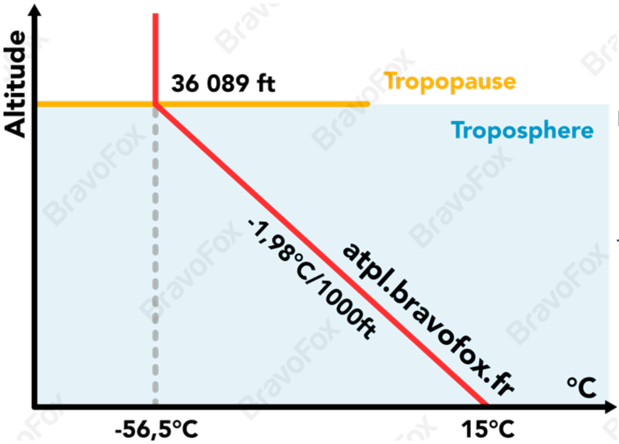
**Two main categories**: Acute(short-term) and chronic.

**Symptoms**: Tiredness, slowed reaction, diminished accommodation, long-term memory access problems, diminished motor skills, tunnelled concentration.

# METEOROLOGY

## 1. ATMOSPHERE

### 1.1 ISA – ICAO STANDARD ATMOSPHERE




ISA condition @MSL:

- 15°C
- 1013,25 hPa

Temperature change:

- -2°C/1000ft up to 36090ft
- -0.65°C/100m up to 36090ft
- Then constant (-56,5°C) to 65617ft

### 1.2 COMPOSITION, EXTENT, VERTICAL DIVISION (TRIMMED)

### 1.3 AIR TEMPERATURE (TRIMMED)

### 1.4 ATMOSPHERIC PRESSURE (TRIMMED)

### 1.5 AIR DENSITY

Density is affected by altitude, pressure, temperature, and amount of water vapour.

↓ Temperature ⇒ ↑ Density

↑ Pressure ⇒ ↑ Density

**Density altitude** is the altitude in standard atmosphere to which the observed density corresponds.

Increasing density = decreasing density altitude.

**At sea level** 1225g/m$^3$.

**Density @40000ft** = $^1/_4$ SL

### 1.6 ALTIMETRY (TRIMMED)

# 2. WIND

$$1\ kts = 1{,}852\ km/h \sim 0{,}51 m/s$$

**Surface wind** is measured 8-10m above ground on a mast with an anemometer.

## 2.1 1ST CAUSE OF WIND - CIRCULATION

**CF** – Coriolis Force (due to Earth rotation, CF is maximum at poles)

**PGF** – Pressure Gradient Force $\Delta P \div (\rho \times \Delta D)$

**Winds:**

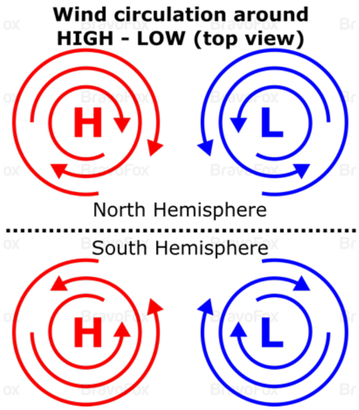
- Coriolis Force **balances** Pressure Gradient Force ⇒ Winds follow **isohypses/isobars**
- Are **perpendicular to** horizontal PGF
- **Speed increase** with increasing PGF, decreasing density (⇒ increasing altitude)
- **Speed decrease** with increasing CF (opposing PGF), increasing latitude (CF increases with lat.)

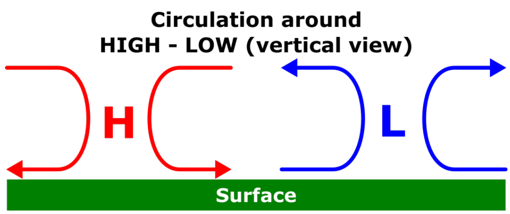
**Geostrophic wind**:

- **Depends only** on PGF and CF (no friction no centrifugal force)
- Occurs only if isobars are straight and PGF is constant (no friction)
- Is present at latitude above 15° (not enough CF below)

**Gradient wind**:

- Is affected by PGF, CF and **centrifugal force**.
- **Speed increase** in HIGH – Anti-cyclonic circulation ⇒ Centrifugal force added to PGF
- **Speed decrease** in LOW – Cyclonic circulation ⇒ Centrifugal force opposes PGF
- *Gradient LOW < Geostrophic < Gradient HIGH*




Cloud can be formed in a LOW due to ascending wind causing condensation of humidity.

**DV - Diurnal variation**: wind getting stronger during day and reduce during night.

- Maximum speed at 15:00
- Minimum speed around sunrise

**@2000ft surface friction** ⇒ Veers or Backs the winds

- In **northern hemisphere** going up **veers** wind ⇒ Clockwise (Left's hand thumb up)
- In **southern hemisphere** going up **backs** wind ⇒ Anti-clockwise (Right's hand thumb up)
- Friction **layer depends on**:
  - Stability (get higher with turbulence),
  - Time of day (thermal convection cause unstable air)
  - Wind speed (instability get higher)
  - Surface type (smooth/rough)
- **Over sea** wind direction change by 10°, speed reduce by 10-30%
- **Over land** wind direction change by 30°, speed reduce by 50%

#### 2.1.1 Hands tip for circulation and friction directions (Trimmed)

### 2.2 Land and Sea breezes (Trimmed)

### 2.3 Mountain and Valley winds (Trimmed)

### 2.4 Mountain waves (Trimmed)

### 2.5 Local winds and associated weather (Trimmed)

### 2.6 Turbulence (Trimmed)

### 2.7 Jet streams (Trimmed)

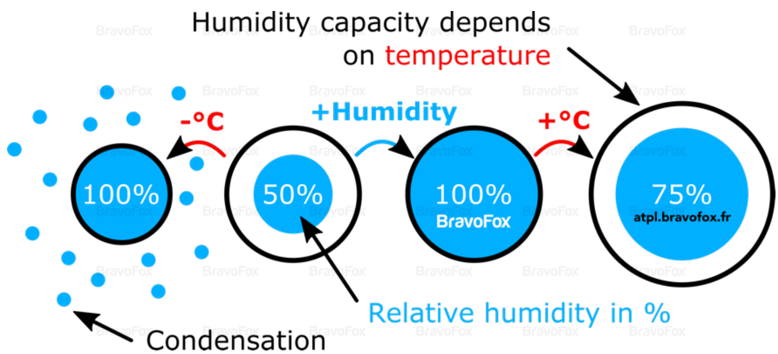
## 3. Thermodynamics

### 3.1 Humidity

**Dew point** – Temperature $T_d$ to which air must be cooled to become saturated with water vapor, assuming constant air pressure and water content.

**Dew point** can be egal or lower to air temperature.

$$\textit{Relative humidity}\ \% = \frac{\textit{actual water content}}{\textit{water vapour capacity}} = \mathbf{100 - 5(T - T_d)}$$




Increase humidity reduces dew point.

Increase pressure reduces evaporation.

**Saturation**: 100% Relative Humidity, occurs at a given temperature and pressure.

**Mixing ratio**: gr of water vapour per kg of air.

**Saturation mixing ratio**: With an **increase in temperature,** mixing ratio increases exponentially.

**Vapor pressure**: Amount of vapor that can be found in air.

**In the lower troposphere, air consists** of 0-5% water vapour.

0g/m$^3$ at the poles, 25g/m$^3$ near the equator.

### 3.2 State of aggregation (Trimmed)

### 3.3 Adiabatic processes (Trimmed)

4. CLOUDS AND FOG
4.1 CLOUD FORMATION (TRIMMED)
4.2 CLOUD DESCRIPTION (TRIMMED)
4.2.1 LOW LEVEL CLOUDS "STRATO" ((TRIMMED)
4.2.2 MEDIUM LEVEL CLOUDS "ALTO" (TRIMMED)
4.2.3 HIGH LEVEL CLOUDS "CIRRO" (TRIMMED)
4.2.4 CLOUDS WITH EXTENSIVE VERTICAL DEVELOPMENT (TRIMMED)
4.3 KEYWORDS FOR CLOUDS QUESTIONS (TRIMMED)
4.4 FOG, HAZE, MIST (TRIMMED)

5. PRECIPITATION
5.1 DEVELOPMENT OF PRECIPITATION. (TRIMMED)
5.2 TYPES OF PRECIPITATION (TRIMMED)

6. PRESSURE SYSTEMS
6.1 THE PRINCIPAL PRESSURE AREAS (TRIMMED)
6.2 PRESSURE SURFACE (TRIMMED)
6.3 ANTICYCLONE (TRIMMED)
6.4 NON-FRONTAL DEPRESSIONS (TRIMMED)

7. AIR MASSES AND FRONTS
7.1 AIR MASSES (TRIMMED)

## 7.2 FRONTS

**Front** is a transition between two air masses, with inclined slope and clouds with precipitation.

**Cold front vertical slope**: 1:80 – **Warm front slope**: 1:120 (warm slope smaller)

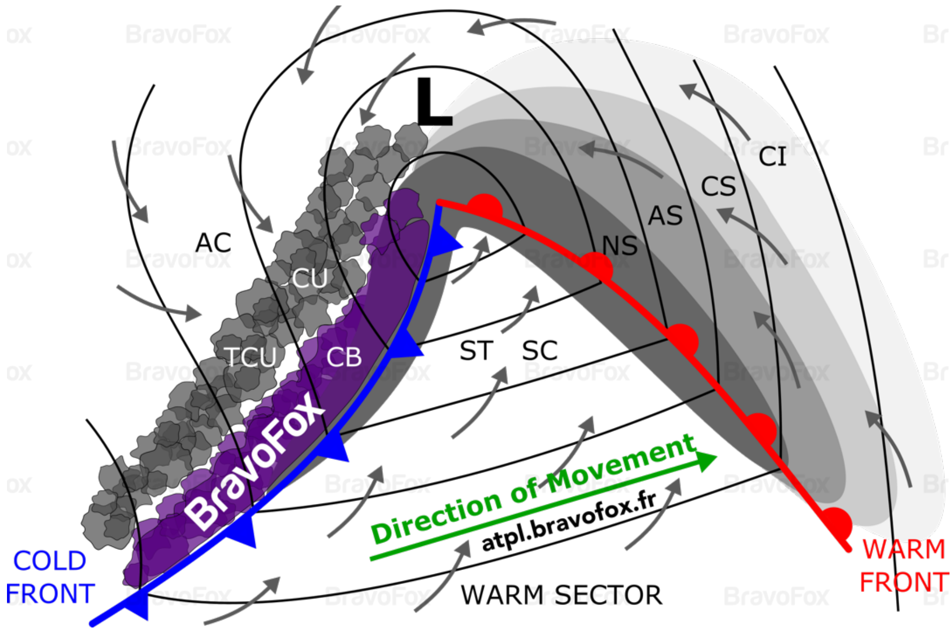
**Frontal depression lifespan:** 3 – 5 days in **Europe**, 4 – 7 days in **Mid-latitude**.

One or two days **between frontal waves** in Western Europe.

**Polar fronts** are more southern during winter, **extending** from: (45°N – 70°N)

- From Newfoundland to N. Scotland during **summer** (60°N)
- From Florida to SW England during **winter**

**Polar fronts depression usually move** toward the east.




**Non-occluded frontal depression moves** in direction of the warm sector isobars.

**Speed is determined** by the proximity of isobars: **Closer** ⇒ **Faster**.

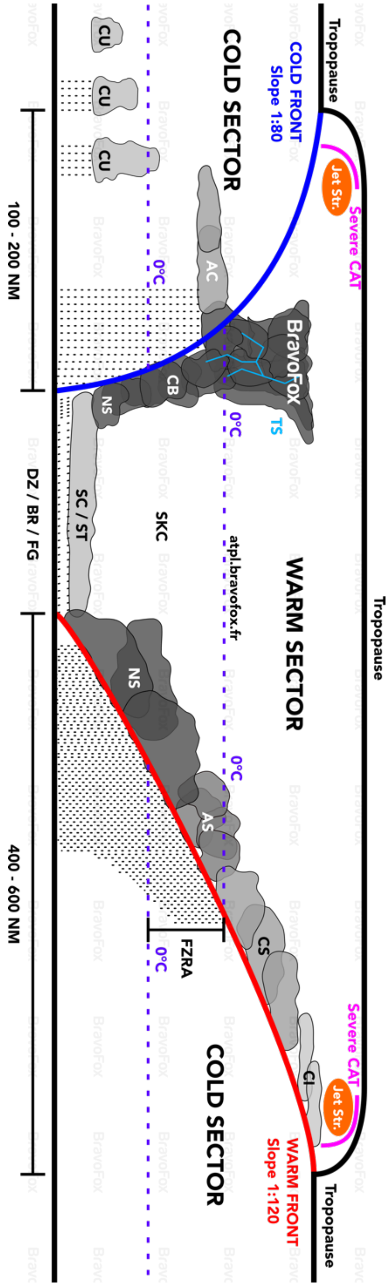
**When a front has to cross a chain of mountains**, its activity strengthens "upwind" of the mountain, due to orographic lifting.

**Low level clouds in front of warm front are due to** rain dragging warm air into the cold air and condensing it.

**Warm sector weather**:

- **Winter**: Stable (ST, SC), poor visibility, mist/drizzle
- **Summer**: Unstable (CU) thunderstorm, good visibility, little or no cloud above 6500ft

(Trimmed)




(Trimmed)

## 7.3 TYPICAL WEATHER SITUATIONS IN THE MID-LATITUDE (TRIMMED)

# 8. CLIMATIC ZONES

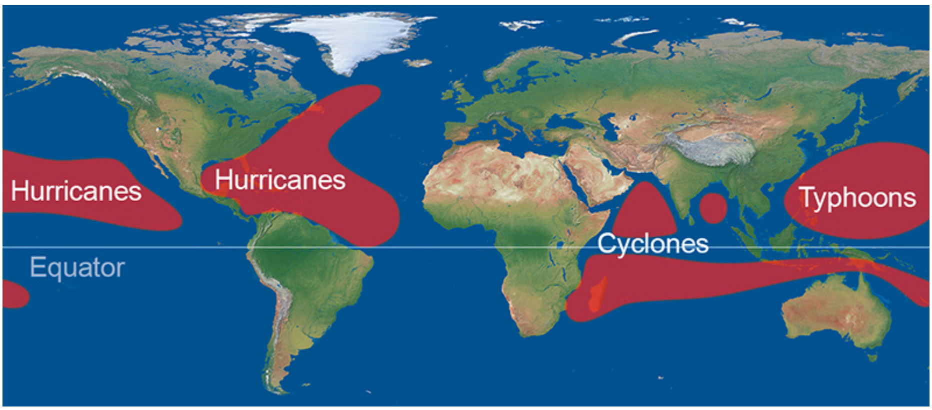
## 8.1 TROPICAL CLIMATOLOGY (TRIMMED)

## 8.2 TROPICAL REVOLVING STORM

**The five stages of development of a Tropical Revolving Storm**:

1. Tropical disturbance, 2. Tropical depression, 3. Tropical storm, 4. Severe tropical storm, 5. TRS

- TRS typically **occurs** in late summer
- TRS **gain its energy** from latent heat from the water in oceans ⇒ Decay **on reaching a land mass**
- TRS tends to **develop mostly in the western parts of the tropical oceans** because there is a maximum of humidity because of the trade winds along sea passage
- **The eye** of a TRS is warmer than its surrounding, extends from surface to the top, air descending
- Total **diameter** of a TRS at mature stage is about 500km
- Dense CI **could indicate the presence of a TRS**
- **The most sever condition** in TRS is in the outer quadrant of the track of the storm. (In the right quadrant, in NH because TRS revolving anti-clockwise) +63kts, ascending air, thunderstorms
- **Most dangerous zone/Greatest wind speeds** in the wall of cloud, 50-100NM outside the eyes




**TRS periods**:

- **Hurricane (USA)**: July to November
- **Typhoon (SE Asia)**: July to November
- **Cyclone**
  - **India**: Mars to December
  - **Africa**: December to April
  - **Pacific**: December to April

*Hurricane: JUNO*

*Typhoon: JUNO*

*Cyclone*

*India: MADE*

*Africa: DECA*

*Pacific: DECA*

**Average TRS per year**:

- West Darwin: 5
- Hurricanes: 6
- Philippines/East Darwin: 9
- Bengal (India): 12
- Japan: 20

*W.H.P.B.J*

*When Human People Buy Jeans*

**Hurricane in the Caribbean** area goes West in early stages and later turning North-East.

**Willy-Willy** is an Australian TRS (pacific cyclone).

## 9. Flight Hazards

9.1 Thunderstorms (TS) (Trimmed)
9.2 Icing (Trimmed)
9.3 Windshear (Trimmed)
9.4 Turbulence (Trimmed)
9.5 Visibility reducing phenomena (Trimmed)
9.6 Inversions (Trimmed)
9.7 Hazard in mountaineous area (Trimmed)
9.8 Tornadoes (Trimmed)

## 10. Meteorological Information

10.1 Observation (Trimmed)
10.2 Weather charts (Trimmed)
10.3 Information for flight planning (Trimmed)
10.4 METAR / TAF(Trimmed)

# GENERAL NAVIGATION

## 1. BASICS OF NAVIGATION

### 1.1 THE SOLAR SYSTEM (TRIMMED)

### 1.2 THE EARTH (TRIMMED)

### 1.3 GREAT CIRCLE TRACK – RHUMB LINE (TRIMMED)

### 1.4 TIME

**Sidereal day**: The time between two successive transit of a celestial body over the same meridian.
A constant duration of 23h 56m 4.1s.

**Solar day**: The time between two successive transits of the real Sun over the same meridian.

**Mean day**: 24h, 15°/h.

**Solar day lasts longer than Sideral day** because both the direction of rotation of the Earth around its axis and its orbital rotation around the sun are the same.

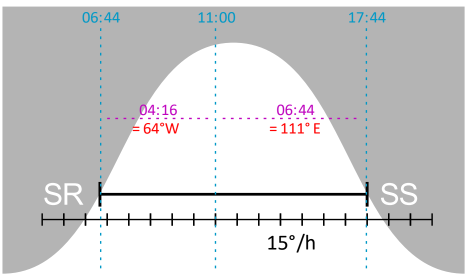
**Standard time** is determined by the government, does not necessarily follow the borders of 15° longitude zone.

**Civil twilight:**

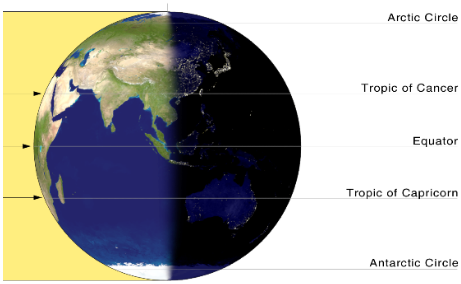
- **Morning** begins when the centre of the Sun is 6° below the celestial horizon.
- **Duration** is the time between sunset and when the Sun is 6° below the true horizon.

Standard Time ≠ Local Mean Time

Sunrise/Sunset




Equinox




Close to the **equinoxes** the influence of latitude on the duration of daylight is at smallest.

International day line

| ←←← Flying West | Flying Est →→→ |
|---|---|
| +1 on calendar | -1 day on calendar |
| You lose a day | You gain a day |

$$NM \times TAS = NAM \times GS$$

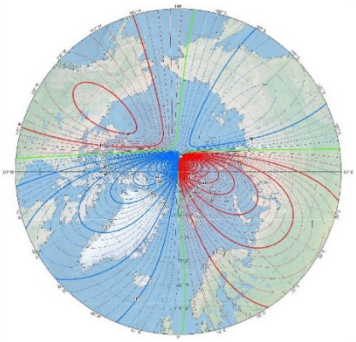
$$NM \times TAS = NAM \times (TAS - HWC)$$

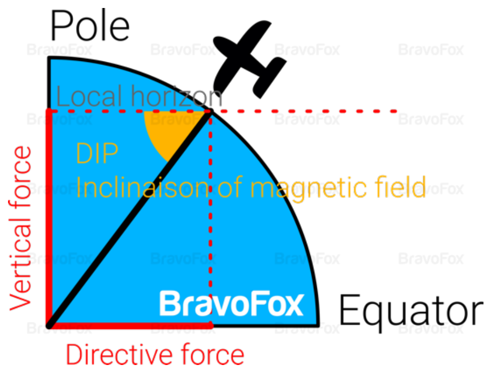
$NM: NM\ distance$

$NAM: Nautical\ Air\ Miles$

$HWC: HeadWind\ Component$

## 1.5 Directions






$$\textbf{Magnetic variation} = True\ North - Magnetic\ North$$

**Magnetic North Pole** rotate around the geographic North Pole at a rate of approximately 1° in 5years.

**Isogonals** (isogonic lines)

- Are lines of equal magnetic variation.
- Converge at magnetics poles and geographic poles.

**Agonic line:**

- 0 Variation.
- Follows separate paths out of the North polar regions, one currently running through western Europe and the other through the USA.

**Aclinic line**:

- The line of zero magnetic dip.
- Magnetic equator.

*Tips*

*A: 0*
*ISO: Equal*
*GO: Variation*
*CLIN: Dip*

*A-GO-nic = 0 variation*
*ISO-CLIN-ic = Equal Dip*
*A-CLIN-in = 0 Dip*

**Isogrives**: Same grivation.

**The blue pole** of the Earth magnetic field is situated in North Canada.

*(The compass needle seeking north is red)*

| CH | + | DEV | = | MH | + | VAR | = | TH | - | CONV | = | GH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 220° | | 5°W | | 215° | | 10°E | | 225° | | 180° | | 45° |
| 220 | + | (-)5 | = | 215 | + | (+)10 | = | 225 | - | 180 | = | 45 |

**CH**: Compass Heading
**DEV**: Deviation
**MH**: Magnetic Heading
**VAR**: Variation
**TH**: True Heading
**CONV**: Convergence
**GH**: Grid Heading

**North Hemisphere**

- Position East => CONV West
- Position West => CONV East
- TH – CONV = GH

**South Hemisphere**

- Position East => Convergence East
- Position West => Convergence West

- TH + CONV = GH

### 1.6 DISTANCE (TRIMMED)

## 2. MAGNETISM AND COMPASSES (TRIMMED)

## 3. CHARTS

### 3.1 GENERAL PROPERTIES (TRIMMED)

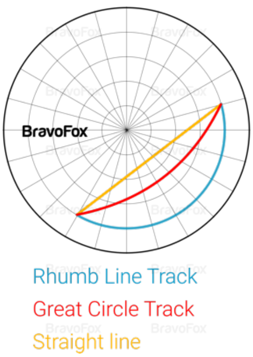
#### 3.1.1 LAMBER CONFORMAL CONIC CHART (TRIMMED)

#### 3.1.2 POLAR STEREOGRAPHIC CHART (TRIMMED)

#### 3.1.3 DIRECT MERCATOR CHART (TRIMMED)

### 3.2 REPRESENTATION

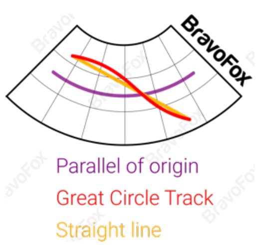
#### 3.2.1 POLAR STEREOGRAPHIC




**Great circles** are curves concave to the pole.

**Parallels of latitude** are circles around the pole.

#### 3.2.2 LAMBERT CONFORMAL CONIC CHART




**Great circles that are not meridians** are curves concave to the parallel of origin.

**A straight line on a Lambert** conformal projection chart is approximately a great circle.

#### 3.2.3 DIRECT MERCATOR CHART (TRIMMED)

# 4. DEAD RECKONING NAVIGATION

The **accuracy of manually calculated DR-position** of an aircraft is, among other affected by:
Flight time since last position update. The accuracy of the forecasted wind.

## 4.1 BASIS

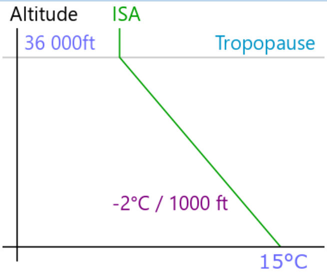
$$\frac{AD}{TAS} = \frac{GD}{GS}$$

**AD**: Air Distance
**TAS**: True Air Speed
**GD**: Ground Distance
**GS**: Ground Speed

$$MH + RB = MB$$

**MH**: Magnetic Heading
**RB**: Relative Bearing
**MB**: Magnetic Bearing

### 4.1.1 TYPICAL ATMOSPHERE



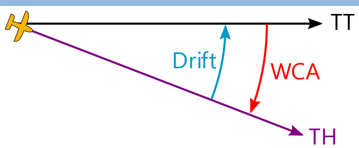

### 4.1.2 MACH NUMBER

$$M_{Number} = TAS/LSS$$

$$LSS = 38.95 \times \sqrt{K°}$$

$$K° = C° + 273$$

## 4.2 WCA – DRIFT




$$TT = TH + Drift$$

$$TT = TH - WCA$$

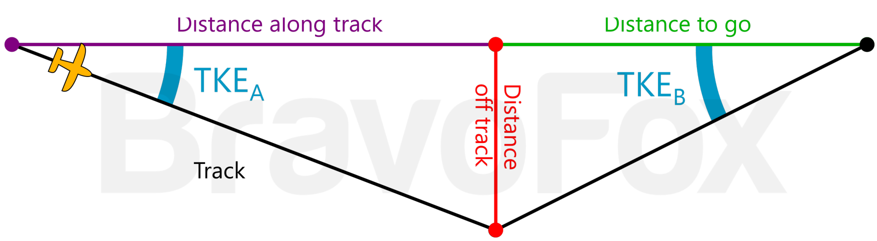
$$WCA = -Drift$$

$$WCA = (60/TAS) \times Crosswind$$

**HWC**: Head Wind Component
**XWC**: Cross Wind Component
**TT**: True Track
**TH**: True Heading
**WCA**: Wind Correction Angle

## 4.3 TRIANGLE OF VELOCITIES

*I strongly recommend to buy the CRP5-W flight computer and learn how to use it. Instead of the classic CRP5, the CRP5-W will save you a lot of time for all triangle of velocities questions.*




$$TKE_A = (distance\ off\ track \times 60) \div distance\ along\ track$$

$$TKE_B = (distance\ off\ track \times 60) \div distance\ to\ go$$

## 4.4 NAVIGATION COMPUTER

### 4.4.1 CRP5 TAS-CAS CONVERSION

1. Align **AIRSPEED** window for Altitude/°C situation
2. Outside scale = TAS
3. Inside scale = CAS

### 4.4.2 CRP5 DETERMINE TAS WITH COMPRESSIBILITY

1. Align **COMPRESSIBILITY** window for compressibility factor
2. Outside scale = TAS with compressibility
3. Inside scale = TAS without compressibility

### 4.4.3 CRP5 DETERMINE MACH NUMBER WITH TAS/°C

1. Align **AIRSPEED** window "Mach No Index" for °C situation
2. Outside scale = TAS
3. Inside scale = Mach number

## 4.5 TRUE ALTITUDE CALCULATION (TRIMMED)

### 4.5.1 CRP5 TRUE ALTITUDE DETERMINATION

1. Align **ALTITUDE** window for Press Alt/°C situation
2. Outside scale = True altitude
3. Inside scale = Indicated altitude

## 4.6 DENSITY ALTITUDE CALCULATION

$DA = PA + (118{,}8ft \times ISA\ Deviation)$

### 4.6.1 CRP5 DENSITY ALTITUDE DETERMINATION

1. Align **AIRSPEED** window for Altitude/°C situation
2. Density altitude in **DENSITY ALTITUDE** window

## 4.7 SPEEDS

**Instrument** ⇘ Position ⇗ **Calibrated** ⇘ Compressibility ⇗ **Equivalent** ⇘ Density ⇗ **True**

*Tips:*

*ICET – Ice Tea*

*PCD – Pretty Cold Drink*

# 5. IN-FLIGHT NAVIGATION

## 5.1 VISUAL OBSERVATION (TRIMMED)

## 5.2 CLIMB AND DESCEND (TRIMMED)

# 6. ICAO CHARTS SYMBOLS

# RADIO NAVIGATION

## 1. BASIC RADIO PROPAGATION THEORY

### 1.1 BASIC PRINCIPLES

$$\lambda = \frac{1}{f} \times c$$

$\lambda$: *Wavelength* (m)

$f$: *Frequency* (Hz)

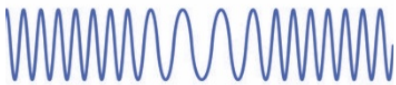
$c$: *Propagation speed* (300 000 000 m/s) (*light speed*)

Modulation:

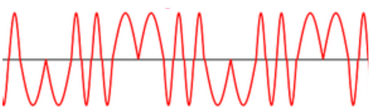
- Addition of a low frequency signal (voice/tone) onto high frequency carrier wave.
- Addition of information onto a radio wave during transmission.

Keying: Interrupting the carrier wave to break into dots and dashes. (Morse code)

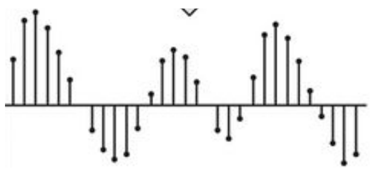
Amplitude modulation



Frequency modulation



Phase modulation



Pulse modulation

Phase: Fraction of one wavelength express in degrees from 000° to 360°.

Phase difference: Angular difference (in degrees).

GPS: Phase modulation

Radar: Pulse modulation

**SSB: Single-sideband modulation** used for HF Volmet and HF two-way communication *(SSB=HF+HF)*

- Modulation technique where only one sideband is transmitted

| | |
|---|---|
| VLF | 3 kHz – 30 kHz |
| LF | 30 kHz – 300 kHz |
| MF | 300 kHz – 3 MHz |
| HF | 3 MHz – 30 MHz |
| VHF | 30 MHz – 300 MHz |
| UHF | 300 MHz – 3 GHz |
| SHF | 3 GHz – 30 GHz |
| EHF | 30 GHz – 300 GHz |

*(Tips: Very Little Man Have Very Unusual Sex Experiences)*

ITU radio signal classification symbols (e.g. A1A, N0N, A3E)

| | |
|---|---|
| 1 | Type of modulation |
| 2 | Nature of the modulation |
| 3 | Type of information |

ITU: International Telecommunication Union
*(Tips: TNT)*

### 1.2 ANTENNAS (TRIMMED)

### 1.3 WAVE PROPAGATION (TRIMMED)

## 2. RADIO AIDS

### 2.1 GROUND DF

**DF**: Direction Finding.

**VDF**: VHF Direction Finding.

**VDF measures the bearing of the aircraft** with reference to true or magnetic north at the station.

It provides homing service to aircraft.

It only requires a VHF radio to be fitted to the aircraft.

**VHF direction finder** uses metric wavelengths.

Use VHF for civil aerodromes and UHF for military aerodromes.

**Range** depends on aircraft altitude, ground transmitter elevation, power of airborne transmitter and power of ground transmitter.

$$D(NM) = 1.23 \times \sqrt{transmitter\ height\ (ft)} + 1.23 \times \sqrt{receiver\ height\ (ft)}$$

| Bearing | Classification |
| --- | --- |

**Bearing**

| | Station | |
| --- | --- | --- |
| | From | To |
| Magnetic | QDR | QDM |
| True | QTE | QUJ |

*(Tips: **R**eal **M**en **E**at **J**elly)*

**Classification**

| Class | Accuracy |
| --- | --- |
| A | ± 2° |
| B | ± 5° |
| C | ± 10° |
| D | More than 10° |

**Multipath signals** may result in bearing errors.

**VDF is likely to be used to fix an aircraft's position** when using the emergency frequency 121.5 MHz.

### 2.2 NDB/ADF – NON-DIRECTIONAL BEACON/AUTOMATIC DIRECTION FINDER (TRIMMED)

## 2.3 VOR AND DOPPLER VOR

**VOR transmit** in VHF.

**CVOR (Conventional VOR)**: Two signals emitted, an FM reference signal and an AM variable signal.

**DVOR (Doppler VOR)**: Opposite of CVOR, doppler effect is used to create a signal which is received by the aircraft's VOR-receiver as a frequency modulated signal. Large antenna compared to CVOR.

**TVOR**: VOR with a limited range used in the terminal area.

**VOT**: a test VOR.

**Radial is determined by** phase difference between the variable signal and the reference signal.

**Radial** is the magnetic bearing from the VOR station. *(great circle)*

<table>
<tr><td rowspan="4">Aircrafts</td><td rowspan="2">at</td><td colspan="2">same distance have equal</td><td rowspan="2">reference signal</td></tr>
<tr><td colspan="2">different distance have unequal</td></tr>
<tr><td rowspan="2">on</td><td>same</td><td colspan="2" rowspan="2">radial have unequal variable signal</td></tr>
<tr><td>different</td></tr>
</table>

| | |
|---|---|
| 108-111.975 MHz | **Terminal VOR** and **ILS** |
| 112-117.975 MHz | **En-route VORs** |
| 118-136 MHz | Communications |

*Tips:*
*08-12: E.**T** Child Movie (Terminal)*
*12-18: En route with friends*
*+18: Adult communications*

**Transmission from VOR may be adversely affected** by scalloping.

**Scalloping** is caused by uneven propagation over irregular ground surfaces ⇒ Signal reflection

**Scalloping** cause short/oscillatory deviation of the indicated course.

**VOR transmitter monitoring system**: Failure of the VOR station to stay within required limits can cause removal of identification and the navigation components from the carrier wave to cease.
*(if the VOR is malfunctioning, it shut down)*

For **VOR apply magnetic variation** at beacon position.

**VOR airborne equipment** are: receiver, antenna (dipole), display

**HSI**: Horizontal Situation Indicator. FROM/TO point in direction of the VOR.

**CDI**: Course Deviation Indicator. FROM/TO show if the course selected go TO the VOR or not.

**RMI**: Radio Magnetic Indicator. Point the station (radial+180°).

**CDI/HSI full-scale deflection** = 10°.

**An aircraft is considered established** within half full scale deflection for ILS and VOR.

2.4 DME – DISTANCE MEASURING EQUIPEMENT (TRIMMED)
2.5 ILS – INSTRUMENT LANDING SYSTEM (TRIMMED)
2.5.1 LOCALIZER (TRIMMED)
2.5.2 GLIDE SLOPE (TRIMMED)
2.5.3 ILS MARKER (TRIMMED)
2.5.4 HSI – CDI (TRIMMED)
2.5.5 ILS BACK-BEAM (TRIMMED)
2.5.6 ILS PRECISION APPROACH (TRIMMED)
2.5.7 MISCELLANEOUS (TRIMMED)
2.6 MLS – MICROWAVE LANDING SYSTEM (TRIMMED)

3. RADAR
3.1 PULSE TECHNIQUE AND ASSOCIATED TERMS (TRIMMED)
3.2 GROUND RADAR (TRIMMED)
3.3 AWR: AIRBORNE WEATHER RADAR (TRIMMED)

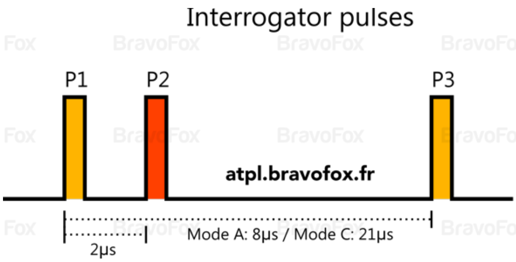
## 3.4 SSR – SECONDARY SURVEILLANCE RADAR AND TRANSPONDER

**Elementary surveillance provides ATC** controller with: aircraft's position, altitude and identification.

**SSR ground transmission:** 1030 MHz – **Aircraft transmission**: 1090MHz

**SSR provide** 4096 different codes. **When selecting a code** set transponder on "STBY". *(old way)*

**Mode S**: 24-bit identifier (16 million combinations)





**P2 function**: To avoid transponder response when the aircraft is on the side lobe.

**Receive a P2 which amplitude < than P1/P3**, aircraft is located in the main lobe of the interrogator.

**Receive a P2 which amplitude > than P1/P3**, aircraft is located in the side lobe of the interrogator.

**Interrogation intermode A/C** ⇒ P1, P2, P3, short P4.

**Interrogation intermode A/C/S** ⇒ P1, P2, P3, long P4. *(also called Mode S "all call", all reply)*

**Interrogation mode S "broadcast"/only** ⇒ P1, P2, P6. *(only mode S transponder will reply)*

**SSR display screen:**

- **Is free of storm clutter** because echo return is not used in SSR.
- Flight level, airplane callsign, ground speed, squawk code *(F.A.G.S)*

**IDENT:** Aircraft send a SPI (Special Position Identification) after the normal response pulse train. **The airplane's symbol** will flash or "fill in" on the controller's display.

**Garbling**: At the ground station when mode A/C replies of two different aircraft overlap.

**Fruiting**: Ground station receive a reply from an aircraft responding to another ground station.

*Garbling: 2 aircraft – Fruiting: 2 ground station.*

*Garbling: Perturbation*

*Fruiting: A ground station get a "free" aircraft without interrogating (receive a "free" response)*

| Mode | Response |
|---|---|
| A | Squawk code |
| C | +Altitude (/100ft) |
| S | +Data* |

*: no EAS, no pitch, no OAT

Data:

- Heading (MH + TH)
- Altitude (QNH + Selected + VS)
- Speed (GS + TAS + Mach)
- Track angle rate + Roll rate

| Code | Situation |
|---|---|
| 7500 | Unlawful interference |
| 7600 | Radio failure |
| 7700 | Civil emergency |

# 4. AREA NAVIGATION SYSTEMS AND RNAV OR FMS

## 4.1 TIME ABBREVIATIONS (TRIMMED)

## 4.2 DEFINITIONS (TRIMMED)

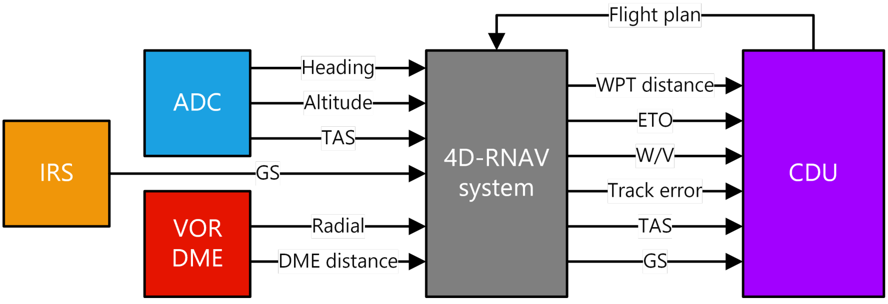
## 4.3 2D RNAV (TRIMMED)

## 4.4 4D RNAV

**ADC**: Air Data Computer

**INS/IRS**: Inertial Navigation/Reference System. A self-contained RNAV equipment, computing position without external signal.

**CDU**: Control and Display Unit




**W/V computed** by FMC **from** IRS+ADC.

**With 4D-RNAV system, XTK-distance** on CDU/Navigation display.

**4D-RNAV system** has its own NAV tuner and the system itself tunes the DME stations providing the most accurate position.

**Typical 4D-RNAV system**:

- Has "direct to" to any waypoint.
- Is capable of parallel off-set tracking.

**Dead Reckoning** is a backup navigation mode:

- **When signal from VOR/DME is lost**, RNAV equipment switch into DR mode
- **Computing position from**: TAS + heading + the last computed W/V.

*Rho = Range > Referring to DME*

*Theta = Angle/track > Referring to VOR*

## 4.5 FMS – FLIGHT MANAGEMENT SYSTEM (TRIMMED)

## 4.6 TYPICAL FLIGHT DECK EQUIPMENT (TRIMMED)

# 5. GNSS

## 5.1 GPS / GLONASS / GALILEO

**SV**: Space Vehicle

**GPS**: Global Positioning System

**GLONASS**: GLObalnaïa NAvigatsionnaïa Spoutnikovaïa Sistéma

**RAIM**: Receiver Autonomous Integrity Monitoring (receiver checks reliability of receiving signal)

| | NAVSTAR GPS | GLONASS | GALILEO |
|---|---|---|---|
| SV | 24 (4/plane) | 24 | 30 |
| Orbital plane | 6 | 3 | 3 |
| SV/orbital plane | 4 | 8 | 9+1 spare |
| Orbital height | 10 900 NM / 20 200 km | 19 100 km | 23 222 km |
| Orbital inclination | 55° to the equator | 65° to the equator | 56° to the equator |
| Orbital period | 11h58, ½ sideral day | 11h15 | 14h |
| Frequencies<br>*(All are UHF)* | L1: 1 575 MHz<br>L2: 1 227 MHz | L1: 1 602 MHz<br>L2: 1 246 MHz | 1 164 – 1 215 MHz<br>1 260 – 1 300 MHz<br>1 559 – 1 591 MHz |
| Coordinate sys. | WGS 84 | PZ-90 | |
| Nb. atomic clock | 4 | | 2 |

**Inclination:** angle between orbital plane and equatorial plane.

**All three systems** use time measurement to determine position.

**Most accurate position fixes** from NAVSTAR GPS and GLONASS. (same principle)

**GPS, EGNOS and GALILEO are compatible**, will not interfere with each other, and the performance of the receiver will be enhanced by the **interoperability** of the systems.

Multichannel receiver is the **most suitable for use on board an aircraft**.

NAVSTAR GPS is **approved for specified flights under IFR** conditions in Europe.

**Satellites transmit** SV time.

**Dilution precision** arises from the number of satellites in view and geometry.

**WGS 84 geometric reference shape**: ellipsoid.

### 5.1.1 NAVSTAR GPS (TRIMMED)

### 5.1.2 GALILEO (TRIMMED)

5.2 GROUND, SATELLITE AND AIRBORNE BASED AUGMENTATION SYSTEMS (TRIMMED)
5.2.1 ABAS – AIRBORNE BASED AUGMENTATION SYSTEM (TRIMMED)
5.2.2 GBAS – GROUND BASED AUGMENTATION SYSTEM (TRIMMED)
5.2.3 SBAS – SATELLITE-BASED AUGMENTATION SYSTEM (TRIMMED)

# 6. PBN – PERFORMANCE BASED NAVIGATION

6.1 CONCEPT (TRIMMED)
6.2 USE OF PBN (TRIMMED)
6.3 NAVIGATION SPECIFICATIONS (TRIMMED)
6.4 PBN OPERATIONS (TRIMMED)
6.5 REQUIREMENT OF SPECIFIC RNAV AND RNP SPECIFICATIONS (TRIMMED)

# OPERATIONAL PROCEDURES

## 1. EASA REGULATION STRUCTURE (TRIMMED)

## 2. GENERAL REQUIREMENTS (TRIMMED)

## 3. AIRCRAFT EQUIPMENT

### 3.1 FLIGHT DECK

**No time piece fitted in the aircraft** ⇒ At least 1 time piece carried by the flight crew.

**Time piece**/watch does not need EASA approval.

Needed to operate in **RVSM airspace**:

- 2 independent altimeters
- altitude alerting system (+/- 300ft)
- automatic altitude control
- SSR mode C (report altitude)

**Require for CAT**:

- SSR Transponder
- 2 radios
- 2 nav sys.
- audio selector for each flight crew station
- headset for each crew member.

**SPIC IFR or Night:** Aircraft has to be fitted with a 2-axis autopilot (heading/altitude).

**MTOW +5700kg:**

- FDR
- CVR

**MTOW +5700kg or +9 pax seats:**

- Windshield wiper needed
- **Altitude alerting system** alerting for deviating from preselected altitude is required
- **Electrical backup power supply** to the backup instruments **for at least 30 minutes**

**+19pax seats**:

- A **locked door** between the passengers and flight deck to prevent passengers from opening it without permission.

**MTOW +5700kg or +19 pax seats:**

- ACAS
- Public address system

**MTOW +15000kg or +19pax seats:**

- Crew member interphone

### 3.2 AIRBORNE WEATHER RADAR (TRIMMED)

### 3.3 FLIGHT DATA RECORDER (TRIMMED)

### 3.4 COCKPIT VOICE RECORDER (TRIMMED)

### 3.5 IFR (TRIMMED)

### 3.6 FOR A VFR FLIGHT DURING DAY USING VISUAL LANDMARK (TRIMMED)

### 3.7 LIGHTS (TRIMMED)

### 3.8 EMERGENCY LOCATOR TRANSMITTER (TRIMMED)

### 3.9 SEAT BELT (TRIMMED)

## 3.10 OXYGEN

**Supplemental oxygen**: Oxygen supplied to the aeroplane occupants in case of cabin pressurization failure.

<table>
<tr><th rowspan="2">Altitude</th><th colspan="3">Pressurized</th><th colspan="3">Non-pressurized</th><th rowspan="2">Altitude</th></tr>
<tr><th>Flight crew</th><th>Cabin crew</th><th>Pax</th><th>Flight crew</th><th>Cabin crew</th><th>Pax</th></tr>
<tr><td>25 000ft</td><td>Not less than 2h</td><td rowspan="4">Not less than 30min</td><td rowspan="2">100% of pax<br>Not less than 10min</td><td rowspan="5">All time</td><td rowspan="4">All time</td><td rowspan="4">100% of pax</td><td>25 000ft</td></tr>
<tr><td>15 000ft</td><td rowspan="3">Not less than 30min</td><td>15 000ft</td></tr>
<tr><td>14 000ft</td><td>30% of pax</td><td>14 000ft</td></tr>
<tr><td>13 000ft</td><td rowspan="2">After 30min<br>10% of pax</td><td>13 000ft</td></tr>
<tr><td>10 000ft</td><td colspan="2">After 30min<br>flying time oxygen</td><td>After 30min<br>flying time oxygen</td><td>After 30min<br>10% of pax</td><td>10 000ft</td></tr>
</table>

**Flight crew:** check oxygen before taxi.

**Cabin crew:** oxygen demonstration before take-off.

**Pressurized aircraft** must be equipped with a **warning system** indicating that the cabin altitude is higher than 3000m (10000ft).

**Cabin oxygen masks** must drop out before the cabin altitude reach 15000ft.

**Above 25 000ft**:

- oxygen mask/inhaler for 110% of seating capacity
- quick donning mask mandatory.

**Above FL410:** one pilot must wear an oxygen mask.

**PBE – Portable Breathing Equipment** are for crew, they protect eyes, nose, mouth and should provide oxygen for a period of at least 15 minutes.

**First aid oxygen/100% medical oxygen:**

- Aircraft shall be equipped if operated above 25 000ft
- Provide 100% oxygen
- For physiological reasons following a cabin depressurisation/when required
- **In use**: no smoking, avoid sparks, operate oxygen system shut off valves slowly.
- Mass flow of **4 litres SPDT** to each user
- Must be sufficient for 2% of effectively pax when cabin pressure +8000ft

**No smoking signs** active when oxygen is being supplied in the cabin.

### 3.11 EXTINGUISHERS (TRIMMED)
### 3.12 EMERGENCY EXIT (TRIMMED)
### 3.13 EVACUATION SLIDE (TRIMMED)
### 3.14 LIFE BOAT/LIFE JACKET (TRIMMED)
### 3.15 MEGAPHONE (TRIMMED)
### 3.16 FIRST AID KIT (TRIMMED)
### 3.17 OTHER EQUIPMENT (TRIMMED)

## 4. CREW
### 4.1 FLIGHT TRAINING (TRIMMED)
### 4.2 OPERATOR PROFICIENCY CHECK (TRIMMED)
### 4.3 RECENT EXPERIENCE (TRIMMED)
### 4.4 TIME

02:00-04:59 = **Night duty**. (in the time zone to which the crew is acclimatised)

02:00-05:59 = **Window of circadian low**

### 4.5 FLIGHT DUTY PERIOD

At least 10h of rest shall be provided to a crewmember before the flight duty when he starts **away from his home base**.

Maximum daily FDP is 13h **can be extended** by 1 hour.

- **Unforeseen circumstances/Captain's discretion**: 2 hours.
- **Augmented crew**: 3 hours.

| Maximum duty hours | | | |
|---|---|---|---|
| Period | 7 days | 14 days | 28 days |
| hours | 60 | 110 | 190 |

*Trick: around 8h/day*

### 4.6 FLIGHT HOUR PERIOD

| Maximum flight hours | | | |
|---|---|---|---|
| Period | 28 days | 1 year | 12 consecutive months |
| Hours | 100 | 900 | 1000 |

### 4.7 STANDBY TIME (TRIMMED)
### 4.8 IFR OR NIGHT CAT (TRIMMED)
### 4.9 RULES VIOLATIONS (TRIMMED)

# 5. PLANNING MINIMA

## 5.1 TAKE-OFF ALTERNATE (TRIMMED)

## 5.2 DESTINATION (TRIMMED)

## 5.3 DESTINATION ALTERNATE (TRIMMED)

## 5.4 ETOPS (TRIMMED)

# 6. OPERATIONS

## 6.1 DEPARTURE/CONTINUE CONDITIONS (TRIMMED)

## 6.2 MINIMUM RVR FOR TAKE-OFF (TRIMMED)

## 6.3 MINIMUM OBSTACLE CLEARANCE (TRIMMED)

## 6.4 RNP REQUIREMENT (TRIMMED)

## 6.5 SEARCH AND RESCUE (TRIMMED)

## 6.6 FUEL (TRIMMED)

## 6.7 LVO: LOW VISIBILITY OPERATION (TRIMMED)

## 6.8 VISUAL APPROACH (TRIMMED)

# 7. APPROACH

**MDH** is referred to the runway threshold and not runway elevation if threshold elevation is more than 2m/7ft under aerodrome elevation.

## 7.1 LDA SAFETY FACTOR / LANDING DISTANCE AVAILABLE SAFETY FACTOR

**Turbo-jet:** 0.6 – **Turbo-prop:** 0.7

## 7.2 RVR

**RVR is reported** when if falls below 1 500ft.

**Minimum RVR for visual approach** = 800m.

**If RVR is less than applicable minima**, approach shall not be continued beyond 1000ft above the aerodrome.

## 7.3 NON PRECISION

**Indirect approach followed by visual manoeuvre/circling**

| Aeroplane Category | A | B | C | D |
|---|---|---|---|---|
| MDH | 400ft | 500ft | 600ft | 700ft |
| RVR | 1500m | 1600m | 2400m | 3600m |

*A / B / C / D*
*4 / 5 / 6 / 7*

**Planning minima** ⇒ Ceiling considered

**Operating minima** ⇒ Ceiling not considered

**MDH cannot be lower than** OCH.

## 7.4 PRECISION

| Category | RVR | DH | Requirements |
|---|---|---|---|
| CAT I | ≥550m | ≥200ft/60m | |
| CAT II | ≥300m | ≥100ft/30m | DH determined by radio altimeter<br><br>At least two pilots<br><br>Callouts <200ft by Radio altimeter |
| CAT IIIA | ≥200m | <100ft/30m or no DH | |
| CAT IIIB | **fail passive** – 125m<br>**fail-operational** – 75m | <50ft/15m or no DH | |
| CAT IIIC | No RVR requirement | No DH | |

## 7.5 MINIMA

The **basic minima** are established by aerodrome state.

**Commercial purposes** = The operator establish minima.

**Minimum flight altitude**: are **established** by operator, are **approved** by competent authority.

## 7.6 SYSTEM MINIMA

| Facility | Lowest DH/MDH |
|---|---|
| ILS / MLS / GLS<br>GNSS / SBAS (LPV) | 200ft |
| GNSS (LNAV)<br>GNSS / Baro-VNAV (LNAV/VNAV)<br>LOC without DME<br>ILS without glideslope<br>VOR / DME<br>SRA ½ NM | 250ft |
| VOR<br>NDB / DME<br>SRA 1 NM | 300ft |
| NDB<br>VDF<br>SRA 2 NM | 350ft |

# 8. AIR LAW

## 8.1 AIRCRAFT CATEGORIES

Speed at threshold $V_{AT}$ = 1.3$V_{SO}$ or 1.23$V_{S1G}$

| Aircraft category | Initial Approach Speed range | Final Approach Speed range | $V_{AT}$ | Max Speed for departure | Max Speed for Visual Circling |
|---|---|---|---|---|---|
| A | 90/150 | 70/100 | ≤90kt | 120kt | 100 |
| B | 120/180 | 85/130 | >90 to ≤120kt | 165kt | 135 |
| C | 160/240 | 115/160 | >120 to ≤140kt | 265kt | 180 |
| D | 185/250 | 130/185 | >140 to ≤165kt | 290kt | 205 |
| E | 185/250 | 155/230 | >165 to ≤210kt | 300kt | 240 |

## 8.2 AIRSPACES

<table>
<tr><th></th><th>Type of flight</th><th>Separation</th><th>Service Provided</th><th>Speed limitation*</th><th>Req. Radio</th><th>Req. Clearance</th></tr>
<tr><td>A</td><td>IFR</td><td>All</td><td>Air traffic control service</td><td></td><td>Yes</td><td>Yes</td></tr>
<tr><td rowspan="2">B</td><td>IFR</td><td rowspan="2">All</td><td rowspan="2">Air traffic control service</td><td rowspan="2"></td><td rowspan="2">Yes</td><td rowspan="2">Yes</td></tr>
<tr><td>VFR</td></tr>
<tr><td rowspan="2">C</td><td>IFR</td><td rowspan="2">All excluding VFR/VFR</td><td>Air traffic control service</td><td></td><td rowspan="2">Yes</td><td rowspan="2">Yes</td></tr>
<tr><td>VFR</td><td>Air traffic control service for separation from IFR<br>VFR/VFR traffic information service</td><td>Yes</td></tr>
<tr><td rowspan="2">D</td><td>IFR</td><td rowspan="2">IFR/IFR</td><td>Air traffic control service<br>Traffic information about VFR as far as practical</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td><td rowspan="2">Yes</td></tr>
<tr><td>VFR</td><td>IFR/VFR and VFR/VFR traffic information</td></tr>
<tr><td rowspan="2">E</td><td>IFR</td><td rowspan="2">IFR/IFR</td><td>Air traffic control service<br>Traffic information about VFR as far as practical</td><td rowspan="2">Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>VFR</td><td>Traffic information as far as practical</td><td></td><td></td></tr>
<tr><td rowspan="2">F</td><td>IFR</td><td rowspan="2">IFR/IFR as far as practical</td><td>Air traffic advisory service<br>Flight information service</td><td rowspan="2">Yes</td><td>Yes</td><td rowspan="2"></td></tr>
<tr><td>VFR</td><td>Flight information service</td><td></td></tr>
<tr><td rowspan="2">G</td><td>IFR</td><td rowspan="2"></td><td rowspan="2">Flight information service</td><td rowspan="2">Yes</td><td>Yes</td><td rowspan="2"></td></tr>
<tr><td>VFR</td><td></td></tr>
</table>

*250kt IAS below 10 000ft AMSL. When the height of the transition altitude is lower than 10 000 ft AMSL, FL100 should be used.

# 9. ADMINISTRATIVE PROCESS

## 9.1 THE OPERATOR (TRIMMED)

## 9.2 AOC (TRIMMED)

## 9.3 OPERATIONS MANUAL (TRIMMED)

## 9.4 MANAGEMENT SYSTEM (TRIMMED)

## 9.5 SAFETY MANAGER (TRIMMED)

## 9.6 CARGO LOAD (TRIMMED)

## 9.7 SUBCONTRACTOR (TRIMMED)

## 9.8 LEASE (TRIMMED)

## 9.9 DANGEROUS GOOD ACCIDENT/INCIDENT (TRIMMED)

## 9.10 COPY/DOCUMENTS KEPT ON GROUND (TRIMMED)

## 9.11 ACCIDENT (TRIMMED)

# 10. LONG RANGE FLIGHT

## 10.1 ETOPS (TRIMMED)

## 10.2 PRECESSION (TRIMMED)

## 10.3 DISTANCE CALCULATION (TRIMMED)

## 10.4 OCEANIC AIRSPACE (TRIMMED)

## 10.5 NAT REGION (TRIMMED)

## 10.6 NAT HLA OTS REGION

**HLA** – High Level Airspace

**OTS** – Organised Track System

**Is based on 030W meridian:**

- **11:30 – 19:00 UTC** ⇒ Day Time ⇒ Westbound flight
- **01:00 – 08:00 UTC** ⇒ Night Time ⇒ Eastbound flight

**Inform ATS if ETA for the next position** has change by <u>3 minutes or more</u>.

**OTS in flight plan:** <u>abbreviation NAT followed by the code letter</u> assigned to the track.

**Polar track**: Horizontal component of earth magnetic field is <u>less than 6μ Tesla</u>.

⇒ Magnetic compass unreliable. ⇒ **Position report:**

- **Above 70°N**: latitude in degrees, longitude spaced at 20°.
- **Under 70°N**: latitude in degrees, longitude spaced at 10°.

## 10.7 ROUTES T9, T13 & T16

- Are North-South directions.
- Are routes <u>between Northern Europe and Spain/Canaries/Lisbon FIR</u>.

## 10.8 MNPS AIRSPACE

**MNPS** – Minimum Navigation Performance Specification

- **From** 27N° to 90N°
- **Extend vertically** from FL285 to FL420
- **Reference speed:** Mach number
- **Vertical separation** = RVSM Separation ⇒ 1000ft
  **Diversion needed**: Above FL410 ⇒ +/-1000ft
  At FL410 ⇒ -500ft/+1000ft
  Below FL410 ⇒ +/-500ft
- **Lateral separation**: 60NM
- **Longitudinal separation**: 5min if preceding is faster
  10min same speed
- **Leaving airspace**: maintain last declared Mach number from MNPS
- **121.5MHz**: Continuously monitored.
  If fail ⇒ 123.45MHz: Air-to-air comm, May relay position, recommended to be monitored.
- **Diversion needed:** (1) 15NM Offset track (2) climb or descend (3) Divert
- **Radio failure:** Continue in compliance with last oceanic clearance acknowledge.
- **Special routes in MNPS:** Need 1 LRNS (Long Range Navigation System) (Only T9 if 1 LRNS)
- **No restriction** if equipped with 2 LRNS. (Include T13 & T16)
- **NAR Routes:** Routes between NAT Oceanic and North American domestic airspace.

**Deviation around severe weather,** at approximately 10NM of track climb or descend as followed:

| | | |
|---|---|---|
| North | Descend 300ft | |
| | ⇐ Westbound | Eastbound ⇒ |
| South | Climb 300ft | |

## 10.9 COMPASS AND GRID (TRIMMED)

# 11. SPECIAL OPERATIONAL PROCEDURES

## 11.1 OPERATIONS MANUAL (TRIMMED)

## 11.2 ICING CONDITION (TRIMMED)

## 11.3 BIRD STRIKE (TRIMMED)

## 11.4 NOISE ABATEMENT (TRIMMED)

## 11.5 WINDSHEAR/MICROBURST (TRIMMED)

## 11.6 WAKE TURBULENCE (TRIMMED)

## 11.7 UNLAWFUL EVENTS (TRIMMED)

## 11.8 EMERGENCY AND PRECAUTIONARY LANDINGS (TRIMMED)

## 11.9 DECOMPRESSION

| Altitude | Consciousness time | | |
|---|---|---|---|
| | Slow decompression | | Rapid decompression |
| | Seated | Active | |
| 40 000 | 25s | 18s | 12s |
| 35 000 | 45s | 30s | 20s |
| 30 000 | 1.5min | 45s | 30s |
| 25 000 | 5min | 3min | 2min |

**A warning must be triggered** if cabin altitude reaches 10 000ft/3000m.

**Cabin oxygen mask drop** at 15 000ft.

**Quick donning mask** mandatory for pressurized airplane operating at altitude above 25 000ft.

**Oxygen diluter-demand system** supply pure oxygen in normal mode at 32000ft.

Rapid depressurization:

- Loud bang
- Mist in cabin
- Temperature drops
- Pressure drops
- Violent rush of gas from lungs
- Expansion of body gases

Slow decompression may be cause by:

- A leak
- Malfunction of pressurised system

## 11.10 FIRE/SMOKE (TRIMMED)

## 11.11 FUEL JETTISON (TRIMMED)

## 11.12 CONTAMINATED RUNWAYS (TRIMMED)

### 11.12.1 HYDROPLANING (TRIMMED)

### 11.12.2 SNOWTAM (TRIMMED)

## 11.13 DANGEROUS GOODS

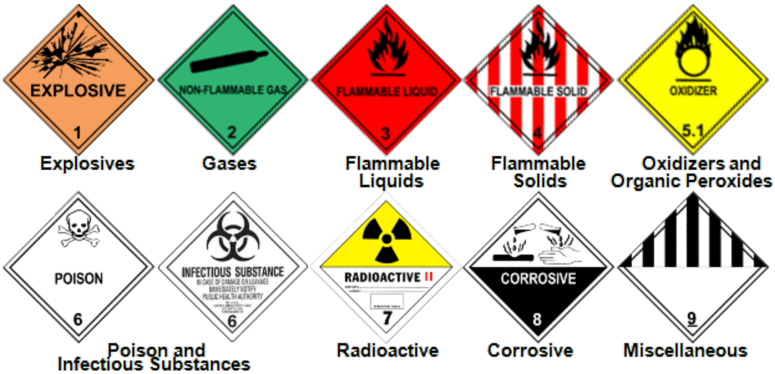
**ICAO Annex 18** is a document dealing with the safety of the air transport of dangerous goods.

**ICAO Doc 9284:** Technical Instructions (for the Safe Transport of Dangerous Goods by Air).

**UN number**: Is a four-digit number assigned by the **United Nations** Committee of Experts on the Transport of Dangerous goods to identify a substance or a particular group of substances.

**Dangerous goods transports document:**

- Shall be drawn up by the shipper
- In English and any other required language
- 2 Copies of **must be retained in the aircraft and on the ground**.




**Radioactive** ⇒ Regulated separation distances from packages of radioactive material to passengers on board.


**Some dangerous goods:**

- Can only be transported in cargo aircraft
- Are too dangerous to be transported on cargo or passenger aircraft

**A passenger is allowed to carry** matchboxes only on himself, avalanche rescue backpack.

**If undeclared dangerous goods are found in passenger or crew baggage,** the operator should submit a report to the competent authority without delay and to the corresponding authority of the state of occurrence.

**Are classified as dangerous goods:**

- Emergency oxygen supplies
- Fire extinguisher
- First-aid kits
- Portable oxygen supplies
- Self-inflating life jacket

Infected live animals **require an adequate authorization from the appropriate authority** to be carried.

**In case of accident involving dangerous goods**, the operator must report within 72 hours to authority.

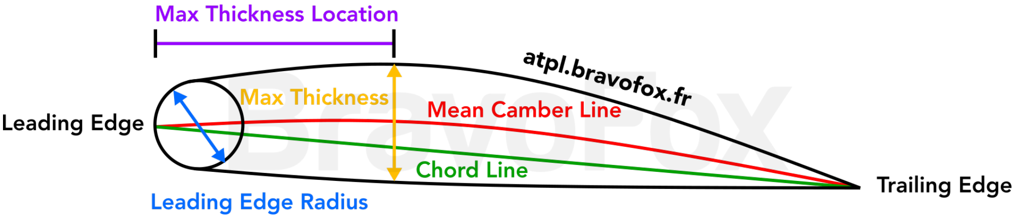
# PRINCIPLES OF FLIGHT

## 1. SUBSONIC AERODYNAMICS (TRIMMED)

### 1.1 BASICS, LAWS, DEFINITIONS (TRIMMED)

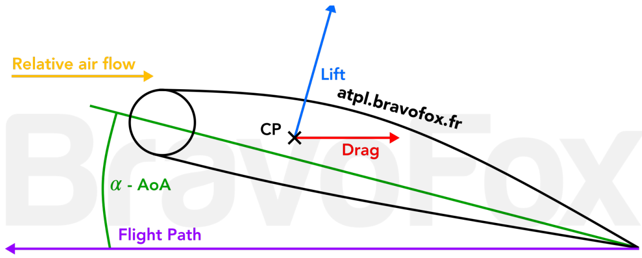
#### 1.1.1 BASIC CALCULATIONS (TRIMMED)

#### 1.1.2 WING

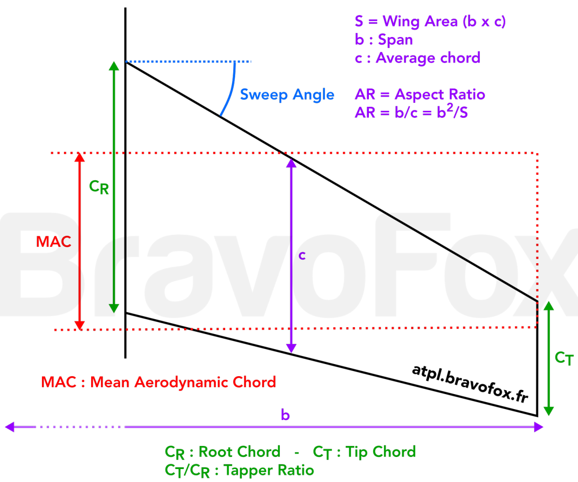



**Incidence**: Angle <u>between chord line and aeroplane longitudinal axis</u>.

**Maximum camber**: Maximum distance <u>between chord line and camber line</u>.




**Lift**: <u>Component of the total aerodynamic force</u>, <u>perpendicular to the undisturbed airflow.</u>




**Sweep angle**: Angle between <u>0.25 chord line of the wing and the lateral axis</u>.

**Dihedral angle**: Angle between <u>0.25 chord line of the wing and the lateral axis</u>.

**MAC**: The chord of an equivalent untwisted, rectangular wing with the same pitching moment and lift characteristics as the actual wing.

## 1.2 2D AIRFLOW

**Lift force** is mainly caused by reduced pressure on the upper side of the aerofoil.

**Lift** is generated when the flow direction is changed.

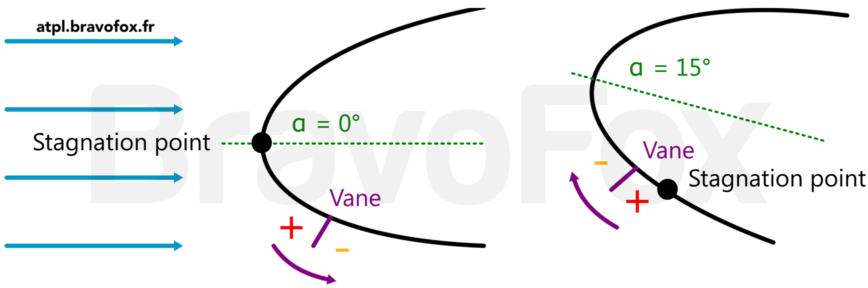
**Centre of pressure**:

- Is the point where the resultant aerodynamic force is applied.
- **Of a symmetrical aerofoil** is located at approximately 25% of the section chord behind the leading edge.
- Is independent of the angle of attack. (**if symmetrical aerofoil**)

**Aerodynamic centre of the wing** is the point where pitching moment coefficient does not vary with angle of attack.

**Stagnation point**:

- The point where the velocity of the relative airflow is reduced to zero.
- **Static pressure** reaches a maximum value.
- Icing is most likely to form on an area around the stagnation point.




**Streamlines converge** ⇒ Static pressure decrease & Velocity decrease.

Speed is pushing the streamlines to the trailing edge.

| Position | Transition point | |
|---|---|---|
| | ← Leading Edge | Trailing Edge → |
| **Airflow at the boundary layer** | Airflow is laminar | Airflow is turbulent |
| **Airflow velocity** | Higher than aircraft speed | Zero |

$$2D\ TOTAL\ DRAG = PRESSURE\ DRAG + SKIN\ FRICTION\ DRAG$$

**Form Drag** is also called Pressure Drag.

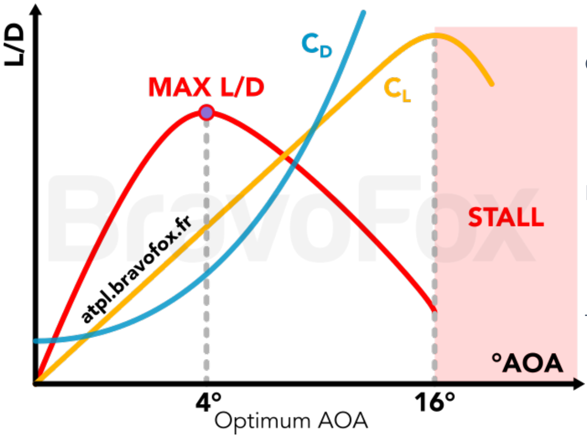
## 1.3 COEFFICIENTS

### 1.3.1 AERODYNAMIC FORCE

$F = q \times C \times S \quad (N)$ $\qquad q = \frac{1}{2}.\rho.V^2 \quad (N/m^2)$ $\qquad \rightarrow F = \frac{1}{2}.\rho.V^2.C.S \quad (N)$

$F$ : *Lift or Drag* – $q$ : *Dynamic pressure* – $C$ : *Coefficient of Lift or Drag*
$S$ : *Surface* – $\rho$ : *Density* – $V$ : *Speed*

### 1.3.2 THE "AEROFOIL POLAR": $C_L$ VS $C_D$




$C_L$ is function of:

- Camber of the aerofoil
- Angle of attack

From the **polar curve** one can read:

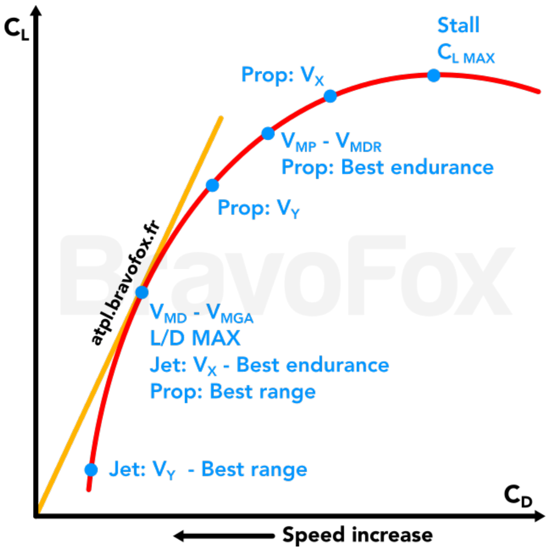
- Maximum $C_L/C_D$
- Maximum $C_L$

Typical:

- **Best ratio $C_L/C_D$** @ 4° AoA.
- **Stall** @ 16° AoA.

Effect of weight/load on $C_L$ is proportional to Lift $\qquad C_{L\,NEW} = C_{L\,OLD} \times n \qquad n = L/W$

### 1.3.3 POLAR CURVE



## 1.4 3D AIRFLOW (TRIMMED)

## 1.5 GROUND EFFECT (TRIMMED)

## 1.6 % OF $C_{LMAX}$ AT 1.3$V_S$ (TRIMMED)

## 1.7 TOTAL DRAG (TRIMMED)

## 1.8 STALL

$V_{SR}$ – Reference stall speed.
$V_{S0}$ –Stall speed in landing configuration.
$V_{S1}$ –Stall speed in specific configuration.
$V_{S1G}$ –Minimum speed at which lift = weight.

**Stall speeds** are determined with CG at the forward limit.

**Minimum control speeds** are determined with CG at the aft limit.

**Boundary layer** is a layer on the wing in which the stream velocity is lower than the free stream.

**Airflow separation** is characterised by airflow reversal on the surface of the body.

The laminar boundary layer becomes turbulent **at the transition point.**

**Increasing the aspect ratio** decrease the critical angle of attack.

**Stalling angle** is unaffected by a turn.

**Accelerated stall** is due to an increase in load factor.

**Deep stall** largest AoA.

**Shock stall** smallest AoA.

**Stall speed increase with altitude** due to **compressibility**. (Initially constant then increase)

**The stick shaker**:

- Activates at lower angle of attack than stick pusher.
- Is triggered at an airspeed greater than $V_S$.
- Input comes from angle of attack, and sometimes the rate of change in AoA.

**The stick pusher**:

- Activate and push the stick forward at or beyond a certain value of angle of attack
- Prevents the pilot from increasing the angle of attack

| Increase stall speed |
|---|
| ↑ More mass |
| ↑ Swept wing |
| ↑ Forward CG |
| ↑ High altitude |
| ↑ Bank angle |
| ↑ Turbulence |
| ↑ Icing |
| Pulling out from a dive |
| ↓ Less thrust |

**Load factor**

$$n = \frac{L}{W} = \frac{1}{\cos\theta} \qquad V_{SNEW} = V_{S0}\sqrt{n} = V_{S0}\sqrt{\frac{1}{\cos\theta}} \equiv V_{S0}\sqrt{\frac{New\ Weight}{Old\ Weight}}$$

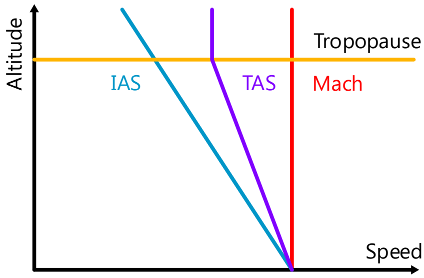
n = 1 ⇒ steady straight level flight
n < 1 ⇒ steady climb or descent ($L = W\cos\gamma$)
n > 1 ⇒ gust from ahead or below, pulling out from a dive ($L > W$)

$$\rightarrow 0.13g\ margin: 1.13 = \frac{1}{\cos\theta} \rightarrow \theta = \cos^{-1}\frac{1}{1.13} = 28°$$

| Straight wing vs Swept wing | Straight wing | Swept wing |
|---|---|---|
| Stall speed | Lower | Higher |
| Stall | From the root | From the tip |
| When exceeds critical AoA CP move | Aft | Fore |
| Just before the stall | Nose-down tendency | Nose-Up tendency |

## 1.9 BOUNDARY LAYER (TRIMMED)
## 1.10 FLAPS - SLATS (TRIMMED)
## 1.11 SPOILERS – SPEED BRAKES (TRIMMED)

# 2. HIGH SPEED AERODYNAMICS
## 2.1 SPEEDS




Speed of sound depends on temperature (Not altitude nor density).

$$a = 38{,}95\sqrt{T}$$

$a$ : *Local Speed of Sound*
$T$ : *absolute temperature in °Kelvin*

$$M_{number} = \frac{TAS}{a}$$

| Speed | MCRIT | Mach 1.3 | Mach 5 |
|---|---|---|---|
| | Subsonic | Transonic | Supersonic |

Subsonic MNUMBER ⇒ The airflow everywhere around the aeroplane is subsonic.

Transonic MNUMBER ⇒ Both subsonic and supersonic local speeds occur.

Supersonic MNMBER ⇒ The airflow everywhere around the aeroplane is supersonic.

In supersonic flight aerofoil pressure distribution is rectangular.

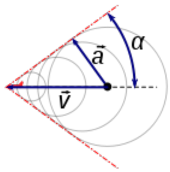
Compressibility effects depend on Mach number.

## 2.2 SHOCK WAVES

MNUMBER increase ⇒ Shock wave move rearward ⇒ CP move rearward.

Mass increase ⇒ AoA increase ⇒ Shock wave intensity increases.

In the shock wave kinetic energy change to heat energy ⇒ T° increases ⇒ Speed of sound increase.




$$\sin\alpha = \frac{a}{TAS} = \frac{1}{M}$$

$a$ : *Local Speed of Sound*

In supersonic flight, all disturbance produced by an aeroplane are within the conical zone.

Oblique shock wave: *SSDLMT*

| In front | | Behind | |
|---|---|---|---|
| - | S | + | (S)tatic temp |
| - | S | + | (S)tatic press |
| - | D | + | (D)ensity |
| - | L | + | (L)ss |
| + | M | - | (M)no |
| + | T | - | (T)otal press |

Normal shock wave
- Is always normal to the local flow
- Cause separation of the boundary layer.
- Can occur at different points on the aeroplane in transonic flight.
- Behind local MNUMBER < 1. From Supersonic to subsonic.
- **Least energy loss** when local MNUMBER just above Mach 1.

Expansion wave
- Everything decreases except Speed / MNUMBER.

2.3 MCRIT (TRIMMED)
2.4 BUFFET ONSET (TRIMMED)
2.5 MEANS TO INFLUENCE MCRIT (TRIMMED)

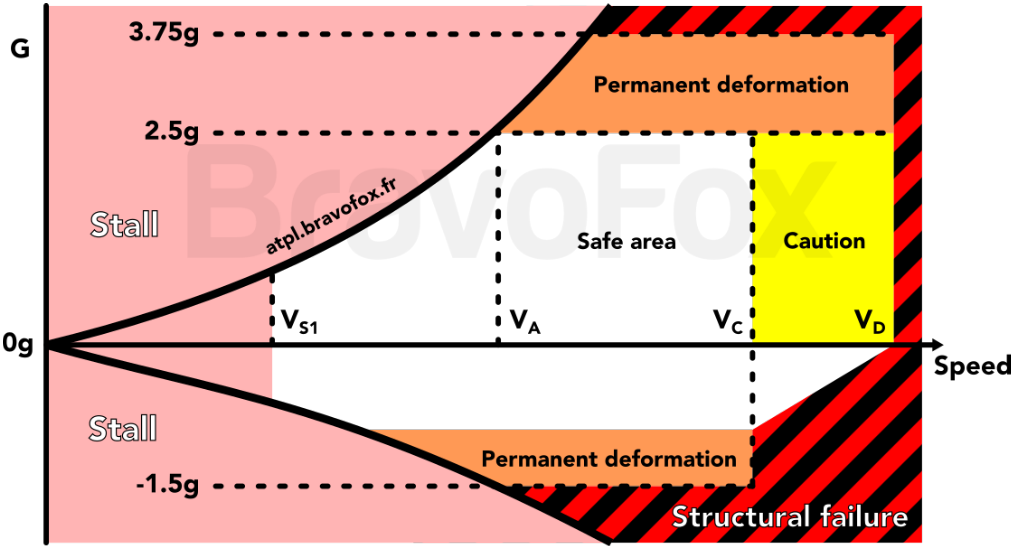
3. FLIGHT MECHANICS
3.1 FORCES ACTING ON AN AEROPLANE (TRIMMED)
3.2 ASYMMETRIC THRUST (TRIMMED)

4. STABILITY
4.1 STATIC AND DYNAMIC STABILITY (TRIMMED)
4.2 STATIC AND DYNAMIC LONGITUDINAL STABILITY (TRIMMED)
4.3 STATIC DIRECTIONAL STABILITY (YAWING) (TRIMMED)
4.4 STATIC LATERAL STABILITY (ROLLING) (TRIMMED)
4.5 DYNAMIC LATERAL/DIRECTIONAL STABILITY (TRIMMED)

5. CONTROL
5.1 PITCH (TRIMMED)
5.2 ROLL (TRIMMED)
5.3 YAW (TRIMMED)
5.4 REDUCE CONTROL FORCE (TRIMMED)
5.5 TRIM (TRIMMED)

6. LIMITATIONS
6.1 OPERATING LIMITATIONS (TRIMMED)
6.2 GUST ENVELOPE (TRIMMED)

## 6.3 MANOEUVRING ENVELOPE




$V_A$ – Manoeuvring speed, Maximum speed for control surface full deflection (above ⇒ perm. damage)

Limit load factor is taken into account for **determining** $V_A$.

$V_A$ **depend** on mass and pressure altitude.

$$V_A = VS_1 \times \sqrt{n}$$

$V_C$ – Speed chosen by designer and which is used to assess the strength requirements in cruise.

$V_{MO}$ should not be greater than $V_C$.

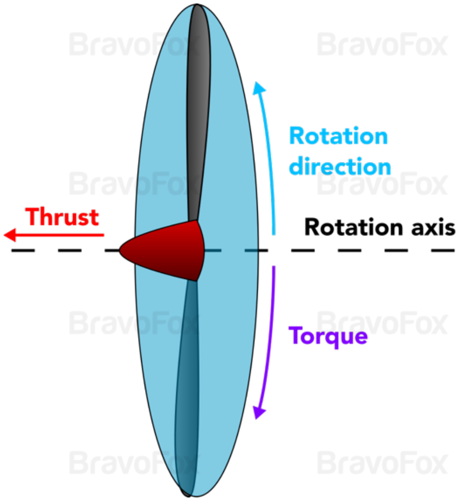
| Load factor limitations | | | |
|---|---|---|---|
| Category | | g | |
| CS25 | Large / transport | -1 | +2,5 |
| CS23 | Normal | -1,52 | +3,8 |
| | Utility | -1,76 | +4,4 |
| | Acrobatic | -3 | +6 |

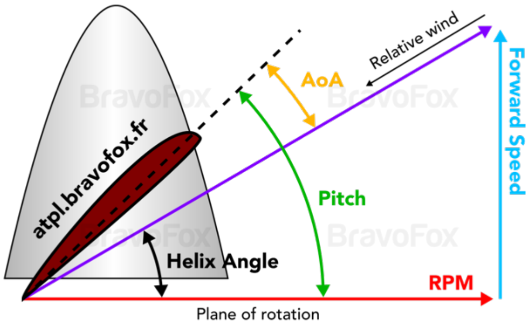
+2g with flaps

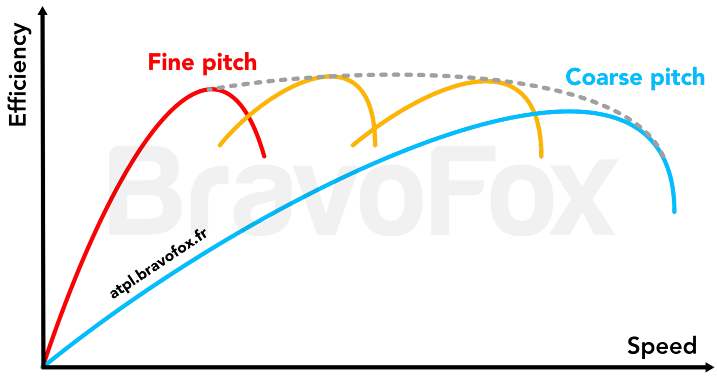
**Ultimate load factor exceeded** ⇒ Structural failure

# 7. PROPELLERS

## 7.1 TORQUE / THRUST / PITCH




**Propeller efficiency** is the ratio of Power available to Shaft power. $\frac{Thrust \times TAS}{Torque \times RPM}$

**Increase pitch** ⇒ Decrease drag ⇒ Decrease rate of descend

**Decrease pitch** ⇒ Increase drag ⇒ Increase ROD.

**Reference section of a propeller** blade is usually taken at 0.75R / 75% of blade radius.

## 7.2 ENGINE FAILURE (TRIMMED)

## 7.3 FEATURES FOR POWER ABSORPTION (TRIMMED)

## 7.4 SECONDARY EFFECTS OF PROPELLERS (TRIMMED)

# VFR COMMUNICATIONS

## 1. DEFINITIONS

### 1.1 MEANINGS AND SIGNIFICANCE OF ASSOCIATED TERMS

**Duplex communication**: Between two stations in both directions simultaneously.

**Simplex communication**: Between two stations in one direction at a time.

**Blind transmission**: Two-way communication cannot be established but it is believed that the called station is able to receive.

**Air-Ground Communication:** Two-way communication between aircraft and stations on the surface.

**Aeronautical station**: Sea

**Aircraft station**: Plane

**General call**: "All stations […]"

**Broadcast:** Not addressed to a specific station.

### 1.2 AIR TRAFFIC SERVICES ABBREVIATIONS

| | |
|---|---|
| **AIS**: Aeronautical Information Service<br>**AFIS**: Aerodrome Flight Information Service<br>**ATIS**: Automatic Terminal Information Service | **CTR**: Control Zone<br>**TMA**: Terminal Control Area<br>**FIR**: Flight Information Region |
| **HJ**: Sunrise to Sunset<br>**HN**: Sunset to Sunrise<br>**HX**: No Specific Working Hours<br>**HS**: Service Available during operations hours | **MSAW**: Minimum Safe Altitude Warning<br>**PAPI**: Precision Approach Path Indicator |
| **UTC**: Universal Coordinated Time<br>**VFR**: Visual Flight Rules | |

### 1.3 Q-CODE GROUPS COMMONLY USED IN RTF AIR-GROUND COMMUNICATIONS

| | Station | |
|---|---|---|
| | From | To |
| Magnetic | QDR | QDM |
| True | QTE | QUJ |

*(Tips: **R**eal **M**en **E**at **J**elly)*

**QNH/QFE**: Pressures

**QNH**: Altimeter sub-scale setting to obtain altitude or elevation when on the ground.

**QFE**: Altimeter sub-scale setting to obtain height then 0ft when on the ground.

### 1.4 CATEGORIES OF MESSAGES

**Priority**: Distress > Urgency > Direction > Safety > Meteo > Regularity

*Tips: DUDS MisteR*

**Safety message**: ATC Clearance / ATC Messages / Meteorological messages (SIGMET, AIRMET, SPECI…)

# 2. GENERAL OPERATING PROCEDURES

## 2.1 TRANSMISSION OF LETTERS/NUMBERS/TIME/TECHNIQUE (TRIMMED)

## 2.2 STANDARD WORDS AND PHRASES (TRIMMED)

## 2.3 RADIOTELEPHONY CALL SIGNS (TRIMMED)

### 2.3.1 ATC SERVICES WITH RADAR (TRIMMED)

### 2.3.2 ATC SERVICES WITHOUT RADAR (TRIMMED)

### 2.3.3 ATS SERVICE AT AIRPORT (TRIMMED)

## 2.4 PROCEDURES (TRIMMED)

## 2.5 READ BACK (TRIMMED)

## 2.6 READABILITY (TRIMMED)

# 3. RELEVANT WEATHER INFORMATION TERMS (VFR)

**ACARS**: Aircraft Communications Addressing and Reporting System

Digital datalink system, used among other to get weather report.

**VOLMET**: Worldwide radio network which broadcast weather reports (METAR, SPECI, TAF, SIGMET) of specific airports on shortwave frequencies.

**CAVOK**:

- Visibility 10km+
- No significant cloud below 5000ft
- No weather of significance.

## 3.1 METAR

**Visibility** reported in meter up to 5000m, above in kilometres.

**Temperature** in degrees Celsius.

WS = **Windshear**

**Wind**: In degrees true / knots (Tower gives in degrees magnetic).

**METAR result in prompt ATIS update** when receiving a MET REPORT SPECIAL.

**RVR**: R22/1000U ⇒ Runway 22 / 1000m / U = Up, increasing / D = Down, reducing / N = no change

## 3.2 ATIS

**ATIS** provide routine information to arriving and departing aircraft by means of continuous and repetitive broadcast.

Is **broadcast** on discrete VHF frequency or/and VOR.

**D-ATIS**: Data link Automatic Terminal Information Service.

## 3.3 CLOUD

**Cloud base/ceiling** referred to aerodrome elevation.

| | |
|---|---|
| FEW | 1-2 oktas |
| SCT | 3-4 oktas |
| BKN | 5-7 oktas |
| OVC | 8 oktas |

### 3.4 SIGNIFICANT CHANGE

- Temperature increase 2°C or more
- Wind direction change 60° or more
- Wind speed change 10kt or more
- Visibility changes (800m / 1500m / 3000m / 5000m)
- RVR (Runway Visual Range) (150m / 350m / 600m / 800m)
- Onset cessation or change in intensity of significant phenomena (freezing precipitation, dust or sand storm, thunderstorm, squall, tornado, …)
- Significant changes in cloud bases

### 3.5 BRAKING COEFFICIENT

| | | |
|---|---|---|
| ≥ 0.4 | 5 - Good | |
| 0.36 - 0.39 | 4 – Medium / Good | Up to 3mm of water |
| 0.30 - 0.35 | 3 – Medium | |
| 0.26 - 0.29 | 2 – Medium / Poor | More than 3mm of water |
| ≤ 0.25 | 1 – Poor | |
| 9 | Unreliable | Wet snow and slush |

## 4. COMMUNICATION FAILURE

### 4.1 TOWER VISUAL SIGNAL (TRIMMED)

## 5. DISTRESS AND URGENCY

### 5.1 DISTRESS (TRIMMED)

### 5.2 URGENCY (TRIMMED)

## 6. VHF PROPAGATION AND ALLOCATION OF FREQUENCIES

### 6.1 PROPAGATION DISTANCE (TRIMMED)

### 6.2 RANGE (TRIMMED)

### 6.3 FREQUENCY ALLOCATION (TRIMMED)

# IFR COMMUNICATIONS

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**Aeronautical station**: Sea

**Aircraft station**: Plane

**General call**: "All stations [...]"

**Broadcast:** Not addressed to a specific station.

**Visual approach**: Visual reference to the terrain.

**TCAS**: Traffic alert and Collision Avoidance System.

**When following a RA** ⇒ include "TCAS RA" with callsign, then "Clear of conflict, returning to ...".

**When RA is in conflict with clearance** instruction ⇒ Follow RA and report "Unable, TCAS RA".

**SELCAL**: System which permits the selective calling of individual aircraft over radio.

**ACARS**: Aircraft Communications Addressing and Reporting System. No need for make regular report

### 1.2 AIR TRAFFIC SERVICES ABBREVIATIONS

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| **HJ**: Sunrise to Sunset<br>**HN**: Sunset to Sunrise<br>**HX**: No Specific Working Hours | **MSAW**: Minimum Safe Altitude Warning<br>**MLS**: Microwave Landing System<br>**PAPI**: Precision Approach Path Indicator |
| **UTC**: Universal Coordinated Time<br>**RVR**: Runway Visual Range<br>**VFR**: Visual Flight Rules | **RNAV:** Area Navigation<br>**SID:** Standard Instrument Departure<br>**STAR**: Standard Instrument Arrival<br>**PBN**: Performance Based Navigation |
| **INS:** Inertial Navigation System<br>**APV:** Approach Procedure with Vertical guidance<br>**SSR**: Secondary Surveillance Radar | **VMC**: Visual Meteorological Conditions<br>**IMC:** Instrument Meteorological Conditions |

### 1.3 Q-CODE GROUPS COMMONLY USED IN RTF AIR-GROUND COMMUNICATIONS (TRIMMED)

### 1.4 CATEGORIES OF MESSAGES (TRIMMED)

## 2. GENERAL OPERATING PROCEDURES

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**RVR**: R22/1000U ⇒ Runway 22 / 1000m / U = Up, increasing / D = Down, reducing / N = no change

**ATC transmit RVR** for each third of the runway (touchdown, mid-point, stop end).

### 3.2 ATIS

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- Onset cessation or change in intensity of significant phenomena (freezing precipitation, dust or sand storm, thunderstorm, squall, tornado, …)
- Significant changes in cloud bases

### 3.5 BRAKING COEFFICIENT (TRIMMED)

### 3.6 ENROUTE REPORT (TRIMMED)

## 4. COMMUNICATION FAILURE

### 4.1 TOWER VISUAL SIGNAL (TRIMMED)

## 5. DISTRESS AND URGENCY

### 5.1 PAN PAN MEDICAL (TRIMMED)

### 5.2 DISTRESS (TRIMMED)

### 5.3 URGENCY (TRIMMED)

## 6. VHF PROPAGATION AND ALLOCATION OF FREQUENCIES

### 6.1 PROPAGATION DISTANCE (TRIMMED)

### 6.2 RANGE (TRIMMED)

### 6.3 FREQUENCY ALLOCATION (TRIMMED)