PILOT 360
FLY SAFER

ERTR.IN
YOUR RADIO TELEPHONY PARTNER

RADIO TELEPHONY RESTRICTED

AERONAUTICAL

Table of Content

- SECTION – 4 RTR MET AND REGULATIONS

- SECTION – 5 RADIO ELECTRICAL

- SECTION – 6 MISCELLANEOUS

Definitions

Radio Telephony is the Long-distance voice communication using radio waves.

Communication = Exchange of information by speaking, writing, or even pointing. (Even hand gestures count in aviation!)

Right of Way - The aircraft that has the right of way shall maintain its heading and speed.

Aerodrome - An area of defined dimensions on land or water (including any buildings, installations and equipments) intended to be used either wholly or partly for the arrival, departure and surface movement of aircraft.

Airport - It is an area used for take-off/landing for a/c usually with runway facilities including aerodrome and customs.

Objective of ATS –

- To prevent collision btw a/c in flight and on maneuvering area.
- Expedite and maintain an orderly flow of air traffic.
- Assist for SAR.

Air Taxi – Movement of helicopter above the surface of an AD at a ground speed of less than 20 kts.

Air Report – A report from an aircraft in flight prepared in conformity with requirements for position, operational and meteorological reporting.

Uncertainty phase (INCERFA) - A situation where doubt exists as to the safety of the aircraft and its occupants.

- Doubt about safety of aircraft
- No communication or arrival 30 minutes after expected time

Alert phase (ALERFA) - When apprehension exists as to the safety of the aircraft and its occupants.

- Apprehension about safetys
- Continued loss of contact or aircraft fails to land **within 5 minutes** after clearance

Distress phase (DETRESFA) - A situation where there is reasonable certainty that the aircraft and its occupants are threatened by grave and imminent danger and do require immediate assistance.

- **Reasonable certainty of grave danger**
- Distress message received or aircraft believed crashed

Aeronautical Information Publication – A publication issued by AAI and containing aeronautical information of a lasting character essential to air navigation.
AIP Amendment – Permanent Changes (more than 3 months)
AIP Supplement – Temporary Changes (less than 3 months)

Restricted area – An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Prohibited area – An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is totally prohibited.

Danger area – An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Decision Height – The height in a precision approach at which a missed approach must be initiated if the required visual reference to continue that approach has not been established.

Ceiling – The height above the ground or water of the base of the lowest layer of the cloud below 6000m or 20000ft covering more than half the sky.

Instrument Meteorological Conditions – Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

Expected Approach Time – The time at which ATC expects that an arriving aircraft, following a delay, will leave the holding point to complete its approach to landing.

Estimated Off Block Time – The estimated time at which the aircraft will commence movement associated with departure.

Estimated Time of Arrival – For IFR flights, the time at which it is estimated that the aircraft will arrive over that designated point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced. For VFR flights, the time at which the aircraft will arrive over the aerodrome.

Filed Flight Plan – The flight plan as filed with an ATS unit by the pilot or a designated representative, without any subsequent changes.

Flight Time – The total time from the moment an aircraft first moves under its own power for the purpose of taking off until the moment it first comes to rest at the end of the flight.

Flight Level – A surface of constant atmospheric pressure which is related to a specific pressure datum, 1013.2 hPa, and is separated from other such surfaces by specific pressure intervals.

FIR – Flight information and alerting services are provided.

Heading – The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

Holding Pattern – Series of pre-defined maneuvers carried out by an a/c to hold over a nav aid.

Height – The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

Maneuvering Area – That part of an aerodrome to be used for landing, take-off and taxiing of aircraft, excluding aprons.

Movement Area – That part of an aerodrome to be used for landing, take-off and taxiing of aircraft, consisting of maneuvering area and aprons.

Transition Altitude – The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes.

Transition Level – The lowest flight level available for use above the transition altitude.

Transition Layer – The airspace between the transition altitude and the transition level.

Search and Rescue: India is divided into four SAR areas its boundaries being same as the FIR. Each SAR is established with SARCC (search and rescue coordination center). SAR comes under the authority of regional director of aerodromes.

ELT - (Emergency Locator Transmitter)

- ✓ Frequency: 121.5/243 mhz.
- ✓ Activated when crash force exceeds 5-7g.
- ✓ Batteries last for 48 hrs.
- ✓ Signal picked by SARSAT (search and rescue satellite)

FDR: Records Last 25 hrs data (black box) (orange coloured)

CVR: Records data of last 02 HRS.

FOQA - Flight Operation Quality Assurance. Record each and every data during flight.

Aerodrome Lighting and Features

TWY Lights - Blue in color.

TWY Centerline LIGHTS - Continuous light of green colour.

Threshold light - Unidirectional light of green colour.

False light - Any light within 5 km of aerodrome or aeronautical beacon which is likely to confuse or mislead an a/c is not permitted and govt is authorized to extinguish the same.

Aerodrome Reference Point - It is a designated point established in a horizontal at or near the geometric centre of the landing area. It is marked with a metallic plate embedded in the ground in the horizontal position engraved with name of the aerodrome, latitude and longitude and elevation of the highest point of landing area.

Apron - A defined area, on a land aerodrome intended to accommodate a/c for purpose loading or unloading passenger, mail, cargo, fueling, parking and maintenance.

Stand - A designated place on apron for the purpose of parking of aircraft.

Taxiway - A defined path on a land acrodrome established for taxiing of aircraft and intended to provide a link between one part of aerodrome and another.

Intermediate holding position: A designated position intended for traffic control at which taxiing ac and vehicles shall stop until further cleared to proceed, when instructed by aerodrome control tower.

Runway: A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Threshold: The beginning of that portion of runway which is usable for landing.

Touchdown: The point where the nominal glide path intercepts the runway.

Shoulder: An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Selection of runways should be based on-

1. Wind direction
2. Traffic conditions
3. Type of a/c
4. Type of approach to land
5. Sun

METAR: THE routine weather report of an aerodrome issued every half an hour. It gives surface wind, visibility, prevailing weather condition like temp, dew point, QNH and trend forecast.

SPECI - This is selected special weather report that is issued when a significant change in METAR report takes place. SPECI is issued in between immediately and is valid till the issuance of the next METAR.

VOLMET - Current weather reports and aerodrome forecasts SIGMETS of certain solutions are broadcasted in HF from Mumbai and Kolkata at half hour intervals.

SIGMET - Information used by a meteorological watch office concerning the occurrence or specified enroute weather phenomena, which may affect the safety of aircraft operations.

AIRMET - Information used by a meteorological watch office concerning the occurrence or expected occurrence of specified enroute weather phenomena, which may affect the safety of low level ac operation which was not included in the forecast issued for low flights.

Taxiway stripes - Solid Yellow in color

Civil aerodrome beacon - Flashing green and white

Low Visibility Procedure (LVP) - Comes in operation when either Touchdown Zone (TDZ), Mid or End RVR below 800 m and/or ceiling below 200 feet. Pilots will be informed via ATIS that LVP in force.

Visibility - The ability as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night.

Flight Visibility - The visibility forward from the cockpit of an a/c in flight.

Ground Visibility - The visibility at an aerodrome as reported by an accredited observer.

Runway visual Range - The range over which the pilot of an a/c on the center line of the rwy can see the surface markings or the lights delineating the runway or identifying its centre line.

Dew Point - It is the temperature to which a given parcel of air must be cooled at constant barometric pressure, for water vapor to condense into water.

CPDLC (Controller Pilot Data Link Communication) - Communication via text msg by FMS on VHF. It is an alternate to voice communication avbl at Delhi, Mumbai, Chennai, Kolkata airports.

Need to report to ATC when:

1. Change in TAS 5% or more.
2. Change in ETA 3 min or more.

SVFR: Vis should not be less than 1500m.

CAVOK - Code word used for cloud and visibility OK. When

1. Visibility is 10 km
2. No CB Cloud
3. No other clouds at 5000 feet or below.
4. No precipitation, TS, Sandstorm, Dust storm, Fog forecast.

CLOUD AMOUNT:

FEW	1-2 OKTAS
SCT (Scattered)	3-4 OKTAS
BKN (Broken)	5-7 OKTAS
OVC (Overcast)	8 OKTAS

Time

- All ATS units shall use UTC (coordinated universal time) and shall express time in HOURS and MINUTES.
- Time checks shall be given to the nearest half-minute.
- Time check shall be checked as necessary to ensure correct time to within plus or minus thirty seconds of UTC (Whenever Data-link com is utilized by ATS unit, should be corrected to 1 sec of UTC).
- Time is given in 24 hrs watch.
- Midnight starts at 0000 hrs.
- Time check shall be obtained from a standard time station prior to taxi.

SECTION – 1 GOVERNING BODIES

National Law

The evolution of aviation in India is marked by significant milestones that transitioned the sector from colonial-era regulations to modern operational standards.

- **The First Flight**: On **18 February 1911**, the first commercial civil aviation flight took place in India between **Allahabad and Naini**, covering a distance of **9.7 km**. This event is historically significant as the **world's first airmail service** and marked the beginning of civil aviation in India.

- **Regulatory Beginnings:**
  - **1927**: A separate **Department of Civil Aviation** was set up to manage civil aviation matters. The **Aero Club of India** was also established this year.
  - **1931**: **Lt. Col. Shelmerdine** was appointed as the first **Director General of Civil Aviation (DGCA)**.

- **Legislation:**
  - **1934**: The Indian Aircraft Act was promulgated.
  - **1937**: The **Aircraft Rules, 1937** were formulated.
  - **2024**: The **Bharatiya Vayuyan Adhiniyam, 2024** (Indian Aviation Act, 2024) replaced the colonial-era Aircraft Act of 1934.
    - Objective: To modernize the aviation sector, enhance safety, and streamline regulations for design, manufacture, and operations.
    - Status: Received Presidential assent and came into force on **January 1, 2025**.

Ministry of Civil Aviation (MoCA)

The **Ministry of Civil Aviation (MoCA)** is the nodal ministry responsible for the formulation of national policies and programmes for the development and regulation of the civil aviation sector.

- **Headquarters Location: Rajiv Gandhi Bhavan, Safdarjung Airport, New Delhi.**
- **Primary Functions:**
  - Administers the **Bharatiya Vayuyan Adhiniyam, 2024** and **Aircraft Rules, 1937**.
  - Oversees airport development, air traffic services, and carriage of passengers/goods.
  - Coordinates with Parliament and international bodies (ICAO).
  - Ensures the orderly growth and expansion of civil air transport.

Composition of the Ministry

The Ministry is structured hierarchically:

1. **Cabinet Minister for Civil Aviation** (Head)
2. Minister of State for Civil Aviation
3. **Secretary, Civil Aviation** (Assisted by one Additional Secretary, Joint Secretaries, Directors, etc.)

Organizations under Administrative Control of MoCA

MoCA exercises control over several attached and autonomous organizations, PSUs, and joint ventures.

Note: The **Indian Meteorological Department (IMD)** is not under the Ministry of Civil Aviation; it functions under the Ministry of Earth Sciences, though it provides essential services to aviation.

Directorate General of Civil Aviation (DGCA)

The **DGCA** is the primary regulatory body for civil aviation in India, focusing chiefly on **safety oversight** and **airworthiness**.

- **Headquarters**: Located in New Delhi at two sites:
    1. **Opposite Safdarjung Airport**, New Delhi.
    2. **Udaan Bhawan**, Safdarjung Airport, New Delhi.

- **Relationship**: It is an attached office of the Ministry of Civil Aviation.

Key Responsibilities of DGCA

1. **Licensing**: Issues licenses for **Pilots, Aircraft Maintenance Engineers (AME)**, **Air Traffic Controllers (ATCOs)**, and Flight Engineers.

2. **RTR Examination**: Conducts the **Radio Telephony Restricted (RTR)** examination and issues licenses as per the Bharatiya Vayuyan Adhiniyam, 2024.

3. **Examinations**: Conducts technical exams (Pilot, AME, ATCO) through the

4. **PARIKSHA** portal (managed by the Central Examination Organization - CEO).

5. **Airworthiness**: Registers civil aircraft and grants **Certificates of Airworthiness (C of A)**.
6. **Safety Oversight**: Certifies aerodromes, CNS/ATM facilities, and conducts safety audits/inspections.

7. **Drones**: Regulates Remotely Piloted Aircraft Systems (RPAS/Drones), approves Remote Pilot Training Organisations (RPTOs), and certifies remote pilots.

8. **International Coordination**: Coordinates with **ICAO**, files differences regarding Annexes, and ensures compliance.

Directorates: DGCA comprises **17 Directorates** (e.g., Airworthiness, Air Safety, Flight Standards, Aerodrome Standards, etc.).

- **Divisions**: It has **4 specific Divisions:**

  1. **RTR Division**
  2. **Surveillance & Enforcement Division**
  3. **Training Division**
  4. **Information Technology (IT) Division**
  5. (Note: Cargo Regulation is not a standalone division).

DGCA Offices

- **Regional Offices (RO)**: 7 locations (Delhi, Mumbai, Chennai, Kolkata, Hyderabad, Bangalore).

- **Sub-Regional Offices (SRO)**: Locations include Amritsar, Bhubaneswar, Dehradun, Nagpur, Agartala, Trivandrum, Bhopal, Lucknow, Patna, Kanpur, Guwahati.

International Civil Aviation Organization

ICAO is a specialized agency of the **United Nations** created to promote the safe and orderly development of international civil aviation.

Establishment: Born from the Chicago Convention on 4 April 1947.
Headquarters: Montreal, Canada.
Membership: 193 Member States.
Objectives: To prevent economic waste caused by unreasonable competition, ensure fair opportunity for all states to operate airlines, and encourage the development of airways and airports.

Structure of ICAO

1. **The Assembly**: The sovereign body where **all 193 contracting states** are represented. Meets every **3 years**. Each state has one vote.

2. **The Council**: The permanent governing body comprising **36 elected member states** (3-year term). Its most important duty is to **adopt International Standards and Recommended Practices (SARPs)** and incorporate them as **Annexes**.

3. **The Secretariat**: Headed by the **Secretary General**. Divided into five bureaus (Air Navigation, Air Transport, Technical Co-op, Legal, Admin).
   - India's Participation: India participates through the **Representative of India (ROI)**.

ICAO Publications & Documents

- **Annexes**: 19 documents containing Standards and Recommended Practices (SARPs).
- **PANS (Procedures for Air Navigation Services)**: Operating procedures not yet mature enough to be SARPs (e.g., Doc 4444).
- **Technical Manuals**: Guidance for implementing standards.
- **ICAO Circulars**: Specialized information on technical subjects.

International Telecommunication Union (ITU)

The **ITU** is the UN specialized agency responsible for information and communication technologies.

- **Founded**: **17 May 1865** (as International Telegraph Union) in Paris.
- **Headquarters**: Geneva, Switzerland.
- **Role**: Standardizes global telecommunications and regulates the **radio frequency spectrum**.

Key ITU Instruments

1. **International Telecommunication Convention**: The foundational treaty that defines the ITU's structure and purposes. It is binding on all members.

2. **Radio Regulations (RR):**

    - **Purpose**: To regulate the use of the radio spectrum to **prevent harmful interference** between different services.
    - **Scope**: Covers the spectrum from **9 kHz to 300 GHz**.
    - **Updates**: Revised every **3 to 4 years** by the **World Radiocommunication Conference (WRC)**.
    - **Functions**: Frequency allocation, Assignment, Spectrum Management, and **Satellite Orbit Management** (Geostationary orbits).

- **Headquarters**: Geneva, Switzerland
- **Role**: Regulates and coordinates global radio frequencies.

For your understanding consider ITU as the traffic police of radio waves!

ITU REGULATIONS

- Regulations followed by all countries
- Under Ministry of Communication & Information Technology

Radio Communication Licensing

Two Types of Licenses:

i. Equipment License
ii. Operating License

Governed by **ITU Radio Regulations (1992)**

Authority	Full Form	HQ / Role
ICAO	International Civil Aviation Organization	Ministry of Civil Aviation (Annex 10), HQ: Montreal, Canada
ITU	International Telecommunication Union	Ministry of Communication & IT (WPC Wing)
DGCA	Directorate General of Civil Aviation	Entire Aviation Regulatory Body

International Air Transport Association (IATA)

IATA is the trade association for the world's airlines.

- **Founded**: **April 1945** in **Havana, Cuba**.
- **Nature**: It is a private industry body, **not** a government regulator.
- **Functions:**
  - Promotes inter-airline cooperation (ticketing, baggage).
  - Conducts the **IATA Operational Safety Audit (IOSA)**.
  - Promotes safe, reliable, and economical air services.

Other Important Organizations under moca

Organization	Acronym	Role & Description
Bureau of Civil Aviation Security	**BCAS**	Responsible for aviation security standards and protocols.
Airports Authority of India	**AAI**	Manages Public Airports and provides **CNS/ATM** (Air Navigation) services.

Aircraft Accident Investigation Bureau	**AAIB**	Investigates accidents and incidents.
Commission of Railway Safety	**CRS**	Responsible for rail safety (Administratively under MoCA, acts under Railways Act, 1989).
Airports Economic Regulatory Authority	**AERA**	Regulates tariffs and airport service quality.
Indira Gandhi Rashtriya Uran Akademi	**IGRUA**	Pilot training academy.
Pawan Hans Helicopters Ltd.	**PHHL**	Helicopter services (PSU).
Rajiv Gandhi National Aviation University	**RGNAU**	Aviation education and training.
Al Assets Holding Limited	**AIAHL**	Asset holding company.

ANNEXURES

Annex	Subject
1	Personnel Licensing
2	Rules of the Air
3	Meteorological Service
4	Aeronautical Charts
5	Units of Measurement
6	Operation of Aircraft
7	Aircraft Registration & Markings
8	Airworthiness
9	Facilitation
10	Aeronautical Telecommunications
11	Air Traffic Services
12	Search and Rescue
13	Aircraft Accident Investigation
14	Aerodromes
15	Aeronautical Information Services
16	Environment Protection
17	Aviation Security
18	Aviation Security
19	Safety Management

Aeronautical Telecommunication Services

The international aeronautical telecommunication service is the overarching framework for all aviation communication. It is divided into four distinct parts:

1. **Aeronautical Fixed Service (AFS)**: A telecommunication service between specified fixed points (e.g., ground-to-ground communication between airports).

2. **Aeronautical Mobile Service (AMS)**: A mobile service between aeronautical stations (ground) and aircraft stations (air), or between aircraft stations (air-toair).

3. **Aeronautical Radio Navigation Service (ARNS)**: A service for the purpose of radio navigation (e.g., VOR, ILS).

4. **Aeronautical Broadcasting Service (ABS)**: A service intended for the transmission of information relating to air navigation (e.g., AT IS, VOLMET).

Division	Full Form	Example
AMS (moves)	Aeronautical Mobile Services	Aircraft moving under AMS
AFS (fixes)	Aeronautical Fixed Services	All ATC units come under AFS
ABS (speaks)	Aeronautical Broadcasting	ATIS / DATIS, VOLMET / DOLMET (All-weather Services radio)
ANS (guides)	Aeronautical Navigation Services	NDB, VOR, DME, all NAVAIDs

ICAO Location Indicators

To ensure precise global communication, every significant aeronautical facility is assigned a unique code.

Location Indicator

- **Definition**: A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.
- **Authority**: These indicators are assigned by States and checked by ICAO for conformity.
- **Purpose**: They identify specific geographical locations that form part of the Aeronautical Fixed Service (AFS).

Aeronautical Fixed Service (AFS)

- **Definition**: A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient, and economical operation of air services.

Note: Separate location indicators should not be assigned to different units at one geographical location if a three-letter designator (like TWR or ACC) can be added to the four-letter code to suffice.

Formulation and Assignment of Indicators

The world is divided into **22 non-overlapping AFS routing areas** to facilitate message routing. The four letters of the code follow a specific logic:

First Letter: The AFS Routing Area

- The **first letter** represents the **AFS routing area** within which the location is situated.
- The boundaries of these areas are decided solely by AFS requirements (not necessarily political borders) to assist message routing.
- **Example**: The letter **'V'** is assigned to the routing area covering **India, Sri Lanka, Thailand, etc**. (South East Asia).

Second Letter: The State/Territory

- The **second letter** identifies the specific **State or territory** within that routing area.

- **Examples within Routing Area 'V'**:
  - I = India (e.g., V 1 DP - Delhi)
  - C = Sri Lanka (e.g., V C Bl - Colombo)
  - G = Bangladesh (e.g., V G ZR - Dhaka)
  - T = Thailand (e.g., V T BD - Bangkok)

Third Letter: The Communication Centre

- This letter is often assigned to assist in routing messages to a specific communication centre within that State. For example, in India, this often designates the Flight Information Region (FIR) or region (e.g., 'D' for Delhi region, 'B' for Mumbai region).

Fourth Letter: The Specific Location

- The State assigns this letter to identify the specific airport or station.
- **Restriction:** States assigned the letter "N" should avoid using "NN" for the third and fourth letters. Generally, the combination "NNN" should not be used for the last three letters.

Administration and Changes

Stability in these codes is crucial for global safety. Therefore, strict rules apply to changing them.

1. **Impact Assessment**: Indicators should only be amended after considering the worldwide repercussions on communication systems.

2. **Notification**: Changes must be promulgated by NOTAM or AIP as far in advance of the effective date as practicable.

Reassignment Rule: A location indicator should not be reassigned to another location for a period of at least six months after the cancellation of its previous assignment. This prevents confusion between old and new locations.

SECTION – 2 RADIO PHRASEOLOGY AND OPERATIONS

Transmission of Letters:

Letter	Word	Pronunciation
A	Alpha	AL FAH
B	Bravo	BRAH VOH
C	Charlie	CHAR LEE
D	Delta	DELL TAH
E	Echo	ECK OH
F	Foxtrot	FOKS TROT
G	Golf	GOLF
H	Hotel	HO TELL
I	India	IN DEE AH
J	Juliet	JEE LEE ETT
K	Kilo	KEYLOH
L	Lima	LEE MAH
M	Mike	MIKE
N	November	NO VEM BER
O	Oscar	OSS CAH
P	Papa	PAH PAH
Q	Quebec	KEH BECK
R	Romeo	ROWMEOH
S	Sierra	SEE AIR RAH
T	Tango	TANG GO
U	Uniform	YQU NEE FORM
V	Victor	VIK TAH
W	Whiskey	WISS KEY
X	X-ray	ECKS RAY
Y	Yankee	YANGKEY
Z	Zulu	ZOO LOO

Transmission of Numbers:

Numbers	Transmitted as
0	ZE-RO
1	WUN
2	TOO
3	TREE
4	FOW-ER
5	FIFE
6	SIX
7	SEV-EN
8	AIT
9	NIN-ER
Decimal	DAY-SEE-MAL
100	HUN-DRED
1000	TOU-SAND

TRANSMISSION OF TIME

Time checks shall be given to the nearest minute. **Co-ordinated Universal Time (UTC) is to be used at all times**, unless otherwise specified. 2400 hours designates midnight (end of the day) and 0000 hours the beginning of the day. It is transmitted as:

1720 : Wun Sev-en Too Ze-ro
0915 : Ze-ro Nin-er Wun Fife

AIRCRAFT CALL SIGNS

VT-CPL : Victor Tango Charlie Papa Lima
VT-349 : Victor Tango Tree Fow-er Nin-er
6E-360 : Ifly Tree Six Ze-ro

FLIGHT LEVEL

FL 290 : Flight level Too Nin-er Ze-ro
FL 070 : Flight level Ze-ro Sev-en Ze-ro
FL 160 : Flight level Wun Six Ze-ro

HEADING

070 degree : Heading Ze-ro Sev-en Ze-ro
290 degree : Heading Too Nin-er Ze-ro
130 degree : Heading Wun Tree Ze-ro

WIND DIRECTION & SPEED

030 degree 15 knots : Wind Ze-ro Tree Ze-ro degree Wun Fife knots
210 degree 20 knots Gusting 35 knots : Wind Too Wun Ze-ro degrees Too Ze-ro knots Gusting Tree Fife knots

TRANSPONDER CODES

0270 : Squawk Ze-ro Too Sev-en Ze-ro
1469 : Squawk Wun Fower Six Nin-er

RUNWAY

07 : Runway Ze-ro Sev-en
29L : Runway Too Nin-er Left
36R : Runway Tree Six Right

ALTIMETER SETTING

1013 : QNH Wun Ze-ro Wun Tree
1024 : QNH Wun Ze-ro Too Fower

Mach Number

0.67 : Mach Decimal Six Sev-en

ALTITUDE

1500 : Wun Tou-sand Fife Hun-Dred Feet
5000 : Fife Tou-sand Feet

CLOUD HEIGHT

3500 : Tree tou-sand fife hun-dred feet
4100 : Fower tou-sand wun hun-dred feet

VISIBILITY

7000 : Visibility Sev-en Tou-sand Meter
500 : Visibility Fife Hun-dred meter

RUNWAY VISUAL RANGE (RVR)

100 : RVR Wun hun-dred
1100 : RVR Wun tou-sand Wun hun-dred

FREQUENCY

121.65 : Wun Too Wunn Decimal Six Fife
118.000 : Wun Wun Ait Decimal Ze-ro
122.040 : Wun Too Too Decimal Ze-ro Fower
126.002 : Wun Too Six Decimal Ze-ro Ze-ro Too
121.650 : Wun Too Wun Decimal Six Fife Ze-ro

ATC CALLSIGN:

Unit/Service Available	Call Sign Suffix
Area Control Centre	CONTROL
Upper/Lower Control Area	UPPER LOWER CONTROL
Approach Control	APPROACH
Approach Control Radar / Area Control Radar	APPROACH RADAR/CONTROL RADAR
Aerodrome Control	TOWER
Surface Movement Control	GROUND
Radar (in general)	RADAR
Precision Approach Radar	PRECISION
Direction-finding Station	HOMER
Flight Information Service	INFORMATION
Clearance Delivery	DELIVERY
Apron Control	APRON
Company Dispatch	DISPATCH
Aeronautical Station	RADIO
Flow Control	FLOW

STANDARD WORDS AND PHRASES

Words / Phrase	Meaning
ACKNOWLEDGE	Let me know that you have received and understood the message
AFFIRM	Yes
APPROVED	Permission for proposed action granted
BREAK	I hereby indicate the separation between portions of the message
BREAK BREAK	I hereby indicate the separation between messages transmitted to different aircraft in a very busy environment
CANCEL	Annul the previously transmitted clearance
CHANGING TO	When transferring to a pilot-to-controller channel: Aircraft CHANGING TO… (air traffic services unit concerned)
CHECK	Examine a system or procedure
CLEARED	Authorized to proceed under the condition specified
CLEARED FOR IMMEDIATE TAKE OFF	Taxi immediately to runway and commence take off without stop.
CLIMB	"Climb to a FL, Altitude or Height."
CONFIRM	I request verification of (clearance, instruction, action, information)
CONTACT	Establish communications with…
CORRECT	"True" or "Accurate".
CORRECTION	An error has been made in this transmission (or message indicated), the correct version is…
CORRECTION, I SAY AGAIN	If a correction can best be made by repeating the entire message, the operator shall use the phrase "CORRECTION, I SAY AGAIN"

	before transmitting the message a second time.
DESCEND	“Descend to a FL, Altitude or Height.” Over Chennai.
DISREGARD	Ignore
HOLD SHORT	“Stop before reaching the specified location.” Only used in limited circumstances where no defined Point exists (e.g. Where there is no suitability located holding Point), or to reinforce a clearance limit.
GO AHEAD	Proceed with your message
HOW DO YOU READ	What is the readability of my transmission
1 SAY AGAIN	I repeat for clarity or emphasis
MAINTAIN	Continue in accordance with the conditions specified or in its Literal sense, e.g. maintain VFR.
MONITOR	Listen out on (frequency).
NEGATIVE	"No" or "Permission not granted" or "That is not correct" or, "not capable"
NEGATIVE, I SAY AGAIN	If, in checking the correctness of a read back, an operator notices incorrect items, he shall transmit the words “NEGATIVE I SAY AGAIN” at the conclusion of the read back followed by the correct version of the items concerned
OPERATIONS NORMAL	When “Operations normal” reports are transmitted by aircraft, they should consist of the prescribed call followed by the words “OPERATIONAL NORMAL”
OUT	This exchange of transmission is ended and no response is Expected.
OVER	My transmission is ended and I expect a response from you

READ BACK	Repeat all, or the specified part of this message back to me exactly as received.
RECLEARED	A change has been made to your last clearance and this new clearance supersedes your previous clearance or part thereof.
REPORTS	Pass me the following information
REQUEST	I should like to know or I wish to obtain
ROGER	I have received all of your last transmission
SPEAK SLOWER	Reduce your rate of speech
STANDBY	Wait and I will call you
UNABLE	I cannot comply with your request, instructions or clearance
WILCO	I understand your message and will comply with it

TRANSMITTING TECHNIQUE

- The following transmitting techniques will ensure that the transmitted speech is clearly and satisfactorily received.
- Before transmitting pause, check that the receiver volume is set at the optimum level and listen out on the frequency to be used to ensure that there will be no interference with a transmission from another station.
- Be familiar with microphone operating techniques and do not turn the head away from it while talking or vary the distance between it and the mouth. Severe distortion may occur due to:

a. Talking too close to the microphone
b. Touching the microphone with the lips
c. Holding the microphone or boom (of a headset)

- Use the normal conversation tone, speak clearly and distinctly.
- Maintain an even rate of speech not exceeding 100 words per minute. When it is known that elements of a message will be written down by the recipient, speak slightly slower.
- Maintain the speech volume at a constant level.

- A slight pause before and after numbers will assist in making them easier to understand.
- Avoid using hesitation sounds such as “er”, " ah".
- Depress the transmit switch fully before speaking and do not release it until the message is complete. This will ensure that the entire message is transmitted. However, do not depress the transmit switch until ready to speak.
- Be aware that the mother tongue of the person receiving the message may not be English. Therefore, speak clearly and use standard radiotelephony words and phrases whenever possible.
- One of the most irritating and potentially dangerous situations in radiotelephony is a “stuck” microphone switch. Always ensure that the switch is released after the transmission.
- Do keep in mind that the controller may have additional tasks to accomplish prior to responding to your call. Hence, after a call has been made, a period of 10 seconds should elapse before a second call is made.
- This should eliminate unnecessary transmissions while the receiving station is getting ready to reply to the initial call.
- If there is a doubt that a message has been incorrectly received, a repetition of the message shall be requested either in full or part by speaking **" SAY AGAIN"**
  - Say Again – Repeat entire message
  - Say again… (item) – Repeat specific item
  - Say again all before…(the first word satisfactorily received)
  - Say again all after… (the last word satisfactorily received)
  - Say again… (word before missing portion) to… (word after missing portion)

TRANSMISSION QUALITY

Numbers	Readability Scale Meaning
1	UNREADABLE
2	READABLE NOW AND THEN
3	READABLE BUT WITH DIFFICULTY
4	READABLE
5	PERFECTLY READABLE

ATC CLEARANCE, RADIO CALL FORMAT

Provisions governing clearances are contained in ICAO DOC 4444. A clearance may vary in content from a detailed description of the route and levels to be flown to a brief SID according to the local procedures. Generally, controllers will avoid passing a clearance to a pilot engaged in complicated taxing manoeuvres and on no occasion when a pilot is engaged in line up or take-off manoeuvres.

An ATC route clearance is NOT an instruction to take-off or enter an active runway. The word 'TAKEOFF' is used only when an aircraft is cleared for take-off. At all other times the word "DEPARTURE' is used.

The stringency of the read back requirement is directly related to the possible and seriousness of a misunderstanding in the transmission and receipt of ATC clearances and instructions.

ATC route clearances shall always be read back unless otherwise authorized by the appropriate ATS authority in which case they shall be acknowledged in a positive manner. Read backs shall always include the aircraft call sign. The ATS messages listed below are to be read back in full by the pilot. If a read back is not received, the ATC will ask the pilot to do so.

- Taxi instructions
- Level instructions
- Heading instructions
- Airways or Route Clearance unless otherwise authorized by appropriate ATS authority.
- Runway. in-use
- ATC clearance
- Clearance of Take-off, Landing, Back track, Hold short off a runway –
- Altimeter setting like QNH, QFE, QFF
- Frequency changes
- Transition level

Note: Any instruction/ request that is not a clearance does not have to be read back. Appropriate use of the word WILCO (WILL COMPLY) reduces unnecessary chatter.

POSITION REPORTING

Position reports shall contain the following elements of information:

a. Aircraft identification
b. Position Checked
c. Time the position was checked
d. Fight Level
e. Next Position and ETA.

METEOROLOGICAL REPORTING

Met reports shall contain the following elements of information:

a. Air Temperature
b. Wind Direction
c. Wind Speed
d. Turbulence
e. Aircraft Icing

EMERGENCY PHRASEOLOGY

Condition	Definition	Signal	Priority
Distress	A condition of being hreatened by serious and/or imminent danger and of requiring immediate assistance.	MAYDAY (spoken three times)	Absolute priority over all other communications.
Urgency	A condition concerning the safety of an aircraft, vehicle, or person, but which does not require immediate assistance.	PAN-PAN (spoken three times)	Priority over all communications except distress.

Action by Aircraft in Distress

- The initial call is made on the air-ground frequency in use.
- If contact is impossible, switch to 121.5 MHz (VHF Emergency).

Distress Message Format

1. **Signal: MAYDAY, MAYDAY, MAYDAY**
2. **Station Addressed:** (e.g., DELHI TOWER)
3. **Aircraft Identification:** (e.g., VT-ABC)
4. **Nature of Distress:** (The Condition)
5. **Intentions:** (Intention of the person in command)
6. **Position:** (Present position, Level, Heading)
7. **Pilot Info:** POB (Persons on Board), Endurance.

Urgency Procedures (PAN-PAN)

- **Signal**: PAN-PAN, PAN-PAN, PAN-PAN
- **Station Addressed**: Name of Station
- **Aircraft ID**: Call Sign
- **Nature of Urgency**: Description
- **Intentions**: What the pilot plans to do
- **Position**: Current position/level medical Transports

Medical Transports

For aircraft used for medical transports (protected under Geneva Conventions), the signal is **PAN-PAN MEDICAL**.

- **Pronunciation:** "May-Dee-Cal" (French pronunciation).
- **Format**: The transmission must include the initial urgency call followed by **MEDICAL** and the flight details:

  PAN-PAN, PAN-PAN, PAN-PAN

  EDICAL

  (Followed by station address, aircraft ID, position, and transport details).

The States of Emergency are classified as follows:

Pilots are urged, in their own interests to request assistance from the emergency service as soon as there is any doubt about the safe conduct of their flight. The provision of assistance may be delayed if a pilot does not pass clear details of his/her difficulties and requirements, using the international standard RTF 'MAY DAY, MAY DAY, MAY DAY' or 'PAN PAN, PAN PAN, PAN PAN' as appropriate.

If subsequent to the transmission of a 'MAYDAY' or 'PAN PAN', a pilot considers the problem not to be as serious as first thought and priority attention is n-o longer required, the emergency condition may be cancelled at the pilot discretion.
It is invariably preferable for pilots believing themselves to be facing an emergency situation to declare them as early as possible and then cancel later if they decide the situation allows.

If a pilot is already in communication with an ATS unit, before the emergency arises, assistance should be requested on the frequency in use. In this case, any SSR code setting previously assigned by ATC (other than 7700) should be retained until instruction are received to change the code.

CANCELLING MAYDAY/PAN PAN

When an aircraft is no longer in distress/urgency it shall transmit a message cancelling the emergency condition.
E.g. Transmission to cancel MAYDAY

Aircraft - Mumbai Tower, Vistara One Two Three CANCEL MAYDAY, Engine restarted, Runway in sight, Request Landing.
Controller - Vistara One Two Three, Cleared to Land, Runway Two Seven, Wings Two Seven Zero degrees One Zero knots.
Aircraft - Cleared to Land, Runway Two Seven, Vistara One Two Three.

IMPOSITION OF SILENCE:

Transmissions from aircraft in distress have priority over all other transmissions. On hearing a distress call, all stations must maintain radio silence on that frequency unless

- The distress is cancelled or the distress traffic is terminated;
- All distress traffic has been transferred to other frequencies;
- The station controlling communications gives permission;
- It has itself to render assistance.

Any station which has knowledge of distress traffic, and which cannot itself-assist the station in distress, shall nevertheless continue listening to such traffic until it is evident that assistance is being provided. Stations should take care not to interfere with the transmission of urgency calls.

E.g. Transmission for Imposition of Silence by ATC

"ALL STATIONS, DELHI TOWER, STOP TRANSMITTING, MAYDAY"

Meaning – All stations on Delhi Tower Frequency stop transmitting due aircraft in distress

OR

"Vistara One Two Three, STOP TRANSMITTING, MAYDAY"

Meaning - Vistara One Two Three, stop transmitting due aircraft in distress

COMMUNICATION FAILURE

Communication failures are classified into three types: **Air-Ground**, **Ground-to-Air**, and **Receiver Failure**.

Air-Ground Failure
(When the aircraft cannot contact the ground station on the designated frequency)

Pilot Actions:

1. **Attempt Alternate Frequencies**: Try secondary frequencies or other appropriate frequencies for
2. **Attempt Relay**: Try to contact other aircraft or aeronautical stations to relay the message.
3. **Monitor**: Listen on the appropriate VHF frequency for calls from nearby aircraft.

Blind Transmission Procedure:

If the above attempts fail, transmit the message twice on the designated frequency(ies).

- **Phrase: "TRANSMITTING BLIND"**
- **Network Operation**: Transmit twice on both Primary and Secondary frequencies.
- **Frequency Change**: Announce the frequency to which you are changing before switching.

Receiver Failure

(When the aircraft receiver has failed; pilot can talk but cannot hear)

Procedure:

1. **Schedule**: Transmit reports at the scheduled times or positions.
2. **Phrase**: **"TRANSMITTING BLIND DUE TO RECEIVER FAILURE"**
3. **Repetition**: Transmit the message, then immediately **repeat the entire message**.
4. **Next Transmission**: Advise the time of the **next intended transmission**.
5. **Intentions**: Advise the pilot's intentions regarding the continuation of the flight.
6. **SSR Code**: Squawk **7600**.

Ground-to-Air Failure

(When the ground station cannot contact the aircraft)

ATS Unit Actions:

1. Request other stations or aircraft to relay traffic.
2. If that fails, transmit messages **Blind**.
   - **Restriction:** Do **not** transmit ATC Clearances blind (unless specifically requested by the pilot).

Message Priorities in Radiotelephony

In voice communication (AMS), messages are prioritized strictly by their content to ensure safety.

Priority Order	Message Type	Radiotelephony Signal	Description
1 (Top)	**Distress**	**MAYDAY**	Grave and imminent danger; immediate assistance required.
2	**Urgency**	**PAN-PAN**	Safety of aircraft/person, but **no immediate danger**. (Includes PANPAN MEDICAL).
3	**Direction Finding**		Communications relating to radio direction finding.
4	**Flight Safety**		ATC clearances, position reports, instructions.
5	**Meteorological**		Weather information.
6	**Flight Regularity**		Operation schedules, servicing, arrival messages.

Important Note on NOTAMs: A NOTAM (Notice to Air Missions) may qualify for any category from Priority 3 to 6 depending on its content and importance to the aircraft.

Aeronautical Fixed Telecommunication Network (AFTN)

The AFTN is a worldwide system of aeronautical fixed circuits provided for the exchange of messages and digital data between aeronautical fixed stations.

Message Categories and Priority Indicators

There are **08 (eight)** distinct categories of messages within the AFT N system. Each category is assigned a specific **two-letter Priority Indicator** to ensure urgent messages are processed first.

Category of Message	Priority Indicator	Definition & Content
Distress Messages	**SS**	Grave and imminent danger, immediate
Urgency Message	**DD**	Concerning the safety of a ship, aircraft, or person (no immediate danger).
Flight Safety Messages	**FF**	1. Movement and control message (PANS-ATM). 2. Messages of immediate concern to aircraft in flight or preparing to depart. 3. Important MET info (SIGMET, volcanic ash).
Meteorological Messages	**GG**	1. Forecasts (TAF, Area/Route forecasts). 2. Observations and reports (METAR, SPECI).
Flight Regularity Messages	**GG**	1. Aircraft load messages (Weight & Balance). 2. Changes in operating schedules/ servicing. 3. Arrival/Departure reports from operating agencies.

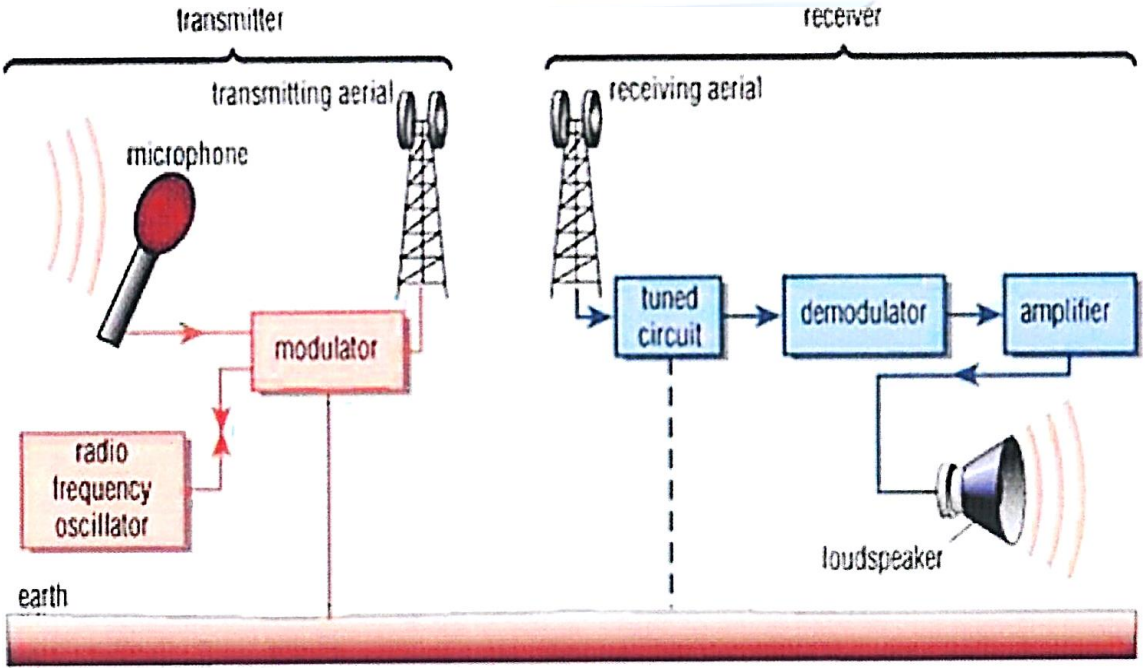
Aeronautical Information Services (AIS)	**GG**	1. Messages concerning NOTAMs. 2. SNOWTAMs.
Aeronautical Administrative Messages	**KK**	1. Operation/maintenance of safety facilities. 2. Functioning of telecom services. 3. Exchange between civil aviation authorities.
Service Messages	**As appropriate**	Messages regarding the technical operation of the network itself.

Note: While Meteorological, Flight Regularity, and AIS messages all share the priority indicator **GG**, they are distinct categories based on content.

RADIO OPERATIONS

Device	Function	Principle
Microphone	**Input Device**. Allows transmission of voice/audio.	Converts **sound waves (mechanical energy) into electrical signals.**
Headphones	**Output Device**. Allows private, clear listening.	Converts **electrical signals back into audible sound.**

Headphones are essential in aircraft to allow the operator to hear incoming signals clearly without ambient noise (engine/wind noise) interfering.



Squelch

- **Purpose**: To suppress background static noise when a desired radio signal is not present or is too weak.
- **Mechanism**: It acts as a noise gate, muting the receiver's audio output until a valid RF signal is detected that meets a specific strength threshold.

- **Benefit**: Prevents the unpleasant sound of continuous static, especially on twoway radios where communication is sporadic.

Automatic Volume Control (AVC) / Automatic Gain Control (AGC)

- **Purpose**: To maintain a consistent output volume for the operator despite variations in the incoming signal strength.
- **Mechanism**: AVC automatically detects the strength of the incoming signal and adjusts the receiver's internal amplifier gain accordingly.
- **Benefit**: Improves listening comfort and clarity by ensuring that loud signals don't sound too strong and weak signals aren't too soft.

Volume Control

- **Purpose**: A **manual interface** (usually a knob) that allows the operator to set the loudness of the output from the headphones or speakers for comfort or clarity.

Transmitter Tuning (Pilot's Perspective)

For pilots, **tuning** refers to the selection and adjustment of radio frequencies for communication and navigation.

- **Process**: Pilots use a Radio Tuning Panel or control display to dial or type in the desired numerical frequency (e.g., 116.90 MHz).

- **Active/Standby**: Radios typically use Active (currently transmitting/receiving) and **Standby** (preset for quick swap) frequencies, allowing for rapid transition between ATC channels.

- **Redundancy**: Aircraft have multiple radios to allow simultaneous monitoring and provide redundancy for primary ATC, emergency (123.5 MHz), or weather frequencies.

Transmitter Tuning (Technical)

- **Process**: The technical adjustment of the transmitter hardware to ensure it operates at the precise desired frequency and matches the antenna for efficient power transfer.

Simplex and Duplex Operation

These terms define the **directionality** of communication between two devices.

Mode	Directionality	Simultaneous Tx/Rx	Typical Example
Simplex	**One-way** (Unidirectional)	No	Radio/TV Broadcast (Receiver cannot reply)
Duplex	**Two-way** (Bidirectional)	Yes or No	Aviation, Telephony
Half Duplex	Two-way, **One direction at a time**	No	Walkie-Talkie (Push-totalk, release-to-listen)
Full Duplex	Two-way, **Both directions simultaneously**	Yes	Standard Telephone Conversation

Aviation: Most standard air-to-ground communication uses Half-Duplex (one party talks, the other listens), although the equipment is technically capable of **Full-Duplex** operation if separate channels were use

Radio Transmission

Radio communication is essential for maintaining **safety and efficiency** in flight operations.

- **Air-to-Ground Communication**: Pilots communicate with Air Traffic Control (ATC) for clearances, instructions, and flight updates.

- **Air-to-Air Communication**: Used for formation flying, collision avoidance, and exchanging critical weather or flight conditions with nearby aircraft. • Navigation: Radio signals are

fundamental for navigation aids like the Instrument Landing System (ILS) for precision approaches and VOR (VHF Omnidirectional Range).

- **Emergency Situations**: Radio is vital for pilots to declare emergencies, request assistance, and receive guidance.

Types of Text Communication in Aviation

System	Full Form	Function
CPDLC	Controller Pilot Data Link Communication	Text-based communication between aircraft and ATC
ACARS	Aircraft Communication Addressing and Reporting System	Connects aircraft to company operations

For ease of your understanding:

CPDLC = WhatsApp with ATC
ACARS = Email with your airline

Q CODES

QTE – True Bearing

QUJ – True Course

QDR – Magnetic Bearing

QDM – Magnetic Course

QDL – Series of Bearings

QRK – Readability

QSA – Signal Strength (1,2,3,4,5)

QAH – Height

QTJ – TAS

QTI – Heading

QBI – Mandatory IFR

QFU – Magnetic orientation of runway

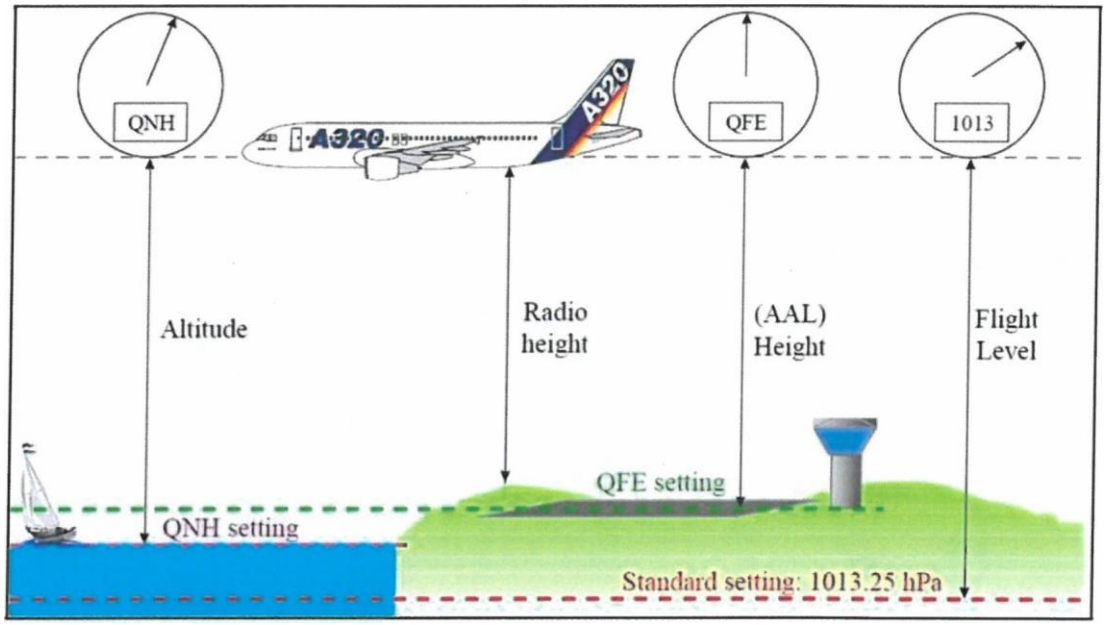
QTF – Position of station according to bearings taken by direction finder station

QNH – Aerodrome pressure deduced to MSL under standard atmospheric conditions.

QFE – Aerodrome pressure prevailing at aerodrome.

QNE – Height of an object or a place measured from the datum of 1013.25 hPa.

QFF – Aerodrome pressure deduced to MSL under existing atmospheric conditions.



- **What it indicates:** When set on the altimeter, the instrument displays the aircraft's **Altitude** (AMSL)
- **On the Ground**: If a pilot sets the QNH while the aircraft is on the ground, the altimeter will read the Aerodrome Elevation (the height of the airport above sea level).
- **Usage**: This is the most widely used setting for operations at low levels (below Transition Altitude) to ensure terrain clearance. It is a regional setting; pilots must reset it as they fly into new pressure regions.

QFE is the atmospheric pressure measured at a specific location (usually the aerodrome reference point or runway threshold).

What it indicates: When set on the altimeter, the instrument displays the aircraft's Height above that specific station.

On the Ground: If a pilot sets the QFE while on the runway, the altimeter will read ZERO .

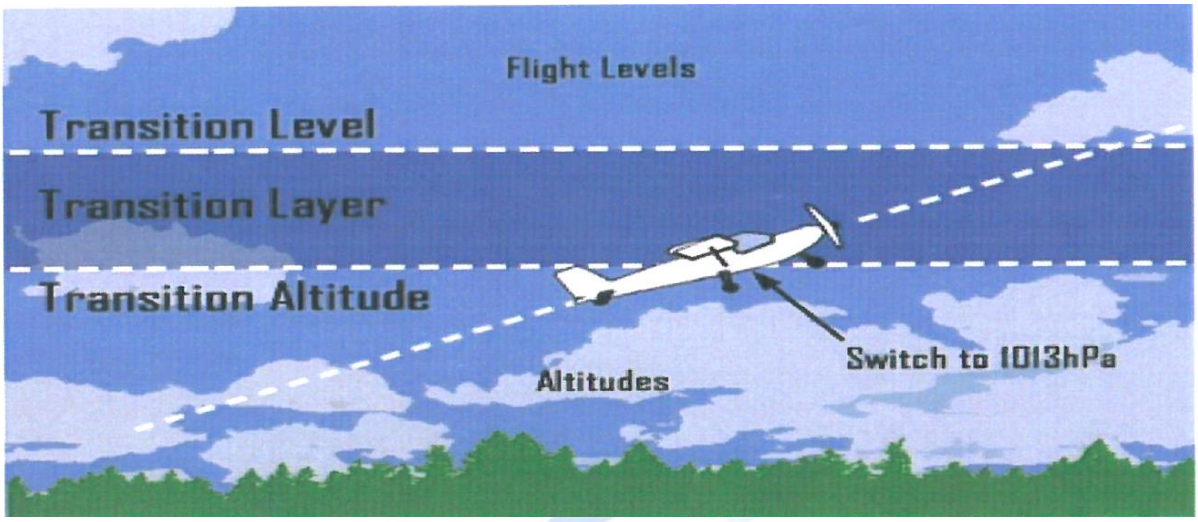
Usage: Historically used for landing and circuit training so pilots know their exact height above the ground.

QNE (Standard Pressure setting refers to the standard datum pressure of 1013.25 hPa (or 29.92 inHg).

What it indicates: When set, the altimeter displays Pressure Altitude or Flight Levels.

Usage: Used by pilots when flying at higher altitudes (above the Transition Altitude). By setting a common standard (1013.2 hPa), all aircraft provide a common datum for vertical measurement, ensuring safe separation regardless of the actual local weather pressure

Transition Altitude



Pilots must switch between QNH and QNE at the **Transition Altitude (TA)**.

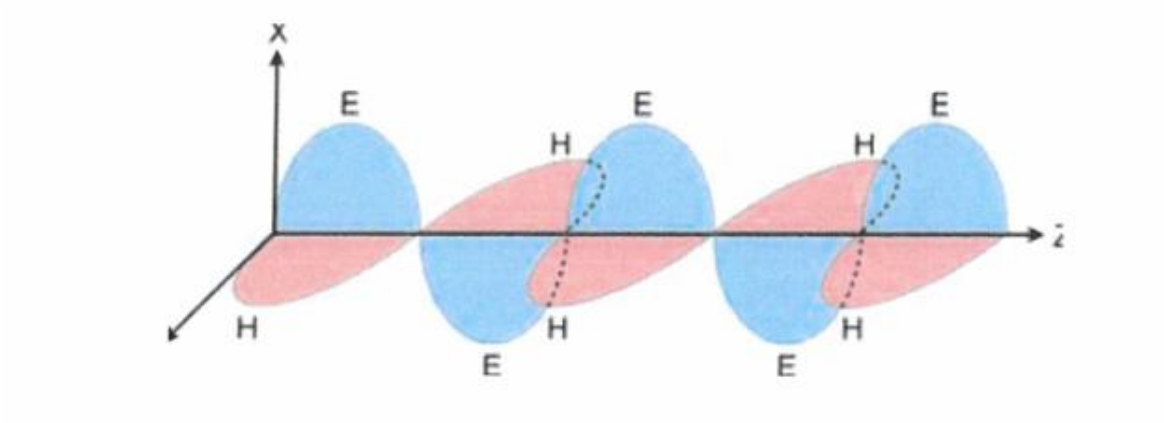
- **Above TA**: All aircraft set 1013.25 hPa. This ensures that Flight Level 350 is the same pressure level for all aircraft, preventing collisions.

- **Below TA**: Aircraft set the local **QNH**.

SECTION-3 RTR RADIO NAV

Radio Waves and Electromagnetic Propagation

When an Alternating Current (AC) is passed through a wire at a high frequency, energy radiates outward in the form of electromagnetic waves, also known as radio waves. These waves consist of two components: an **Electric field** and a Magnetic field, oscillating at right angles to each other and to the direction of travel.



Wave Properties

- **Cycle**: One complete oscillation (one crest + one trough).
- **Period (T)**: The time taken to complete one cycle, typically measured in microseconds.
- **Frequency (f)**: The number of cycles per second, measured in Hertz (Hz).
- **Wavelength (lambda)**: The physical distance between two consecutive crests or troughs, measured in meters.
- **Amplitude**: The maximum displacement from the mean (rest) position (signal strength).

Band Name	Abbreviation	Frequency Range	Primary Propagation	Typical Aviation & Maritime Uses
Very Low	VLF	3 – 30 kHz	Ground Wave (Waveguide)	Long-range submarine communication; some old

				navigation systems.
Low Frequency	LF	30 – 300 kHz	Ground Wave	NDB (Non – Directional Beacons), Maritime broadcasting.
Medium Frequency	MF	300 – 3,000 kHz	Ground Wave (Day) / Sky Wave (Night)	NDB, Commercial AM Broadcast Maritime distress (2182 kHz).
High Frequency	HF	3 – 30 MHz	Sky Wave	Long-range Voice Comms (Oceanic/Polar), HF DL (Data Link).
Very High Frequ	VHF	30 – 300 MHz	Line-of-Sight (Space Wave)	ATC Voice Comms (118-137 MHz), VOR, ILS Localizer, Marker Beacons.
Ultra High Frequency	UHF	30 – 3,000 MHz	Line-of-Sight	ILS Glide Path, DME, Military Comms, SSR Transponders (1030/1090 MHz), GPS (L1/L2).
Super High Frequency	SHF	3 – 30 GHz	Line-of-Sight	Radio Altimeters, Weather Radar,

				SATCOM, MLS (Microwave Landing System).
Extremely High Frequency	EHF	30 – 300 GHz	Line-of-Sight	Advanced military comms, Airport Surface Radar (ASDE).

In free space, radio waves travel at the speed of light (c), approximately 3x10^8 m/s.

Polarization

Polarization is defined by the orientation of the electric field.

- **Vertically Polarized**: The electric field oscillates in the vertical plane.
- **Horizontally Polarized**: The electric field oscillates in the horizontal plane.
- **Vertically polarized** waves are preferred in aviation because horizontally polarized waves suffer greater attenuation due to ground reflections and absorption by the Earth's surface.

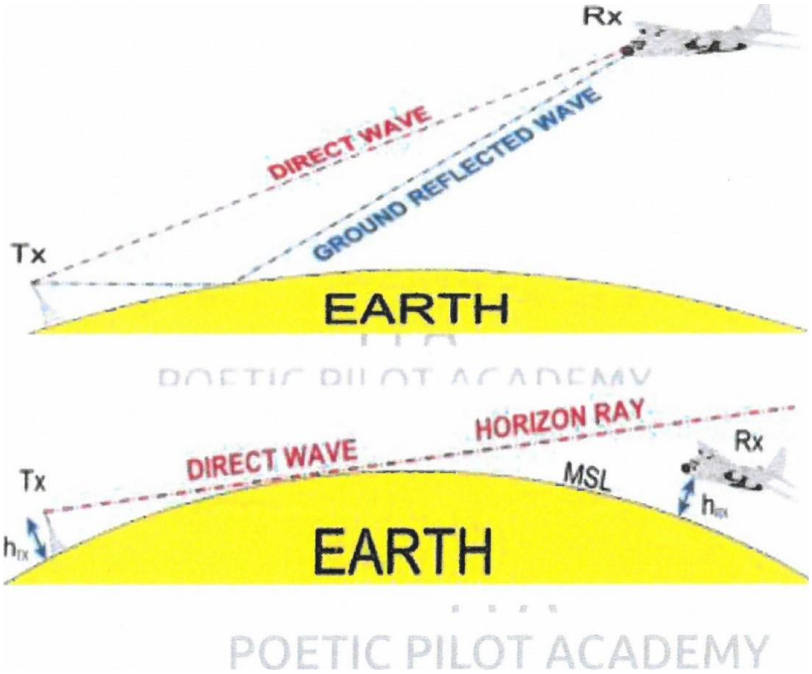
Propagation

Radio Frequency (RF) Propagation refers to how radio waves travel through space and different mediums.
there are two basic methods of propagation:
Surface Wave (Non Ionospheric Propagation)
Space Wave (Ionospheric Propagation)

Sky Wave (Ionospheric Propagation)

Attenuation: The decrease in signal strength (weakening) as the wave travels distance. It occurs as the wave energy is absorbed by the atmosphere or the ground.

- **Fading**: This occurs when a radio signal becomes weak or distorts because the signal takes multiple paths to the receiver and interferes with itself.



(Ground Wave/Surface Wave) Non Ionospheric Propagation

Ground waves travel along the Earth's surface. They follow the curvature of the Earth due to the physical phenomenon of Diffraction.

- **Frequency Range**: Most effective in VLF (Very Low Frequency) and LF (Low Frequency) bands, and the lower part of the MF (Medium Frequency) band (30 kHz — 2 MHz).

- **Characteristics**:
  - They are reliable and not heavily affected by atmospheric changes.
  - They travel best over seawater (good conductivity). Range over sea is roughly 3 x sqrt(Power), whereas range over land is only 2 x sqrt(Power).

- As frequency **increases**, the attenuation of the ground wave increases, drastically reducing its range. This is why VHF/UHF cannot use ground waves.

Sky Wave (Ionospheric Propagation)

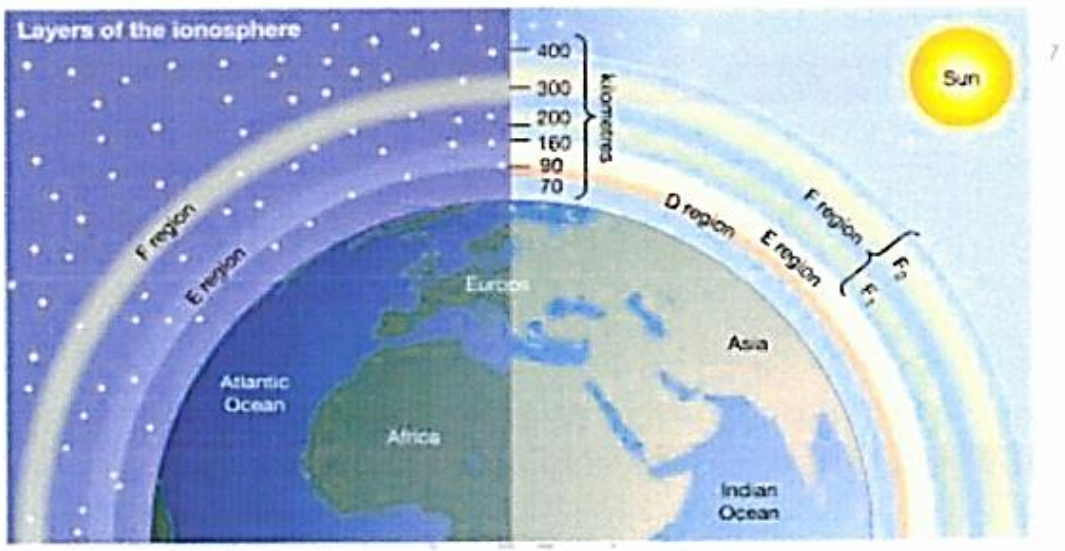
Sky wave propagation utilizes the Ionosphere, a region of ionized particles 60—400km above the Earth, to refract (bend) radio waves back to Earth. This allows for LongRange communication beyond the horizon.

- **Frequency Range**: Primarily HF (High Frequency) band (3 — 30 MHz).

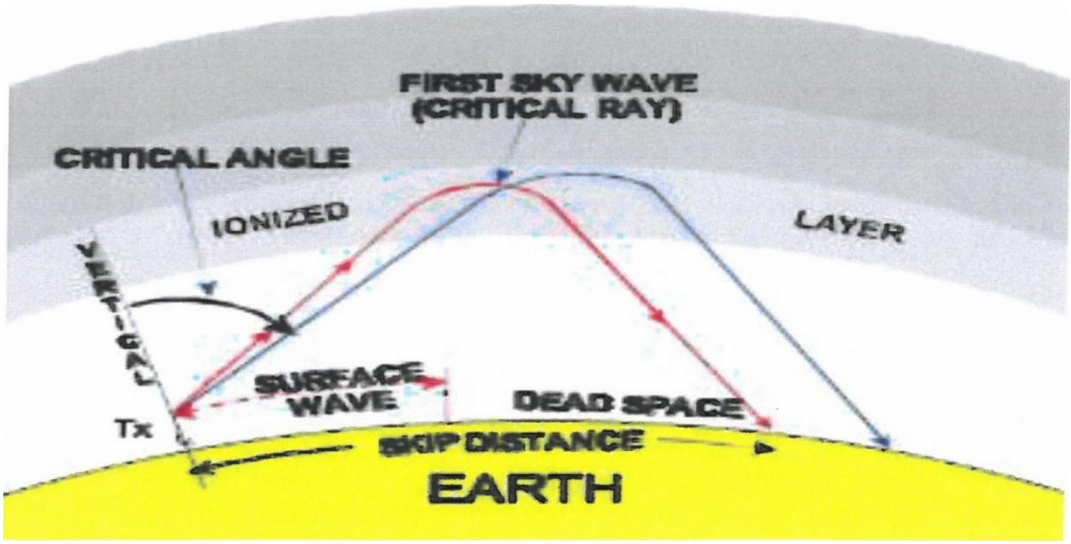
- **The Ionosphere**: Created by solar radiation ionizing the atmosphere. It is stronger in summer and during the day and in lower latitude

Layers of the Ionosphere

1. **D Layer (—75 km)**: Exists only during the day. It absorbs/attenuates radio waves. It does not refract useful signals.
2. **E Layer (—125 km)**: Refracts some signals but also attenuates.
3. **F Layer (—225—400 km)**: The most important layer for long-distance HF communication.
    - Day: Splits into Fl (lower) and F2 (higher).
    - Night: Merges into a single, strong F Layer. Because the D layer disappear at night, E layer rises, HF signals often travel further at night



- **Skip Distance:**
- first sky wave returns to Earth.
    - **Factors**: Higher frequencies and lower transmission angles result in longer skip distances.
    - **Dead Space**: The area between the end of the ground wave coverage and the beginning of the sky wave reception. In this zone, no signal is received.
    - **Multi-hop**: Signals can bounce between the Earth and Ionosphere multiple times to travel around the globe.



Space Wave (Line of Sight)

Space Wave propagation occurs when the transmitting and receiving antennas can "see" each other. It consists of a Direct Wave and a Ground-Reflected Wave.

- **Frequency Range**: VHF (Very High Frequency) and above (> 30 MHz).
- **Applications**: VHF Aviation Radio (118-137 MHz), VOR, Satellite Comm (SATCOM), GNSS, AIS.

Radio Horizon

Because the Earth is curved, the range is limited. However, due to slight atmospheric refraction, radio waves bend slightly over the horizon. 17 Therefore, the Radio Horizon is approx. 15% further than the Visual Horizon.

Range Calculation

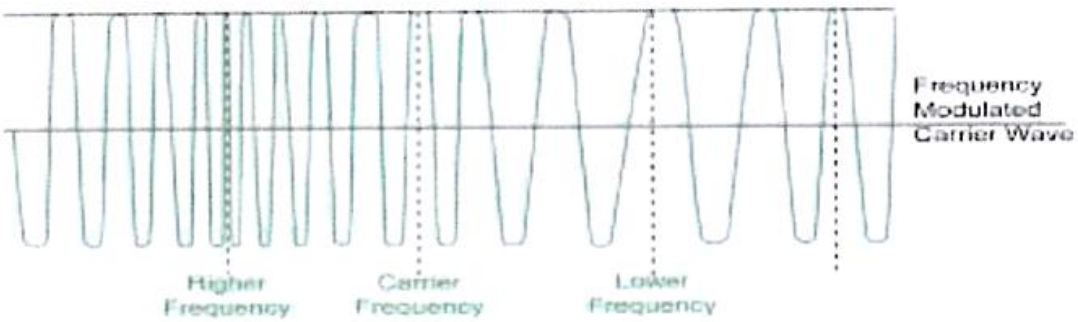
To maximize range, antennas must be placed as high as possible. The theoretical lineof-sight range (in Nautical Miles) can be calculated as:
Range (NM) = 1.25 x MhTX+ 1.25 x hRX where hTX and hRX are the heights of the transmitting and receiving antennas in feet.

Modulation

Modulation is the process of superimposing information (voice/data) onto a carrier wave.

- **Amplitude Modulation (AM)**: The amplitude (strength) varies; frequency remains constant. Used in Aeronautical VHF Voice.

- **Frequency Modulation (FM)**: The frequency varies; amplitude remains constant. Used in Marine VHF and music broadcasting.



Advantages of Radio Communication

- **Reliability & Durability**: Often reliable in emergencies when cellular networks fail. Radios are durable and weather-resistant.
- **Instant Connection**: Provides instant connectivity without dialing or waiting.
- **Group Communication**: Excellent for coordinating efforts among multiple users simultaneously.
- **Geographical Advantages**: Effective in remote or rural locations where cellular service is unavailable.

Disadvantages and Limitations

- **Limited Range**: VHF is limited to the line-of-sight distance.
- **Interference**: Signals can be affected by atmospheric conditions, terrain, and other radio sources, leading to garbled or lost messages.
- **Weakness**: These signals can be easily listened to by others (unless they are encrypted) and can also be blocked or disturbed

Range Limitations (VHF)

The effective range of VHF signals is limited by the distance to the horizon (line-of-sight).

- **Altitude**: Higher aircraft altitude increases the line-of-sight range.
- **Obstructions**: Mountains or large buildings can block or attenuate the signal.
- **Weather**: Thunderstorms can cause static and reduce range.

Frequency Interference

Interference degrades clarity, increases pilot workload, and risks miscommunication.

- **Adjacent Band Interference**: Occurs when signals from a frequency band near the aviation band (e.g., the FM radio band below VHF) leak into aviation frequencies.
- **Co-channel Interference**: Occurs when the same frequency is reused in nearby geographical areas, causing signals from different users to overlap.
- **External Sources**: New technologies like 5G networks and IOT devices increase the likelihood of interference in the VHF/UHF bands.

NDB & ADF

What is an NDB?

NDB = **Non-Directional Beacon**, a ground-based transmitter that radiates **continuous electromagnetic waves in ALL directions** (omnidirectional).

Technical Characteristics

- **Frequency band:** 190 – 450 kHz (Upper LF, lower MF band)
- **Modulation:**
  - Mostly **unmodulated plain carrier wave**
  - Sometimes modulated with Morse code → emission codes NON A1A / NON A2A
- **Antenna Polarisation:**
  - **Vertical**, because NDB uses **ground wave propagation**
  - Vertical polarisation reduces ground absorption → better long-distance coverage

Range (DOC – Designated Operational Coverage)

- **Daytime:** Up to 200 NM, depending on power
- **Nighttime:** Usual working range ~70 NM, beyond which skywaves return and cause interference

ADF – Automatic Direction Finder (On Aircraft)

ADF is the airborne receiver that detects and identifies NDB signals.

ADF Frequency Range

- **190 – 1750 kHz**
  (ADF convers a wider band because it also includes frequencies shared with commercial radio broadcasts)

Why ADF range > NDB range?

Because ADF must be capable of tuning to all NDBs **plus** surrounding radio bands to prevent interference.

How ADF Determines Direction (Loop Theory)
ADF uses two antennas:

1. **Loop Antenna**

- Highly directional
- Produces figure-of-eight sensitivity pattern
  As it rotates, the received signal strength varies →
  - 2 maxima (peak)
  - 2 minima/nulls (deep drops)

ADF uses the null to detect the bearing because null is sharper and easier to detect.

Issue → 180° Ambiguity
The null occurs in **two opposite directions**, so the loop alone cannot differentiate **front** from **back**.

2. **Sense Antenna**

• Non-directional
• Adds a uniform signal
• When combined with loop output → produces cardioid pattern
  - clearly identifiable front lobe
  - reduces rear lobe

This removes 180° ambiguity.

Relative Bearing (RB)

ADF needle points TO the station relative to aircraft nose.
QDM, QDR, MB

- QDM = Magnetic bearing to the station
- QDR = Magnetic bearing from the station
- MB = Magnetic Bearing

ADF Errors (Important)

1. **Night Effect**
   - At night, ionosphere reflects MF/LF waves producing skywaves.
   - Beyond 70 NM → ADF needle oscillates/hunts.

2. **Mountain Effect**
   - Mountains reflect NDB waves → multi-path → needle becomes unstable.

3. **Coastal Refraction**
   - When radio wave transitions between land → sea (or vice versa)
   - Wave bends (refracts) depending on conductivity difference
   - Greatest when flying oblique to coastline
   - **Minimise error by:**
     - Flying perpendicular (90°) to coast
     - Using NDBs near coastline
     - Flying higher

4. **Thunderstorm Error**
   - Lightning emits electromagnetic pulses
   - Loop antenna senses these pulses → needle jumps towards storm.

5. **Precipitation Static**
   - Raindrops/ice hitting airframe cause static discharge
   - Interferes with ADF reception → decreased accuracy.

6. **Station Interference**
   - Overlapping coverage of multiple NDBs
   - ADF picks mixed signals → needle unstable.

7. **Dip Error (During Turns)**
   - Banking makes vertical waves hit loop antenna at angle
   - Loop becomes misaligned → bearing errors.

VOR – VERY HIGH FREQUENCY OMNIDIRECTIONAL RANGE

Purpose

Provides azimuth (bearing) information incredibly accurately using VHF signals.

Technical Data

- Frequency: 108.00–117.95 MHz
  - 108–112 MHz: Shared with ILS Localizer (odd decimals only)
  - 112–117.95 MHz: VOR only
- **Channel spacing:** 50 kHz
- **Emission code:** A9W

Working Principle – "Bearing by Phase Comparison"
VOR ground station transmits **two 30 Hz signals:**

1. **Reference Signal**
   - Frequency Modulated (FM)
   - Omnidirectional
   - Provides constant phase everywhere

2. **Variable Signal**
   - Amplitude Modulated (AM)
   - Electronically rotates **360° per second**
   - Phase depends on direction

Aircraft compares phase difference between the two signals.
Phase difference = **Your radial**.

Example:

- 0° → radial 000
- 90° → radial 090
- 180° → radial 180
- 270° → radial 270

Polar Diagram

The combination of signals forms a **limacon** pattern (moving cardioid).
Horizontal polarisation → requires horizontal antennas on aircraft.

Site Errors

Happen when VOR waves reflect off:

- Buildings
- Hangars
- Mountains
- Metallic structures

This causes phase distortion → incorrect radial.

DVOR – Doppler VOR

To reduce site errors, DVOR uses **Doppler shift**:

- Has 51 antennas:
  - Reference
  - 50 variable (25 + 25 mirror antennas)

- Creates an electronically rotating field
- Much more accurate than CVOR

Types of VOR

CVOR Older, prone to site error

DVOR Doppler, improved accuracy

TVOR Terminal VOR (short range)

BVOR Broadcasts voice (ATIS)

VOT VOR testing, 108.0 MHz

Cone of Confusion

Directly overhead VOR:

- Radials converge
- Needle swings
- TO/FROM fluctuates
- Momentary “OFF” Flag

ILS – INSTRUMENT LANDING SYSTEM

Purpose

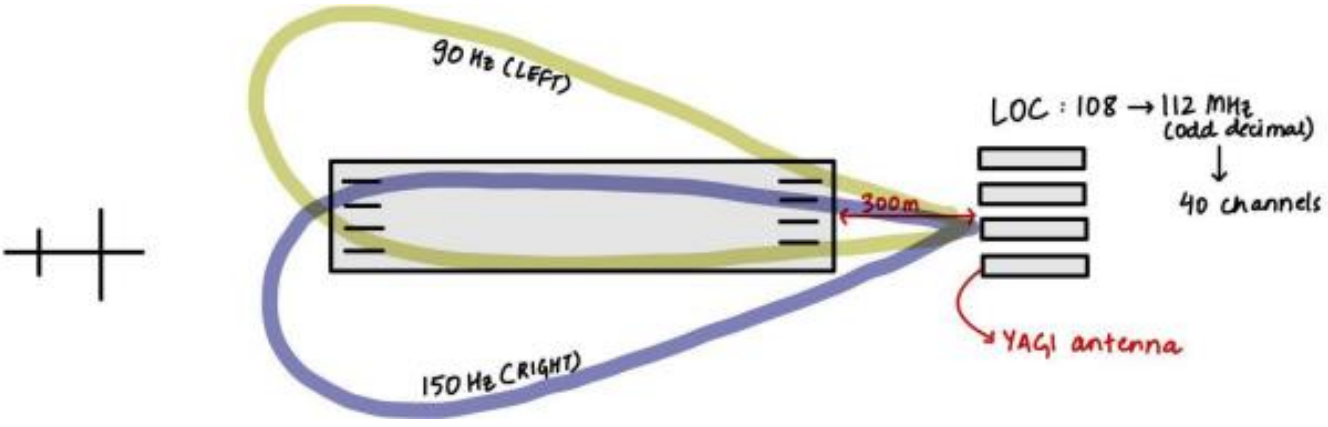
A **precision approach** aid providing:

- A precision approach aid providing:
- Lateral guidance → Localizer
- Vertical guidance → Glideslope
- Range guidance → Marker beacons or DME
- Visual transition → Approach Lighting System (ALS)

Localizer (LOC)

Details

- Frequency: 108–112 MHz (odd decimals only)
- Located at far end of runway
- Width of course: ~700 ft at threshold



Principle – Difference in Depth of Modulation (DDM)

Two overlapping beams:

- Left beam: 90 Hz
- Right beam: 150 Hz
- When aircraft is on centerline:
- Modulation depth equal → DDM = 0

If 90 Hz > 150 Hz → Aircraft right

If 150 Hz > 90 Hz → Aircraft left

Glideslope (GS)

GS Frequency

- 329–335 MHz
- Located near runway touch-down zone (approx 300 m from threshold)

Principle

Two beams:

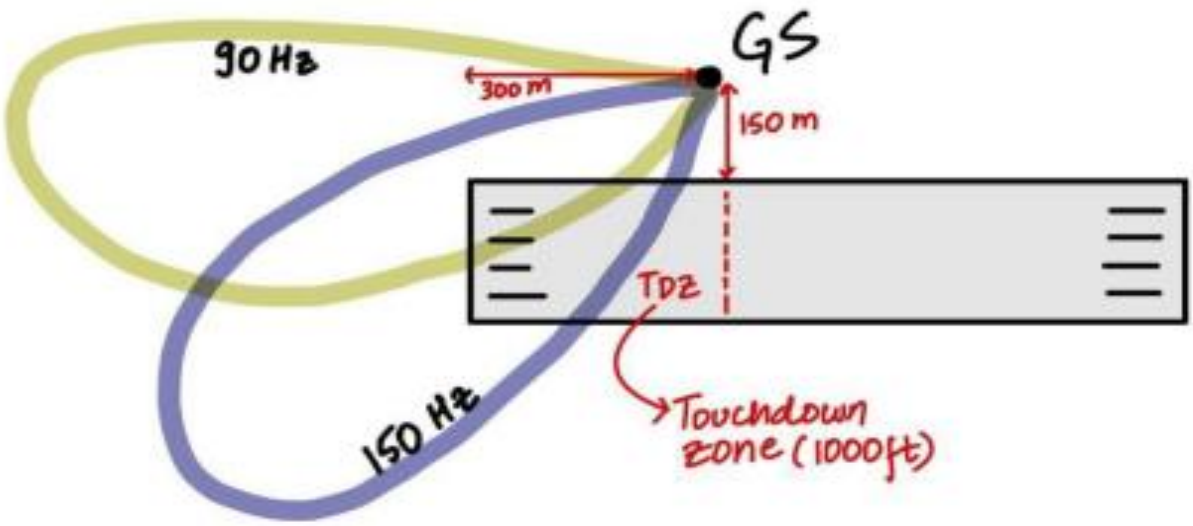
- Upper beam → 90 Hz
- Lower beam → 150 Hz

The aircraft seeks the point where both are equal → the 3° slope.

False Glideslopes

Because GS uses UHF:

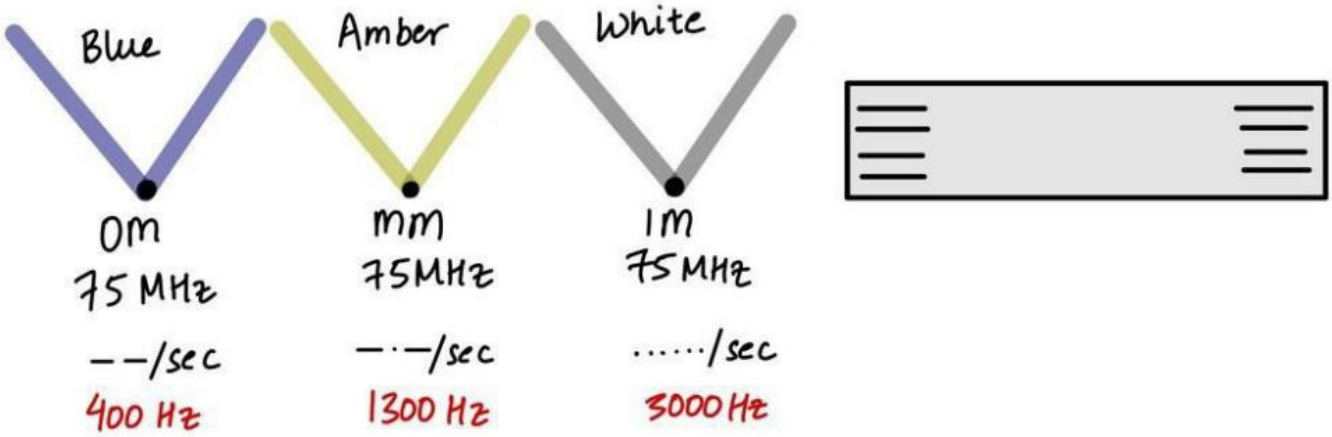
- Harmonic lobes form at multiples of the main angle
- E.g. 6°, 9°
- If aircraft intercepts GS from above → risk of capturing wrong slope.



Marker Beacons (75 MHz)

Marker Distance Audio Light Purpose

OM	4–7 NM	“—”	Blue FAF position
MM	~1000 m	“–.–”	Amber Decision altitude region
IM	200 ft	“.”	White CAT II/III only



DME – DISTANCE MEASURING EQUIPMENT

Principle – Secondary Radar

Aircraft = **Interrogator**

Ground = **Transponder**

Aircraft sends pulses → Station replies → Time difference → **Slant distance**.

Technical Details

- Frequency: 962–1213 MHz
- Channels: 252 total
- Accuracy: ±0.25 NM or 1.25%

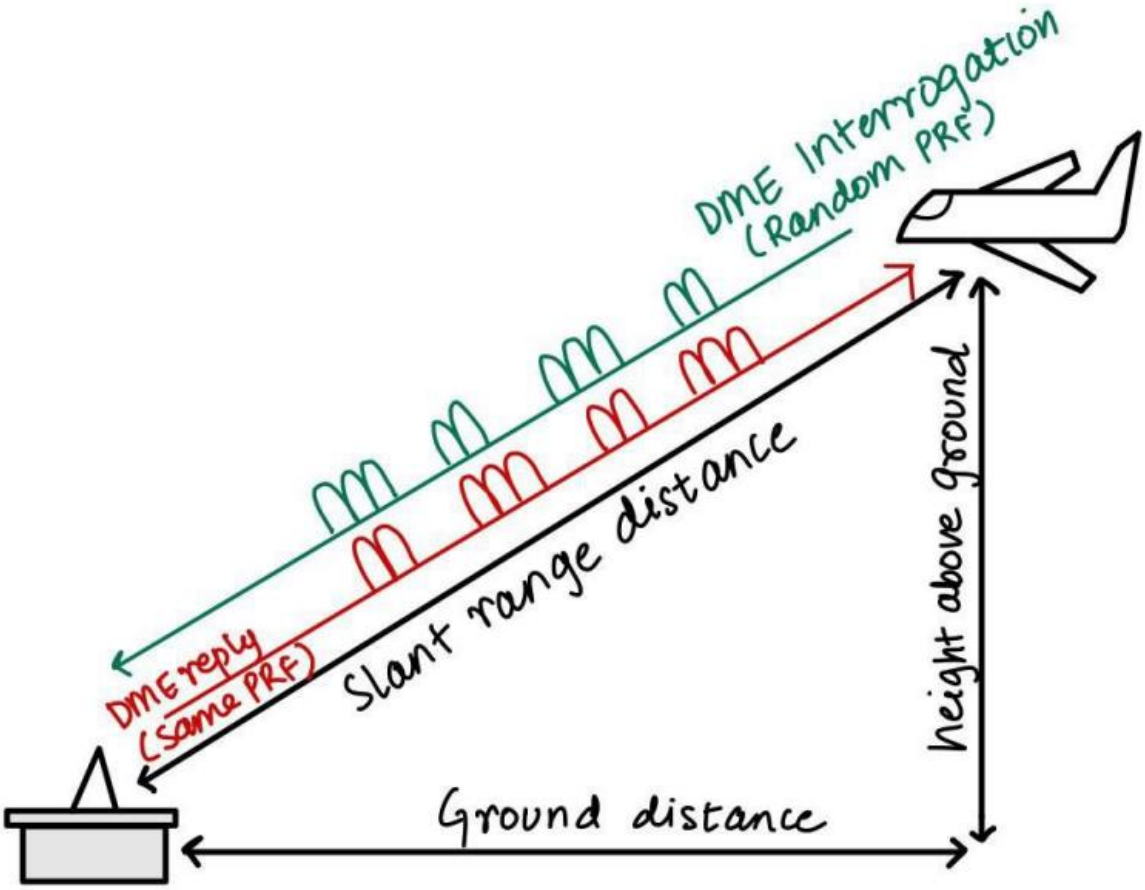
Modes of Operation

- **Search Mode**
  - 150 pps
  - Up to 100 seconds
  - Max 15,000 pps (from many aircraft)

- **Lock-On Mode**
  - 24–30 pps
  - Occurs after matching jitter pattern

- **Standby Mode**
  - If lock fails → 60 pps

- **DME Ground Limitations**
  - Can respond to max 100 aircraft at once
  - Max rate: 2700 pps



GPS – GLOBAL POSITIONING SYSTEM

GPS Segments

1. Space Segment

- 24 satellites
- 6 orbital planes (4 per plane)

2. Control Segment

- Master Control Station → Colorado, USA
- Managed by NASA

3. User Segment

- GPS receivers
- **Types:**
  - Sequential receivers
  - Multichannel receivers

Satellite Types

- Active → amplification built in
- Passive → none (not used)

Working Principle – Trilateration

GPS uses:

- 1–2 GHz frequency range
- Measures time delay of signals

[D = c (T_1 - T_2)]
Need 4 satellites for position (3D + time solution).

Accuracy

- SPS → 5 m
- PPS → 30 cm

Augmentation Systems

SBAS :

Region	System
USA	WAAS
Europe	EGNOS
Japan	MSAS
India	**GAGAN**

Corrects:

- Ionospheric error
- Clock error
- Satellite ephemeris error

Improves to **<1 m** accuracy.

GBAS:

Ground correction at airport
Ultra-precise approach guidance

RAIM (Receiver Autonomous Integrity Monitoring)

- Monitors satellite integrity
- Requires ≥5 satellites
- Identifies faulty satellite

PBN (Pilot Bulletin Number)

RNAV (Area Navigation)

Aircraft can navigate without flying station-to-station.
Uses:

- GPS
- VOR/DME
- DME/DME
- IRS/INS
- FMS waypoints

RNP (Required Navigation Performance)

RNAV + **onboard monitoring and alerting**
Examples:

- RNP 1 → maintain within 1 NM
- RNP AR → special terrain approaches

RADIO AND FREQUENCY CHART

Radio Aid	Frequencies
ADF	190-1750 kHz
ILS LOC	108.1-111.975 MHz
ILS MARKERS	75 MHz
ILS GS	329.15-335 MHz
VHF Comm	118-137 MHz
HF Comm	2.8-22 MHz
VOR	108-117.95 MHz
DME	962-1213 MHz
GPS	1.57542 GHz
Satcom	1500-1600 MHz (A/C to Sat), 4000-6000 MHz (Sat to A/C)
ATC Surveillance Radar	600 MHz, 1300 MHz, 3100 MHz
Precision Approach Radar	10-17 GHz
Ground Surveillance	10-17 GHz
Weather Radar	9375 MHz
Radio Altimeter	4200-4400 MHz

Freq Band	Radio Aid	Freq Used	Principle	Coverage	Accuracy
VLF (3-30 kHz)	VLF Comm	-	Ground wave	5,000 – 20,000 km	-
LF (30-300 kHz)	ADF/NDB	190-1750 kHz	Loop theory (bearing)	Locator 25 nm, Homing 50 nm, Long-range 100nm	70 nm by night, DOC
MF (300-3000kHz)	-	-	-	-	-
HF (300-3000 kHz)	HF Comm	2-25 MHz	Skywave reflection	Skip dependent, up to 2000 nm	-
VHF (30-300 MHz)	Marker Beacon	75 MHz	-	Line of sight	±3% (95%), ±5° gmd arc
	VOR/ DVOR	108.0-117.9 MHz	Phase comparison	Line of sight	±3° Conv. ±1° TAC
	ILS Localiser	108.0-117.975	Phase comparison	±35° (10 nm), ±10° (18 nm)	-
	VHF Comm	118-137 MHz	AM, Vertical polarization	Line of sight	-
	ACARS	136.9 MHz	Datalink	Line of sight	-
	ILS Glide Slope	329.15-335MHz	Lobe comparison	±8° (10 nm), ±7° (200 ft)	±0.5 m
	DME	962-1213 MHz	Random PRF	200 nm	±0.25 nm or 1%

UHF	SSR	1030/1090 MHz	Interrogation /Reply	TA 48-20 sec, RA 35-15 sec	-
	TCAS	1030/1090 MHz	-	-	-
	GPS	L1 1575 MHz, L2 1228 Mhz	PRN Code	Global	GBAS/SBAS >1 m, ±15 m horiz.
SHF (3-30 GHz)	MLS	5030-5090 MHz	TRSB	Az ±40°, EI ±15°, 20 nm	GS ±20°, ±2° V, DME ±100 ft
	Satcom	6 / 4 / 1.5 GHz	GEO Satellite	80°N-80° S	-
	Radio Altimeter	4.2-4.4 GHz	FMCW	<2000 ft AGL	±3 ft or ±1 ft
X Band	Doppler Radar	8.8-13.5 GHz	Doppler shift	-	1% GS & drift
	Weather Radar	9.375 GHz	Searchlight principle	90° horiz., ±15° lat.	-
Ku Band	Seach Radar	12.5-16 GHz	PRI, PW, Beam width	-	-
K Band	Search Radar	16-40 GHz	-	-	-

SECTION - 4 RTR MET and REGULATIONS

METAR

1. Meteorological Aerodrome Report.

It is a routine observation of the current weather at an aerodrome.

- Issued every 30 min in India (00 and 30 min)
- Issued every hour in many ICAO states
- Valid only at the time of observation

✓ METAR = Routine
✓ SPECI = Special report when weather changes significantly

2. Standard METAR Format

A METAR is reported in a fixed sequence:

i. **Type of Report** – METAR / SPECI
ii. **Station Identifier** – e.g., VIDP, VABB
iii. **Date & Time (UTC)** – DDHHMMZ
iv. **Wind** – Direction (true) and speed (KT)
v. **Visibility**
vi. **RVR (Runway Visual Range)**
vii. **Present Weather**
viii. **Clouds**
ix. **Temperature / Dewpoint**
x. **QNH (Pressure)**
xi. **Recent Weather (RE)**
xii. **Trend / Temporary Changes**

3. Explanation of Each Component

A. Visibility

Reported in **metres**.

Examples:

- **1500S** → 1500 m towards the South
- **5000N** → 5000 m towards the North
- **9999** → 10 km or more

B. RVR (Runway Visual Range)

Format**: Ryy/xxxx**

Examples:

- **R15/P1500U** → Runway 15, more than 1500 m, **U = upward trend**
- **R15/M0500** → Less than 500 m

Modifiers:

- U → Upward (improving)
- D → Downward (deteriorating)
- N → No change

C. Present Weather

Uses ICAO two-letter codes:

Precipitation

- DZ = Drizzle
- RA = Rain
- SN = Snow
- SHRA = Rain showers
- +RA = Heavy rain
- –RA = Light rain

Obscuration

- FG = Fog
- BR = Mist
- HZ = Haze
- DU = Dust
- SA = Sand
- VA = Volcanic ash

Thunderstorm

- TS = Thunderstorm
- TSRA = Thunderstorm with rain
- +TSRA = Severe TS with heavy rain

D. Clouds

Reported in oktas (0–8 parts of the sky).

Code	Coverage	Oktas
SKC	Sky Clear	0
FEW	Few	1-2
SCT	Scattered	3-4
BKN	Broken (ceiling)	5-7
OVC	Overcast	8

If cumulonimbus:

- **CB**

If towering cumulus:

- **TCU**

Example: **FEW020** → Few clouds at 2000 ft

E. Temperature & Dewpoint

Format: **T/D**

Example:

- 32/29 → Temp 32°C, Dewpoint 29°C
- M02/M04 → Minus 2°C, minus 4°C

F. QNH (Pressure)

Format: **Q1010** = 1010 hPa

G. Recent Weather

Identified by **RE**

Examples:

- REFG → Recent fog
- RERA → Recent rain

Trends

- **BECMG** → Becoming (gradual change)
- **TEMPO** → Temporary fluctuations
- **FM** → From a specific time

Example

 # METAR VIDP 160230Z 30005KT 290V050 1500S 5000N R15/1500U BR FEW020 FEW025CB SCT120 BKN300 32/29 Q1003 REFG TEMPO FM0330 22015G25KT 3000 +TSRA FEW010 SCT025CB BKN150 BECMG AT0415 27008KT CAVOK=

 # METAR VIDP 030830Z 31005KT 6000 FEW035 SCT100 32/13 Q1010 NOSIG=

 # METAR VABB 030830Z 28010KT 4500 FU NSC 31/21 Q1010 NOSIG=

 # METAR VAAH 030800Z VRB03KT 9999 SCT022 20/13 Q1028 NOSIG

NOTAM – NOTICE TO AIRMEN

A **NOTAM** is a notice distributed by means of telecommunication containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

- **Full Form**: "Notice to Airmen"
- **Governance**: NOTAMs are created and transmitted under guidelines specified by ICAO Annex 15 (Aeronautical Information Services).
- **Objective**: To alert pilots of hazards en route or at specific locations.

NOTAMs are distributed via the **Aeronautical Fixed Telecommunication Network (AFTN)**.

- **Advance Notice**: They should be distributed at least seven days prior to the effective date for significant information, or at least 48 hours advance notice for other operational changes.
- **Distinction from AIP Supplement**:
  - **NOTAMs** cover urgent/short-term changes and are distributed via telecommunication (AFT N).
  - **AIP Supplements** cover temporary changes of long duration (usually 3 months or more) or those with extensive text/graphics and are distributed by means other than telecommunication (e.g., post, email, eAlP).

NOTAM Series in India

NOTAMs are classified into series based on their content and distribution range:

Series	Description & Distribution
Series A	Information of concern to **long or medium-range flights**. Given selected **international** distribution. (Likely to last > 2 hours).
Series B	Full information on all airports/facilities available for international civil aviation. Given distribution to **adjacent states only**. (Likely to last 30 min to 2 hours).
Series C	Information of concern to **domestic** (national) aviation only. Not distributed internationally.
Series D	Information on all **Defense-controlled airports**, facilities, and procedures.
Series G	Contains information of a **General & lasting character (permanent) affecting aircraft operations. Issued only by the International NOTAM Office, Delhi** under the authority of DGCA.
Series S	SNOWTAM: Presence/removal of hazardous conditions due to **Snow**, slush, or ice on aerodrome pavements.

NOTAM Offices

There are **four** International NOTAM offices in India located at the major flight information centers:

1. **Delhi**
2. **Mumbai**
3. **Kolkata**
4. **Chennai**

TAF — Terminal Aerodrome Forecast

TAF is the long forecast.

Validity:

- **TAF 9 hr** → issued every 3 hrs
- **TAF 12–30 hr** → issued every 6 hrs

Helps ATC plan:

- Runway config
- Traffic separation
- Slot management

Example

TAF VABB 030500Z 0306/0412 28006KT 4000 FU FEW100 BECMG 0309/0311 28012KT 5000 FU SCT020 SCT100 TEMPO 0309/0312 29010G20KT BECMG 0315/0317 32006KT 4000 HZ FEW020 BECMG 0320/0322 VRB03KT 3000 HZ BECMG 0403/0405 28006KT 4000 HZ SCT020 BECMG 0409/0411 28012KT 5000 FU SCT020 SCT100=

TAF VIDP 030801Z 0308/0412 32010KT 4500 HZ FEW035 SCT100 TEMPO 0312/0316 32010G20KT 2000 -TSRA SCT030 FEW035CB BKN090 BECMG 0317/0319 24005KT 4000 HZ SCT030 SCT100 TEMPO 0321/0401 29015G25KT 1500 -TSRA SCT030 FEW035CB BKN090 BECMG 0404/0406 05008G18KT 2500 BLDU SCT030 SCT090 TEMPO 0408/0412 18010G20KT 2000 -TSRA SCT030 FEW035CB BKN090=

TAF VABB 030500Z 0306/0412 28006KT 4000 FU FEW100 BECMG 0309/0311 28012KT 5000 FU SCT020 SCT100 TEMPO 0309/0312 29010G20KT BECMG 0315/0317 32006KT 4000 HZ FEW020 BECMG 0320/0322 VRB03KT 3000 HZ BECMG 0403/0405 28006KT 4000 HZ SCT020 BECMG 0409/0411 28012KT 5000 FU SCT020 SCT100=

Automatic Terminal Information Service (ATIS)

- **Definition**: A continuous and repetitive broadcast of recorded aeronautical information at busy airports.
- **Purpose**: To reduce controller workload and frequency congestion.
- **D-ATIS**: Digital ATIS, where the information is transmitted via data link (Text) to the aircraft cockpit, rather than voice.

ATIS Content and Order

To ensure pilots know what to expect, ATIS follows a strict **order of information**:

1. **Airport Name**
2. Designator (The Information Letter, e.g., "Information Charlie")
3. Time of observation (UTC)
4. Type of Approach expected
5. Runway in use
6. Surface Wind
7. Visibility / RVR
8. Present Weather
9. Cloud
10. Air Temperature / Dew Point
11. Altimeter Setting (QNH)
12. Trend / SIGMET

Note: ATIS does **not** typically include the "Expected time of landing" for individual aircraft.

The "Designator" Procedure

Every new ATIS recording is assigned a sequential letter from the phonetic alphabet (Alpha, Bravo, Charlie...).

- **Pilot Responsibility**: Upon initial contact with ATC, the pilot must state, "Information Charlie received. "

- **Meaning**: This confirms the pilot has the specific weather and runway data labeled "Charlie. "

CAVOK

In ATIS and METAR, the term **CAVOK** (Ceiling And Visibility OK) is used to replace visibility, weather, and cloud groups when:

1. Visibility is 10 km or more.

2. No clouds below 5,000 ft or Minimum Sector Altitude (MSA).

3. No significant weather phenomena (e.g., rain, T S)

Departure Information

When ATIS is unavailable, pilots receive specific "Departure Information" from ATC. This allows the pilot to calculate takeoff performance. It typically includes:

- Runway in use
- Wind
- QNH
- Temperature / Dew point
- Visibility
- (Mnemonic: R-W-Q-T-V)

Important Signals:

- A series of projectiles discharged from ground at intervals of 10 sec, each showing red and green lights --- An unauthorized ac that is flying in or above a Restricted, Prohibited or Danger area.
- Rockets or shells throwing red light fired once at a time at short intervals or a parachute flare showing a red light --- AC in Distress.
- Repeated switching on and off the landing lights or navigation lights in such a manner to be distinct from flashing nav lights --- AC in Urgency.

ACKNOLEDGEMENT BY AIRCRAFT

- **In Flight:**

  Day time – By rocking wings (not to do on base and finals)
  Night time – By flashing on and off twice the ac landing lights if not so equipped, switching on and off twice navigation light.

- **On Ground:**

  During Day – Moving AC Aileron & rudder
  Night – same as above

Morse code:

- Distress signal SOS (…--…)
- Urgency signal XXX (-..-, -..-, -..-)

LIGHT FROM TOWER	AIRCRAFT IN FLIGHT	AIRCRAFT IN GROUND
Steady Green	Cleared to land	Cleared for take-off
Steady red	Give way to other aircraft and continue circling	Stop
Series of green flashes	Return for landing	Cleared for taxi

Series of red flashes	Aerodrome unsafe do not land	Taxi clear of landing are in use
Series of white flashes	Land at this aerodrome and proceed to aprons	Return to starting point on the aerodrome
Red pyrotechnic	Notwithstanding previous instructions, do not land for time being	

Interception A/C signal:

1. Rocking a/c and flashing navigation lights at irregular intervals from a position slightly above and ahead and normally to the left of intercepted a/c. You have been intercepted, follow me. (Intercepted a/c will do the same maneuver to show compliance)

2. An abrupt break-away maneuver from intercepted ac consisting of climbing of 90 degrees or more without crossing the line of flight of intercepted ac – You may proceed.

Distance from clouds - VFR

- 1500 m horizontally
- 1000 ft vertically.
- Cloud ceiling 1500 ft.
- Vis – 5 km till FL 100, Vis 8 km from FL 100 to FL 150.

VFR flight shall not be flown

1) Over the congested areas of cities, towns or settlements or over an open air assembly of persons at a height less than 300 m or 1000 ft above the highest obstacle within a radius of 600 m from the aircraft.

2) Elsewhere than specified above, at height less than 150 m or 500 ft above the ground or water.

IFR flight not be flown

1) Over high terrain or in mountainous areas, at a level which is at least 600 m or 2000 ft above the highest obstacle located within 8 km of the estimated position of the aircraft.

2) Elsewhere at a level which is at least 300 m or 1000 ft above the highest obstacle located within 8 km of the estimated position of the aircraft.

Important Flight levels

- Max IFR – FL 460
- Max SVFR – FL 460
- Max VFR – FL 150
- RVSM FL290 to FL410
- Lowest transition at 4000 feet.
- Lowest height level is FL 50
- Track needs a variation layer – 1000 ft gap.

AIRCRAFT SEPARATION

Horizontal Separation:

By maintaining an interval between a/c converging or reciprocal tracks expressed in time or distance.

Lateral Separation:

By maintaining a/c on different routes or different geographical areas.

For VOR: 15 degrees at 28 km or 15 nm.
For NDB: 30 degrees at 28 km or 15 nm.
For DR (Dead Reckoning): 45 degrees at 28 km or 15 nm.

Longitudinal separation:

Same track (using time)

1) 15 min.
2) 10 min. if navigation aid permit frequent determination of position and speed of a/c.
3) 5 min if the preceding a/c is maintaining a TAS 20kts or more.
4) 3 min if the aircraft is maintaining a TAS 40 knots or more.

Using DME -
37 km or 20 nm, provided each a/c uses on track DME stations.
19 km or 10 nm, provided the leading ac maintains a TAS of 20 kts or more faster than the succeeding aircraft.

RADIO COMMUNICATION FAILURE (RCF)

VISUAL FLIGHT RULES (VFR)

- Maintain VMC
- Land ASAP
- Observe tower light signals
  - Steady green: cleared to land
  - Flashing green: return to land
  - Steady red: give way / circle
  - Flashing red: aerodrome unsafe

ISTRUMENT FLIGHT RULES (IFR)

Rule: "**Last Assigned → Last Instructed → Flight Plan**"

Steps:

1. Maintain last assigned level for:
   - **7 min (radar)**
   - **20 min (non-radar)**

   Proceed to clearance limit
2. Hold until EAT/ETA
3. Begin Approach
4. Land
5. Squawk 7600

VISUAL SIGNALS

Green = **G**o

Red = **R**eject / Stop

White = **W**ait / **R**eturn

Signal from Tower	**Meaning on Ground**	**Meaning in Air**
Steady Green	Cleared for takeoff	Cleared to land
Flashing Green	Cleared to taxi	Return for landing
Steady Red	STOP	Give way / Circle
Flashing Red	Taxi clear of runway	Airport unsafe
Flasing White	Return to apron	-

SIGMET (Significant Meteorological Information)

Information issued by a Meteorological Watch Office (MWO) concerning the occurrence of specific en-route weather phenomena which may affect the safety of aircraft operations.

Issued for dangerous phenomena like:

- Severe Turbulence
- Severe Icing
- TS / Squall lines
- Hail
- Tropical cyclones
- Volcanic ash

Covers ALL flight levels.

AIRMET

Purpose: Similar to SIGMET but issued for less severe weather conditions.

Target: Primarily affects the safety of low-level flights and light aircraft.

Content: Moderate turbulence, icing, or mountain obscuration.

- For **low-level flights** (below FL100–150).
- Covers **moderate** turbulence/icing/visibility issues.
- Protects **helicopters, small aircraft, trainers**.

VOLMET

- Continuous radio broadcast of:
  - METAR
  - SPECI
  - TAF
  - SIGMET
- Helps pilots update weather while flying. India VOLMET stations:
  - Mumbai
  - Kolkata

Think of them as:

SIGMET = “Severe warning for ALL aircraft”

AIRMET = “Mild warning for small/low aircraft”

VOLMET = “Weather radio station for aircraft in flight”

PIREP (Pilot Weather Report)

Source: Reported directly by pilots in flight.

Importance: It provides actual weather conditions encountered (e.g., "I have icing at FL200"), which validates and updates ground-based forecasts.

Pre-Flight Briefing Services

A Pre-Flight Briefing is a critical preparatory step that consolidates data from meteorological, aeronautical, and operational sources.
Importance

Safety: Anticipating hazards (weather/airspace).
Compliance: Meeting regulatory requirements (DGCA/ICAO).
Efficiency: Fuel and route optimization.

Components of a Briefing

A comprehensive briefing includes:

Meteorological Data: METARs, TAFs, SIGMETs, Winds Aloft, and Significant Weather Charts (SWC).

NOTAMs (Notices to AirMissions): Advisories about hazards or changes (e.g., Runway closures, unserviceable Nav Aids).

Aeronautical Information: Route charts, SIDs/STARs, and data from the **AIP (Aeronautical Information Publication)**.

Operational Data: Fuel planning, aircraft performance.

Note: Passenger lists or cargo manifests are commercial documents and are not part of the standard navigation/safety pre-flight briefing.

Sources of Information

- **AIP (Aeronautical Information Publication)**: The manual containing lasting/permanent information essential to air navigation.
- **AIS (Aeronautical Information Services)**: The authority providing the data.

FB (Electronic Flight Bags): Tablets used by pilots for real-time data.

FORECAST (TREND)

- Mini forecast attached to METAR.
- Valid for 2 hours.
- Used for landing decision-making.

AIRSPACE CLASSIFICATION

ICAO divides airspace into seven classes: A, B, C, D, E, F, and G.

Each class defines:

- What types of flights are allowed (IFR/VFR)
- What type of separation ATC provides
- What level of pilot communication is required
- Whether speed restrictions apply

This classification ensures safe, orderly, and efficient movement of aircraft in the sky.

CLASS A AIRSPACE

- **Only IFR flights are allowed.**

  VFR operations are strictly prohibited due to high-density traffic or need for maximum control.

- **Separation:**

  All aircraft are provided full ATC separation from each other.

- **Speed Restrictions:**

  No speed limitations apply.

- **Communication:**

  Continuous two-way radio communication must be maintained.

- **Typical Use:**

  High-altitude en-route airspace (upper airspace) where precision and separation are essential.

CLASS B AIRSPACE

- **Both IFR and VFR flights are permitted.**
- **Full ATC Separation** is provided to all aircraft, regardless of flight rules.
- **Speed Restrictions:**
  No speed limitation.
- **Communication:**
  Continuous two-way communication required.
- **Purpose:**
  Used in very busy terminal environments where control of traffic is crucial.

CLASS C AIRSPACE

- **Flights Permitted:** IFR and VFR.

  Separation:
  - IFR ↔ IFR: Separated
  - IFR ↔ VFR: Separated
  - VFR ↔ VFR: Traffic information provided, but no separation required.
- **Speed Limit:**
  250 knots below 10,000 ft.
- **Communication:**
  Two-way communication required.
- **Purpose:**
  To maintain smooth flow of mixed traffic (VFR + IFR) with enhanced safety for IFR flights.

CLASS D AIRSPACE

- **Flights Permitted:** IFR and VFR.

- **Separation:**
  - IFR ↔ IFR: Separated
  - IFR ↔ VFR: Traffic information provided
  - VFR ↔ VFR: Traffic information provided

- **Speed Limit:**
  250 knots below 10,000 ft.

- **Communication:**
  Two-way communication required for all participating aircraft.

- **Purpose:**
  Mainly used around controlled aerodromes with moderate traffic.

CLASS E AIRSPACE

- **Flights Permitted:** IFR and VFR.

  Separation:
  - IFR ↔ IFR: Separated
  - IFR ↔ VFR: Traffic information

- **Speed Limit:**
  250 knots below 10,000 ft.

- **Communication:**
  - IFR flights: Must maintain communication
  - VFR flights: Communication not required

- **Important Note:**
  Class E is considered **controlled airspace for IFR**, but **uncontrolled for VFR.**
  This makes it a transition zone between highly controlled and uncontrolled airspace

CLASS F AIRSPACE (ADVISORY AIRSPACE)

- **Flights Permitted**: IFR and VFR.

- **Separation / Service**:
  - IFR: Receive air traffic advisory (not full separation)
  - VFR: Receive flight information service if requested.

- **Speed Limit**:
  250 knots below 10,000 ft.

- **Communication**:
  - IFR: Required
  - VFR: Not required

- **Purpose:** CLASS F AIRSPACE (Advisory Airspace)
  Used in regions where advisory services are preferred instead of strict control.

CLASS G AIRSPACE (Uncontrolled Airspace)

- **Flights Permitted**: IFR and VFR.

- **Services Provided**:
  Flight Information Service (FIS) to IFR & VFR, but only when requested.

- **Speed Limit**:
  250 knots below 10,000 ft.

- **Communication**:
  - IFR: Required
  - VFR: Not required

- **Purpose**:
  Low-level or remote areas where ATC services are limited.
  Here, pilots are largely responsible for their own separation.

AIRSPACE STRUCTURES ASSOCIATED WITH AERODROMES

AERODROME TRAFFIC ZONE (ATZ)

- Established to protect aircraft operating in the immediate vicinity of an aerodrome.
- Encloses:
  - Aircraft in the circuit
  - Aircraft landing or taking off
  - Aircraft taxiing or hovering close to the aerodrome
- Maximum lateral limit: 5 NM around the aerodrome.
- Purpose: To ensure safe interaction between ground manoeuvring traffic and nearby airborne traffic.

CONTROL ZONE (CTR)

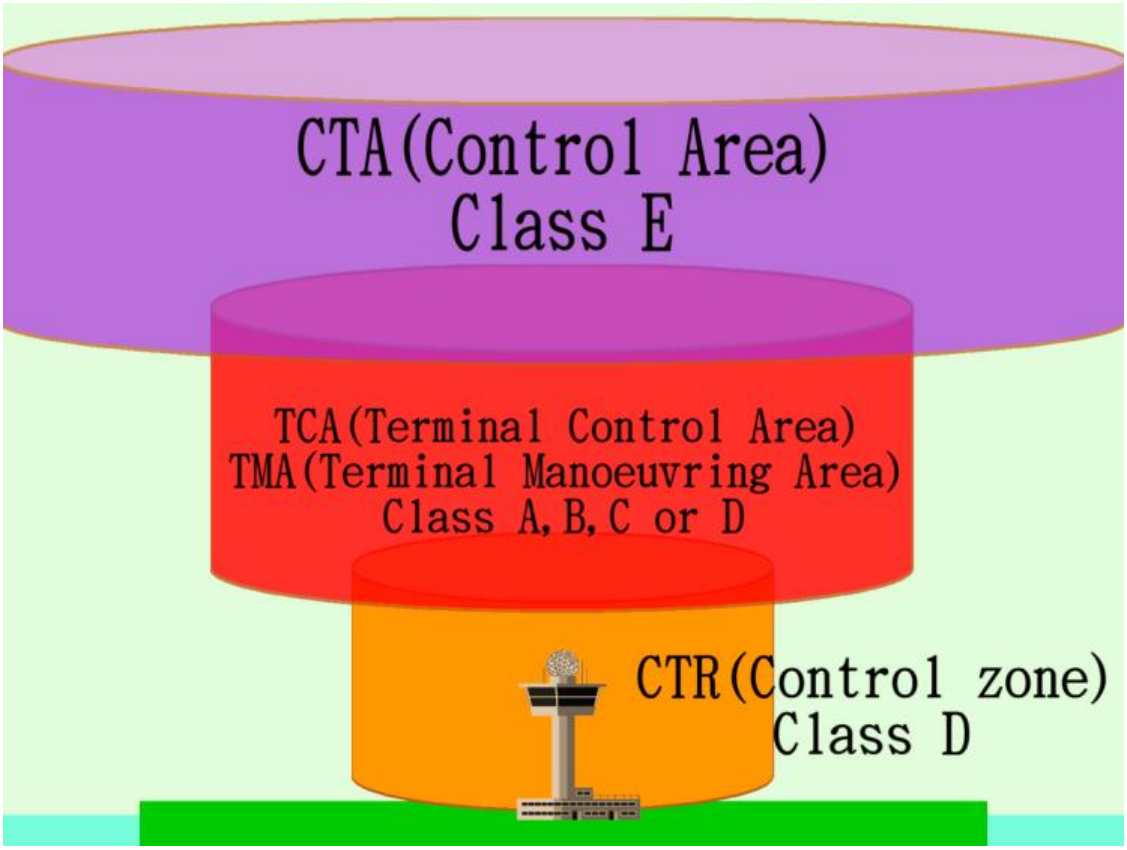
- A controlled airspace extending from the surface up to a specified upper limit.
- Designed to protect arriving and departing traffic.
- Lateral Extension: At least 5 NM from the aerodrome in the direction of approach paths.
- May include multiple aerodromes.
- Ensures ATC maintains control over aircraft near aerodromes in complex environments.

TERMINAL CONTROL AREA (TMA)

- A large, controlled airspace surrounding major airports with heavy traffic.
- Used to manage arrivals, departures, and transitions between en-route and terminal airspace.
- Lower limit: 700 ft AGL.
- Contains multiple control zones and approach paths.
- Ensures high approach/departure efficiency and separation.

CONTROL AREA (CTA)

- A controlled airspace extending upward from a defined surface.
- Lower limit: 200 m (≈ 700 ft) above ground or water.
- Protects en-route traffic operating above the CTR or ATZ.
- Connects TMAs and upper airspace structures to form a continuous, controlled environment.



Aeronautical Information Services (AIS)

In pursuant to **Article 28** of the Chicago Convention, every contracting State undertakes to provide standard systems for air navigation, The standards for **Aeronautical Information Services (AIS)** are established in **ICAO Annex 15**.

Aeronautical Information Service (AIS) refers to the collection, management, and dissemination of aeronautical data.

- **Primary Objective**: To ensure the safety, regularity, and efficiency of international and national air navigation.
- **Provider**: AIS is typically provided by the State's **Civil Aviation Authority (CAA)** or an organization appointed by the State (e.g., Airports Authority of India).

Without AIS, aviation would be risky and chaotic. It ensures:

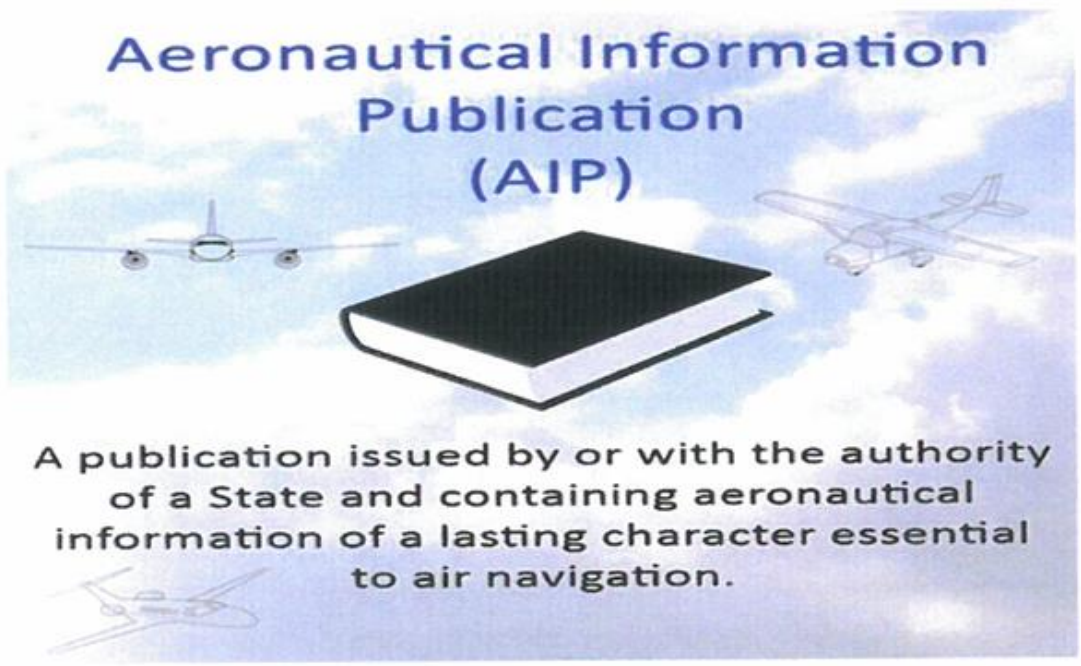
- **Safety**: Accurate data to avoid hazards.
- **Situational Awareness**: Real-time data for pilots and ATC.
- **Pre-flight Planning**: Providing essential data via Pre-flight Briefing services.

Transition to AIM (Aeronautical Information Management)

The aviation industry is moving from AIS (a product-centric service) to AIM (a data-centric service).

- **The Shift**: Moving from paper-based publications to digital, data-centric services.
- **Key Technologies**: Use of GIS (Geographic Information Systems) and digital databases.
- **Benefit**: Provides faster and wider access to real-time data, improving situational awareness and integration with modern aircraft systems (FMS).

The Aeronautical Information Publication (AIP)



The **Aeronautical Information Publication (AIP)** is the primary product of a state's Aeronautical Information Service (AIS).

- **Definition**: A publication issued by or with the authority of a State containing aeronautical information of a lasting character (permanent nature) essential to air navigation.

- **Purpose**: It serves as the fundamental manual for flight operations, ensuring pilots and operators have access to permanent data (like airport layouts and rules) and long-term temporary changes.

- **Governing Standard**: It is part of the AIS framework governed by ICAO Annex 15.

Authority in India

- **AIP**: Published by the **Airports Authority of India (AAI)** on behalf of the State (DGCA).

- **AIC**: Aeronautical Information Circulars are published directly by the **DGCA**.

Structure of AIP India

General (GEN)	Enroute (ENR)	Aerodrome (AD)
• National differences	• General rules and procedures	• Refuellservices
• Aerodrome charges	• ATS airspace class.	• Met services at airports
• Met services on route	• Departure/App procedure	• Watch hours
• Aeronautical charts	• Nav aids, frequencies	• Airport elevation, Rwy length, no. of rwys
• Location indicators (Airport codes)	• Danger, prohibited, restricted areas warnings	• Rescue and firefighting
• SIGMET, VOLMET	• Enroute charts	
• SAR		

The Integrated Aeronautical Information Package (IAIP)

Pilots do not just rely on the AIP book; they use the entire "Integrated Package" which consists of:

1. **AIP** (The core manual).

2. **AIP** Amendments: For permanent changes. Each amendment has a serial number and publication date.

3. **AIP Supplements**: For temporary changes of long duration (three months or longer) or changes with extensive text/graphics.

    - *Identification: Supplement pages should be colored, preferably in Yellow, to be conspicuous.*
    - *Note: If a temporary change lasts less than 3 months, a NOTAM is usually issued instead.*

4. **NOTAM**: For time-sensitive, short-duration changes.

5. **AIC (Aeronautical Information Circulars)**: Notices on safety, technical, or administrative matters (published by DGCA).

6. **Pre-flight Information Bulletins (PIB)**: Summaries of current NOTAMs.

7. **Checklists** of valid NOTAMs.

Note on AIRAC: Operationally significant changes must be published in accordance with the **AIRAC** (Aeronautical Information Regulation And Control) cycle procedures to ensure pilots receive data well in advance of the effective date.

FLIGHT INFORMATION REGION (FIR)

A **Flight Information Region (FIR)** is a designated portion of airspace within which specific services are provided. FIRS form the backbone of global airspace management.

- **Services Provided:**

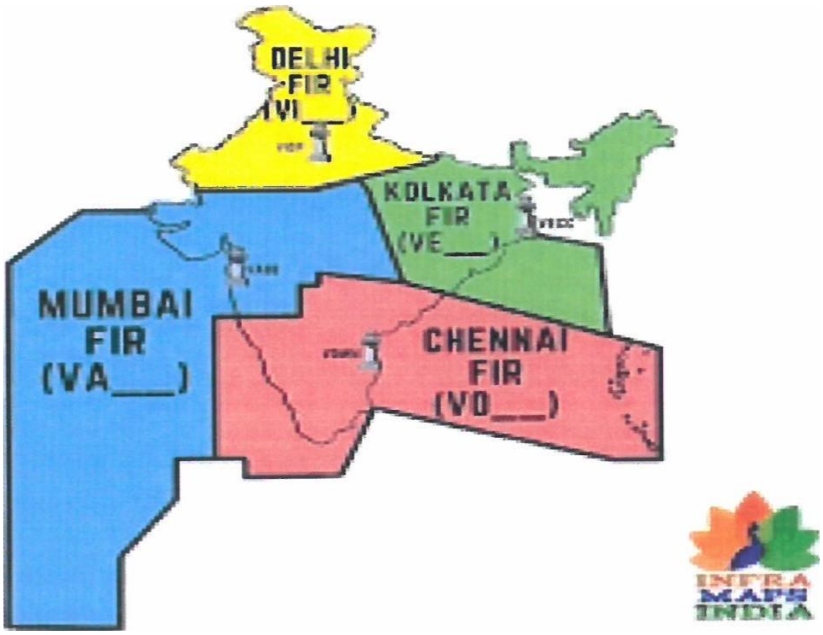
1. **Flight Information Service (FIS)**: Updates on weather, aerodrome conditions, and navigation warnings.

2. **Alerting Service**: Alerting rescue coordination centers if an aircraft is in distress (Search and Rescue)

FIRS in India

1. **VIDP** - Delhi FIR
2. **VABB** - Mumbai FIR
3. **VOMM** - Chennai FIR
4. **VECC** - Kolkata FIR
5. **VEGT** - Guwahati FIR (Sub-AR)

FLIGHT INFORMATION REGIONS OF INDIA



Aeronautical Information Circular (AIC)

An **Aeronautical Information Circular (AIC)** is an official publication issued by the **Directorate General of Civil Aviation (DGCA).**

- **Content:** Administrative, technical, or advisory information that does not qualify for a NOTAM or AIP but is still important.
- **Examples**: Aeronautical tariffs (UDF), Digi Yatra updates, long-term legislative changes, and safety advisories.
- **Nature**: AICs convey Long-term and advisory aviation information.
- **Issuer**: DGCA (Regulatory body).
- **Numbering**: Assigned a serial number/year (e.g., AIC 02/2007).
- **Checklist**: A checklist of current AICs is issued by the DGCA annually.

SECTION – 4 RADIO ELECTRICAL

Electrical Fundamentals

Potential Difference / Volt (V)

The unit of **Potential Difference (PD)** or **Electromotive Force (EMF)**.
It is the electrical **"pressure"** that pushes current.
PD is defined as the work required to move a unit of charge between two points. It is measured in Volts.

Charge, Coulomb (C), and Current I Ampere (A)

Electrical Charge: A fundamental property of matter (positive or negative) that creates an electric field.

Coulomb (C): The Sl unit of electrical charge.

Current (A): The unit of Electric Current. It measures the rate of flow of charge.
One **Ampere** is the flow of one **Coulomb** of charge past a point in one second (1 A = 1 coulomb per second)

Resistance / Ohm

The unit of **Electrical Resistance**.
The opposition a material offers to the flow of electric current.

Power / Watt (W)

The unit of **Electrical Power**.
The rate at which electrical energy is transferred or consumed.

Ohm's Law

Voltage (V) = Current (l) x Resistance (R)
V = I x R
Power is the product of Voltage and Current, and can be calculated using resistance as well:
Power (P) = Voltage (V) x Current (l)

Capacitance (C)

- **Capacitance** is the ability of a component (capacitor) to store electrical charge.
- **Unit**: Farad (F)
- In radio circuits, capacitance:
  - Opposes changes in voltage
  - Decreases with increase in frequency
- Used for frequency tuning in radios.

Inductance (L)

- Inductance is the property of a conductor (coil) by which a change in current induces an opposing EMF.
- Unit: Henry (H)
  - In radio circuits, inductance:
  - Opposes changes in current o Increases with increase in frequency
- Used along with capacitance to form tuned circuits.

Tuning of Frequency

- Radio tuning is achieved by changing the **resonant frequency** of a circuit.
- Resonant frequency depends on **Inductance (L)** and **Capacitance (C)**.
- **Tuning to a new frequency is achieved by varying CAPACITANCE.**

Impedance (Z)

- **Impedance** is the total opposition to current flow in an AC circuit.
- **Unit**: Ohm (Q)

- It is the combination of:
  - Resistance (R)
  - Inductive reactance (XL)
  - Capacitive reactance (XC)

Impedance controls how much current flows in AC circuits.

Impedance—Current Relationship

- As impedance increases, current decreases.
- This relationship follows a form of Ohm's Law for AC circuits:

$$I = V/Z$$

Aircraft Communication Frequency Bands

Bands:

VLF – LF – MF – HF – VHF – UHF – SHF – EHF

- HF: 3000–4000 NM C → Long-range communication
- VHF: 200–250 NM → Short-range communication

VHF Range Formula

Formula:

Range (NM) = 1.23 × (√height of Tx + √height of Rx)

Higher the antenna → farther the signal!

Frequency Bands

Band	Range
VLF	< 30 MHz
VHF	30–300 MHz
EHF	> 300 MHz

Aviation VHF Band: 118–137 MHz

➢ Bandwidth & Frequency Separation

- Bandwidth (BW) = 2 × Audio Frequency (AF)
  (AF is created by the microphone)

Frequency Separation:

Type	Spacing	Channels
Conventional	25 kHz	760
Modern	8.33 kHz	2280

Smaller spacing → More channels → More communication

VHF Communication Symbols (Flight Plan Codes)

Symbol	Meaning
V (VHF ONLY)	25 kHz (Conventional spacing)
Y	8.33 kHz (Modern spacing)

Modern Jet Aircraft Radio Setup

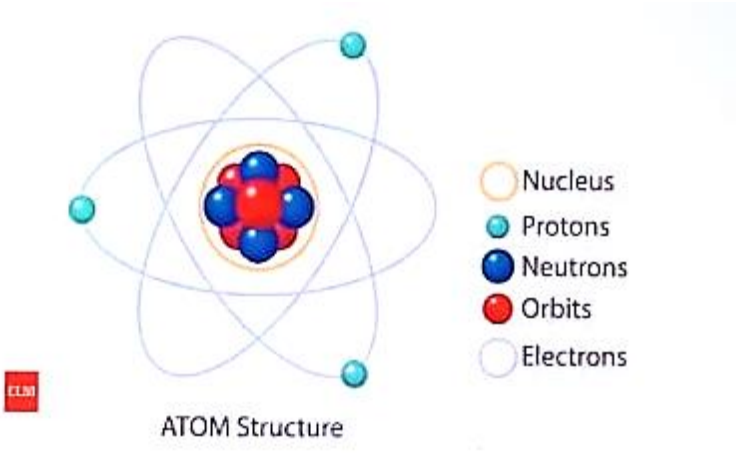
- VHF Radios → ATC, Company, Backup
- 2 HF Radios → Long-range communication

When one radio sleeps, two stay awake — safety never rests!

STRUCTURE OF ATOM

- The nucleus contains:
  - Protons (+ve charge)
  - Electrons (-ve charge) revolve around the nucleus in orbits
  - Neutrons (neutral)

- Number of protons = Number of electrons, hence the atom is electrically neutral.



Ion Formation

- When atoms are given sufficient energy, they become unstable and collisions Occur.

- Electrons move from one atom to another, forming ions:
  - Loss of electron → Positive ion (cation)
  - Gain of electron → Negative ion (anion)

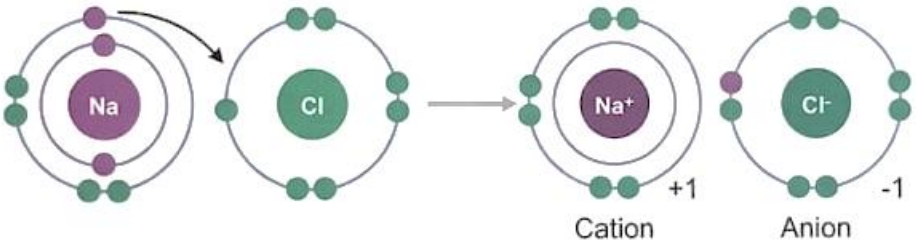


Fig 1. Transfer of an Electron from Na (Sodium) to Cl (Chlorine). Na becomes a Na^+ cation as it loses an electron. Cl becomes a Cl^- anion as it gains an electron.

Ionospheric Attenuation

- Attenuation ∝ 1 / Frequency
  - Higher frequency → Less attenuation E

Why 2850 kHz in HF Communication Band?

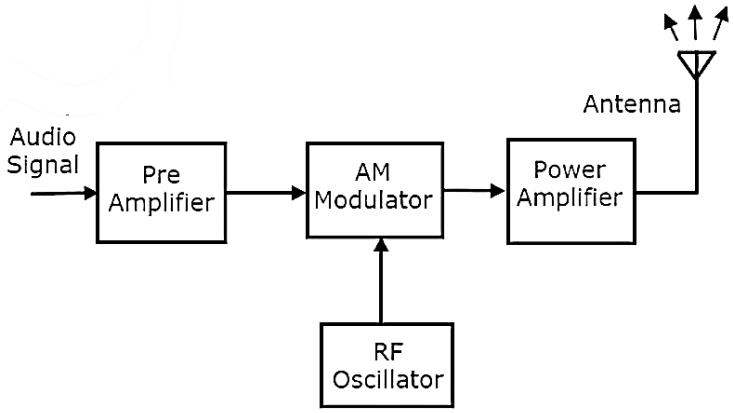
- To increase the number of available channels in HF (High Frequency).
- The higher MF band behaves similarly to lower HF bands.
- Beyond 22,000 kHz (22 MHz), the frequency becomes too high and no skywaves are produced — essential for HF communication.

RADIO COMMUNICATION

➢ **Definition**: Communication using radio waves.

➢ Basic Equipment:

I. Microphone (MIC) → Converts audio (AW) to electrical (AF).
II. Modulator → Combines AF + RF to form a modulated wave.
III. Oscillator → Provides carrier frequency (CF).
IV. Transmitting Antenna (Tx) → Radiates the combined signal.



➢ Modulation

Definition: Superimposing a basic signal (voice) on a carrier wave.

Example:

- Train = Carrier wave
- You = Information signal
- Boarding the train = Modulation

Your voice "rides" the wave like a passenger on a train.

➢ Reception (Demodulation)

- The Receiving Antenna (Rx) captures RF + AF.
- Demodulator separates the audio frequency (AF).
- Speaker converts AF back into sound (AW).
- Hence, base information is extracted from the carrier signal.

SELCAL – SELECTIVE CALLING SYSTEM

Purpose

- Reduces pilot workload — no need to monitor HF radio continuously.
- Used mainly for HF communication (especially long-range flights).
- In INDIA selcal is used in HF communication only
- Provides Audio & Visual indications in cockpit when a call is received.

Concept:

- ATC sends a coded signal to a specific aircraft.
- The aircraft's SELCAL decoder recognizes its assigned code and alerts the pilot.

Communication type:

- Simplex (one direction) (ATC → Aircraft)
- If two-way at the same time → Duplex
- If two-way but one at a time → Half Duplex (R/T Communication)

Indications

- Visual: Light flashes on cockpit panel
- Audio: A "chime" sound plays

SELCAL Codes Assignment

- Issued by ASRI (Aviation Spectrum Resources Inc., USA)
- Governed by ICAO guidelines.
- Due to the limited number of codes, similar code assignments to multiple aircraft may be expected.

- The SELCAL code in the aircraft should be associated with the aircraft's radiotelephony **call sign, flight number, or registration**.

- If an aircraft only has a single-code SELCAL unit and uses a flight number (which changes daily), the **ground stations must be advised** of the correct code for each flight.

- **The aircraft operating agency** is responsible for ensuring the appropriate aeronautical station knows the SELCAL code associated with the aircraft's call sign.

Code Format

- 4 letters (A–S), excluding I, O, N
- Made of two pairs (e.g. AB-CD)
- Each pair arranged in ascending alphabetical order
- No separation between the four letters

Example: AC-DE | CA-ED

Code Capacity

System Type	Unique Codes
SELCAL16	~10,000
SELCAL 32	~200,000

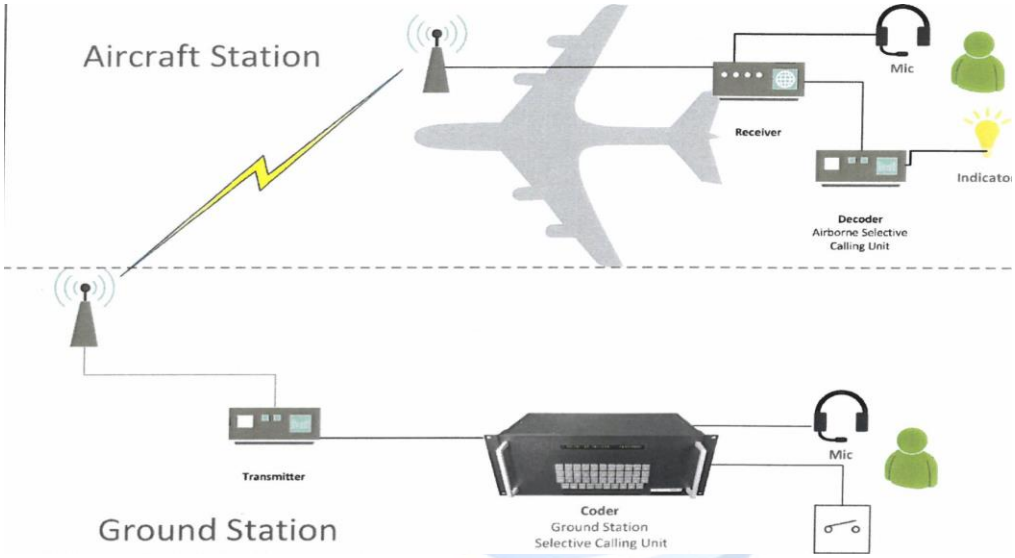
Transmission pattern:

1 sec (one pulse) – 0.2 sec – 1 sec (second pulse)
Total time taken= 2.2 Sec

Components

- SELCAL Encoder – at ATC
- SELCAL Decoder – in Aircraft

ATC → Sends SELCAL tone → Aircraft receives & alerts pilot



SELCAL Check Procedure

- Perform on both Primary & Secondary HF frequencies
- Sequence:
  Check on Secondary
  Then on Primary

Pre-flight Check

The pilot must ensure the system is working before leaving VHF coverage and entering the HF environment.

- **Request**: The aircraft contacts the appropriate aeronautical station and requests a **pre-flight SELCAL check**, providing its code if necessary.

- **Frequency Check**: Checks are normally performed first on the secondary frequency and then on the primary frequency.

- **Malfunction**: If the check reveals the ground or airborne system is inoperative, the aircraft must maintain a continuous listening watch on its subsequent flight until SELCAL is repaired and available.

Establishment and En-Route Procedures

- **Flight Plan Requirement**: The aircraft must **include the SELCAL code in the flight plan** submitted to the appropriate Air Traffic Services (ATS) unit.

- **HF Coordination**: Before leaving VHF coverage, the pilot must establish temporary communication with the **HF aeronautical station to confirm** the station has the correct SELCAL code.

- **Cockpit Reply**: When an aeronautical station calls using SELCAL and the cockpit alert is activated, the pilot replies with the aircraft's **radio call sign**, followed by the phrase "GO AHEAD."

- **Malfunction In-Flight**: If SELCAL malfunctions during flight, the pilot must **immediately advise** the aeronautical stations and switch to **voice calling**. All relevant stations must be advised when the system is again functioning normally.
- If the SELCAL signal remains unanswered after **two calls on the primary frequency and two calls on the secondary frequency**, the aeronautical station must **revert to voice calling**.

If SELCAL is Unserviceable

Flight can still operate
But pilots must continuously monitor HF Radio

Example:

“Delhi Radio, Air India 123, request SELCAL check on Secondary.”
“SELCAL OK on Secondary.”
“Changing over to Primary.”

HF FREQUENCY SELECTION

- Based on sky waves (bounced off ionosphere)
- Affected by Sun radiation

Time	Frequency Usage
Daytime	Higher frequencies
Nighttime	Lower frequencies

Rule of Thumb:

- Night frequency ≈ ½ of daytime frequency
- "Sun Down → Frequency Down"

Frequency Types

1. Primary Frequency – first choice for comms
2. Secondary Frequency – backup

Flight Plan Briefings

1. ATC Briefing: FIC & ADC numbers
2. Comm Briefing: Enroute ATC frequencies
3. MET Briefing: Weather & forecasts enrout

HF COMMUNICATION

- **R.D.A.R.A. – Regional Domestic Air Route Area**
- **M.W.A.R.A. – Major World Air Route Area**

Area Type	Usage	
Domestic HF	Within national airspace	RDARA
International HF	Long-range over oceanic/remote routes	MWARA

MAWARA

Important Operational Points

1. No entry into airspace without ATC permission
2. Before declaring RCF (Radio Communication Failure), verify correct frequency
3. During HF, change between Primary/Secondary as needed

Note!

- Transmitter (Tx): Works better at higher frequencies
- Receiver (Rx): Performs better at lower frequencies

Properties of a Good Receiver (Rx)

1. Selectivity:
- Ability to select the desired frequency and reject unwanted ones.

2. Sensitivity:
- Ability to detect even weak signals.
- Weak signals, once sensed, can be amplified.

3. Fidelity:
- Ability to reproduce incoming signals almost identical to the outgoing ones.

4. Stability:
- Ability to maintain the selected frequency without drift.

Note!
- Selectivity and Sensitivity decrease at higher frequencies.

SUPER HETERODYNE RECEIVER

Concept: To lower the frequency of a receiver

- Heterodyne → Mixing of two frequencies
- The mixer produces two outputs:
  - One is added (sum)
  - One is subtracted (difference)

Example:

F1 = 8000 kHz
F2 = 8455 kHz
F2 + F1 = 16455 kHz
F2 - F1 = 455 kHz

The difference (455 kHz) is called the Intermediate Frequency (IF)

LF Frequency Formula

LF = F2 = [RF + AF] + 455 kHz

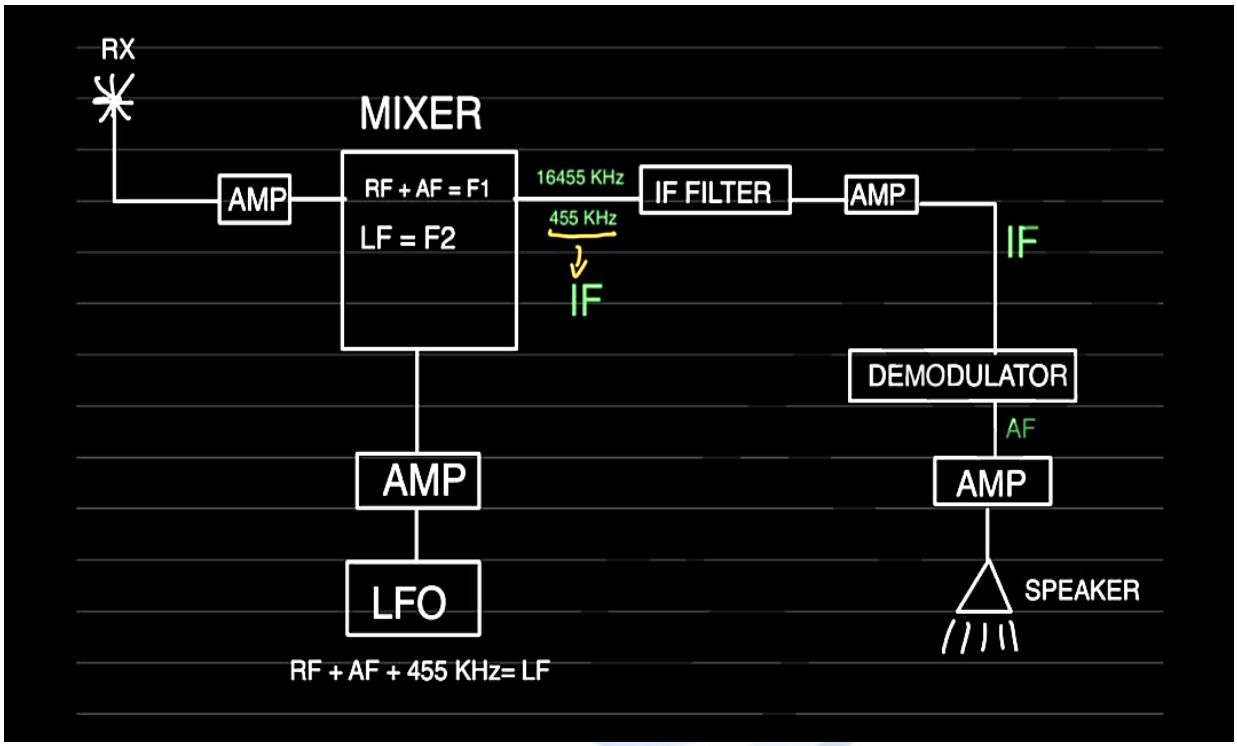
Here, RF+AF = Modulated frequency at the Rx
Where:

- F1 = RF + AF (modulated frequency)
- F2 = LF = Generated locally by the LFO

"Baby Frequency" Concept

- **(F2 + F1)** and **(F2 – F1)** are also called a baby frequency
- Because it is derived from parent frequencies f1 & f2

Super Heterodyne Receiver – Diagram Flow



Within mixer:

- RF + AF = F1
- LF = F2
- Output: IF = 455 kHz

Why 455 kHz as IF?

- 500 kHz is used for maritime distress frequency.
- ITU allocates frequencies like 450, 500, 550 kHz (spaced 50 kHz apart).
- So 455 kHz is chosen as an odd value, avoiding interference with standard maritime bands

Miscellaneous

Recommended Abbreviations & Symbols

A

Abm	Abeam
Abt	About
Abv	Above
Acft	Aircraft
ACC	Area Control or Area Control Centre
A/c	Aircraft
Ack	Acknowledge
Acpt	Accept
AD	Aerodrome
Adj	Adjacent
Ady	Advise, Advisory
Adz	Adz
Aft	After
Agn	Again
Attn	Attention
Alt	Altitude
Altn	Alternate
AP	Airport
A/P	Autopilot
Apch	Approach
App	Approach control or Approach control service
Apn	Apron
Aprx	Approximate or Approximately
Apv	Approve or Approved
Arng	Arrange
Asc	Ascent or Ascending to
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATD	Actual Time of Departure
Auth	Authorized or Authorization
Avbl	Available
AWY	Airway
Azm	Azimuth

B

BA	Braking Action
Bat	Battery
Best	Broadcast
Bdry	Boundary
Becmg	Becoming
Bfr	Before
BKN	Broken
Bldg	Building

Blw	Below
Brg	Bearing
Brk	Brake
Btn	Between

C

Capt	Captain
Cb	Cumulonimbus
Cfm	Confirm
Cld	Cloud
Clr	Clear or Cleared to or Clearance
Clsd	Close or Closed
Cmb	Climb or Climbing to
Cmpl	Complete
Cnl	Cancel
Com	Communication
Cond	Condition
Cons	Continuous
Co-ord	Co-ordinate
Crs	Course
Ctn	Caution

D

DA	Decision Altitude
Dct	Direct
Dev	Deviation
Div	Divert
Dep	Departure
Dut	Deteriorate or Deteriorating to
Des	Descend or Descending to
Dstn	Destination
DH	Decision Height
Dist	Distance
Dla	Delay
Dng	Danger
Doc	Document
Dur	Duration

E

EB	East Bound
Elect	Electric, Electricity
Elev	Elevation
Emer	Emergency
Eng	Engine
Engg	Engineering
Eqpt	Equipment
Est	Estimate or Estimated

Exer	Exercises or Exercise
Ext	External
Extd	Extending or Extend
ETO	Estimate Time over next significant point

F

Fcst	Forecast
FL	Flight Level
Flr	Flares
Flg	Flashing
Flt	Flight
Fluc	Fluctuating or Fluctuated or Fluctuation
Flw	Follow or Following
Fm	From
FSL	Full Stop Landing
Fwd	Forward

G

GA	Go Around or Going Around
Gld	Glider
Gnd	Ground
GP	Glidepath
Gr	Group
GS	Groundspeed
G/S	Glide Slope

H

Hdg	Heading
Hgt	Height
Hldg	Holding
Hr	Hours
Hyd	Hydraulic

I

Ident	Identification
Impr	Improve or Improving
Imt	Immediate or Immediately
Inbd	Inbound
Info	Information
Inop	Inoperative
Intstr	Instrument
Int	Intersection
Intst	Intensity
Isol	Isolated

K

Kt	Knots

L

Lat	Latitude
Ldg	Landing
Len	Length
Lgt	Light
Lgtd	Lighted
LH	Left hand
LLZ	Localizer
Long	Longitude
LSq	Line Squall
Lvl	Level
LW	Landing Weight

M

M	Mach Number (followed by numbers), Metres (preceded by numbers)
M,m	Meter
Mag	Magnetic
Maint	Maintenance
Max	Maximum
Met	Meteorology
MM	Middle Marker
Mnm	Minimum
Mnt	Monitor or monitoring or monitored
Mntn	Maintain
Mntng	Maintaining
Mod	Moderate
Msg	Message

N

NA	Not Available or Not Applicable
Nav	Navigation
NC	No change
Ngt	Night
NM	Nautical Mile
Nml	Normal
Nr	Number
Nxt	Next

P

P…	Prohibited Area (followed by identification)
Parl	Parallel

Pax	Passenger
Per	Performance
Perm	Permanent
PJE	Parachute Jumping Exercise
PN	Prior Notice Required
POB	Persons on Board
Poss	Possible
Pri	Primary
Prkg	Parking
Prov	Provisional
PS	Plus
Psn	Position
Pt	Point
Ptn	Procedure Turn
Pvt	Private
Pwr	Power

Q

Quad	Quadrant

R

R…	Restricted Area (followed by identification)
R	Runway (runway identification)
Rad	Radius
Rash	Rain Showers
RCF	Radio Communication Failure
RCL	Runway Centre Line
Rdl	Radial
Rdo	Radio
Rd	Road
RH	Right Hand
Rec	Receiver or Receive
REDL	Runway Edge Light(s)
Ref	Reference to or Refer to
Reg	Registration
RENL	Runway End Light(s)
Rep	Report or Reporting or Reporting Point
Req	Request
Rerte	Reroute
RG	Range
RH	Rescue Helicopter
RLCE	Request Level Change En-route
RNN	Resume Normal Navigation
Rif	Re-clearance In Flight

ROC	Rate of Climb
ROD	Rate of Descent
RON	Receiving only
RPL	Repetitive Flight Plan
RPLC	Replace or Replaced
Rpt	Repeat
RR	Report Reaching
RTE	Relite
Rwy	Runway

S

SAP	As soon as possible
SAR	Search and Rescue
Sec	Seconds
Sect	Sector
Sfc	Surface
Sgl	Signal
Spd	Speed
SPl	Special Position Indicator
SPOT	Spot Wind
SQ	Squall
Sry	Secondary
STA	Straight in Approach
Std	Standard
Stn	Station
Stnr	Stationary
Subj	Subject to
Svcbl	Serviceable
Sys	System

T

T	Temperature
TA	Transition Altitude
Tail/ TW	Tail Wind
TAS	True Air Speed
Tax	Taxi
Tfc	Traffic
TGL	Touch & Go Landing
Thru	Through
Til	Until
Tkof	Take-off
T/o	Take-off
TOC	Top of Climb
TOD	Top of Descent
Trng	Training
Turb	Turbulence
Twr	Tower

Twy	Taxiway
Typ	Type of aircraft

U

UFN	Until Further Notice
UNA	Unable
Unrel	Unreliable
U/S	Unserviceable
UTC	Coordinated Universal Time

V

Vcy	Vicinity
Vis	Visibility
Vrb	Variable
Vsp	Vertical Speed

W

WDI	Wind Direction Indicator
WEF	With Effect From
WIE	With Immediate Effect
WIP	Work In Progress
Wpt	Waypoint
Wrng	Warning
WS	Wind Shear
Wt	Weight
Wx	Weather
WXR	Weather Radar

X

X	Cross
Xng	Crossing
XCVR	Transreceiver
XFR	Transfer
Xmtr	Transmitter

Y

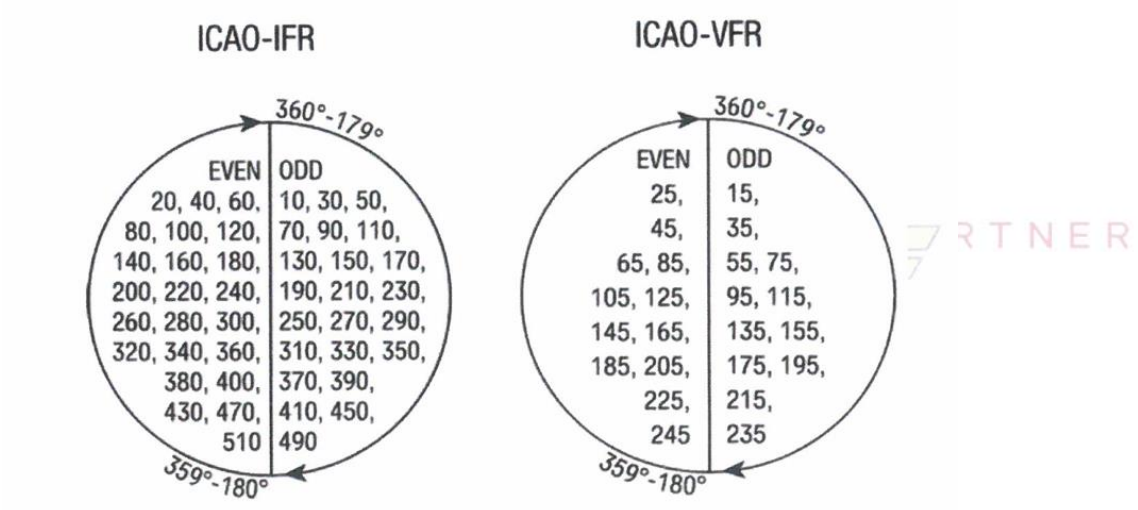
Yr	Yours

Semi-Circular Rule

Purpose:

To provide vertical separation between aircraft flying in opposite directions.

- **Magnetic track 000°–179° (Eastbound):** Cruising levels at odd thousands (e.g., 3,000; 5,000; FL 350).
- **Magnetic track 180°–359° (Westbound):** Cruising levels at even thousands (e.g., 4,000; 6,000; FL 340)
- Based on magnetic track, not heading.
- Applies to cruising levels, not climb or descent.
- Ensures standard vertical separation.



CVSM – CONVENTIONAL VERTICAL SEPARATION MINIMUM

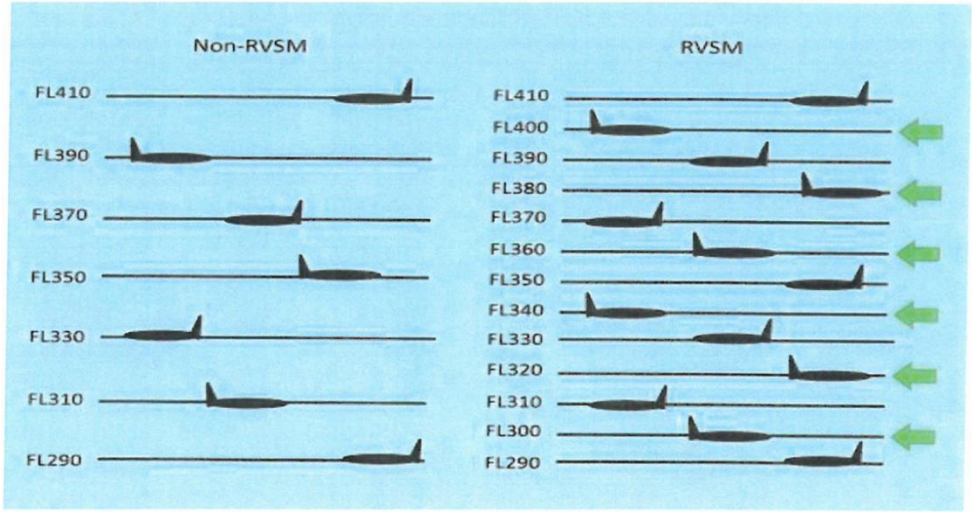
Vertical separation used above FL 290 when aircraft are not RVSM-approved

- Vertical separation: 2,000 ft opposite direction, 4000 ft same direction
- Applied above FL 290
- Used when:
  - Aircraft is not RVSM certified
  - RVSM airspace is not available

RVSM – REDUCED VERTICAL SEPARATION MINIMUM

A system that reduces vertical separation above FL 290 up to FL 410.

- Vertical separation: 1,000 ft opposite direction, 2000 ft same direction
- Applicable between FL 290 and FL 410 inclusive
- Requires;
- Two primary altitude measurement systems
- Automatic altitude-control system (autopilot)
- Altitude alerting device
- Operating transponder (Mode C / Mode S)
- Allo



VFR CIRCUIT PATTERN

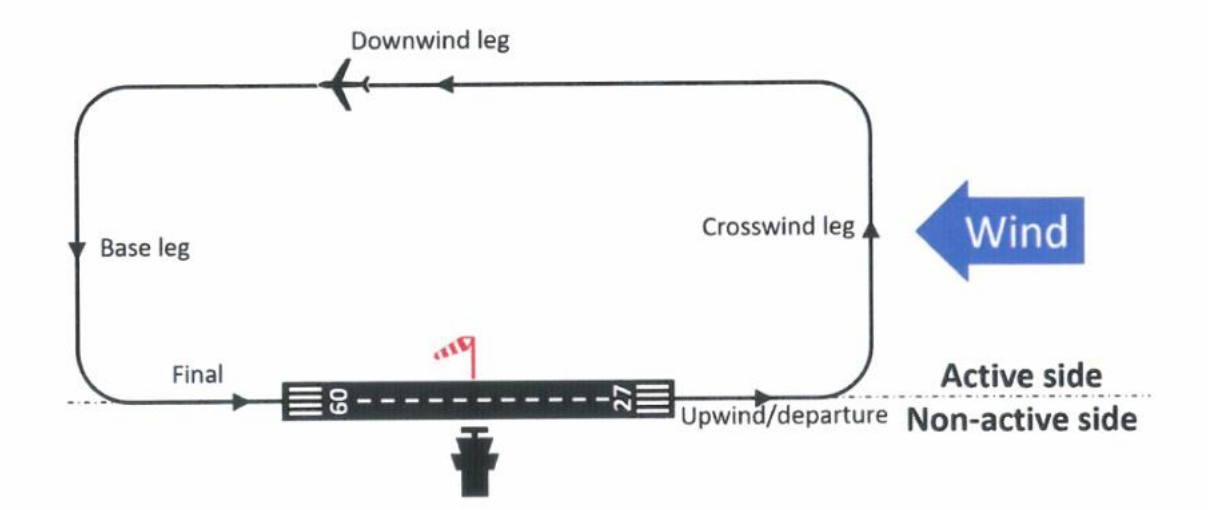
Purpose:

To organize traffic around an aerodrome for safe take-off and landing under VFR.

Standard VFR Circuit (Left-hand unless otherwise published):

- Upwind leg: After take-off, aligned with runway heading.
- Crosswind leg: 90° turn after take-off, climbing.
- Downwind leg: Parallel to runway, opposite direction; checks completed.
- Base leg: 90° turn towards runway, descent initiated.
- Final leg: Aligned with runway for landing.

- Circuit direction and altitude are published for each aerodrome.
- Typical circuit height: ~1,000 ft AGL (unless specified otherwise).
- Maintain see-and-avoid at all times.



Go-Around

A procedure to **discontinue an approach or landing**.

When Used:

- Unstable approach
- Runway obstructed
- ATC instruction
- Unsafe landing conditions

Actions:

- Apply take-off / go-around thrust
- Pitch up, arrest descent
- Retract flaps as per procedure
- Follow published or ATC instructions

Missed Approach Procedure

A published IFR procedure to be followed when an instrument approach cannot be completed to landing.

Key Points:

- Initiated at Decision Altitude (DA) / Minimum Descent Altitude (MDA) if visual references are not acquired.
- Procedure is published on approach charts.
- Includes:
  - Track
  - Altitude
  - Navigation aids
- ATC separation is provided.

Touch-and-Go

A landing in which the aircraft **touches down and immediately takes off again** without stopping on the runway.

Full Stop Landing

A landing in which the aircraft touches down and decelerates to a complete stop on the runway.

TIBA
(TRAFFIC INFORMATION BROADCAST BY AIRCRAFT)

Definition:

TIBA is a procedure used in airspace where no Air Traffic Control (ATC) service is available or where ATS has been temporarily withdrawn. Under TIBA, pilots themselves broadcast essential traffic and position information to other aircraft to maintain situational awareness and separation:

- Used in non-controlled or ATS-unavailable airspace
- Information is broadcast by pilots, not ATC
- Broadcasts are made on a designated common frequency
- Includes position, level, route, intentions, and time
- Helps in collision avoidance and traffic awareness

Typical TIBA Broadcast Content:

- Aircraft identification
- Position (with reference point and time)
- Flight level/altitude
- Route and next reporting point
- Intentions (climb, descent, maintain level)

Purpose:

To ensure **safe and orderly flow of traffic** when ATC services are not provided.

Special Use Airspace (Prohibited, Restricted, Danger)

Prohibited Area (P): An airspace where the flight of aircraft is prohibited (completely forbidden).

Restricted Area (R): An airspace where flight is restricted in accordance with certain specified conditions.

Danger Area (D): An airspace where activities dangerous to flight may exist at specified times.

Identification

1. **Nationality Letters**: Location indicator assigned to India (e.g., V or VI).
2. **Type Letter**: P (Prohibited), R (Restricted), or D (Danger).
3. **Number**: A unique number unduplicated within India.
    - Example: **VIP-89** (India, Prohibited, Area 89).

To avoid confusion among pilots and controllers, identification numbers shall **not be reused for a period of at least one year** after the cancellation of the area to which they referred.

AOR Number

AOR: Aircraft Operator Registration

- Issued by **DGCA** to authorize an aircraft operator to conduct flight operations in India
- Identifies the **operator**, not the aircraft
- Mandatory (with prior permission) for **civil aircraft landing at defence aerodromes**

ADC — Air Defence Clearance

- **ADC** is a **security clearance number issued by Indian Air Defence authorities** confirming that a civil aircraft is **cleared to operate within Indian airspace**, including **ADIZ and defence-controlled areas**.
- **Mandatory prior to departure** for applicable flights.
- **Flight-specific clearance**: valid only for the **approved aircraft, route, date, and time**.

Validity:

- Normally valid for **about 45 minutes from the planned departure time**.
- May be **extended up to approximately 3 hours**, subject to approval.

Fresh ADC Required When:

- **Departure is delayed beyond the validity window** (commonly more than 60 minutes).
- Any change in:
  - Date or time
  - Route
  - Aircraft registration
  - Operator

FIC — Flight Information Centre Number

- **FIC number** is a **confirmation reference** indicating that the **flight plan has been filed, accepted, and validated** by ATS.
- Issued by ATC / Flight Information Centre after successful flight plan submission.
- Confirms the flight is authorized to proceed for departure from an ATS perspective.

Validity:

- Valid for the **life of the flight plan**, typically **about 1 hour** from the filed EOBT.

New FIC Required When:

- Flight plan **expires**.
- Flight plan is **cancelled and refiled**.
- Major changes require **refiling of the flight plan**.

Important:

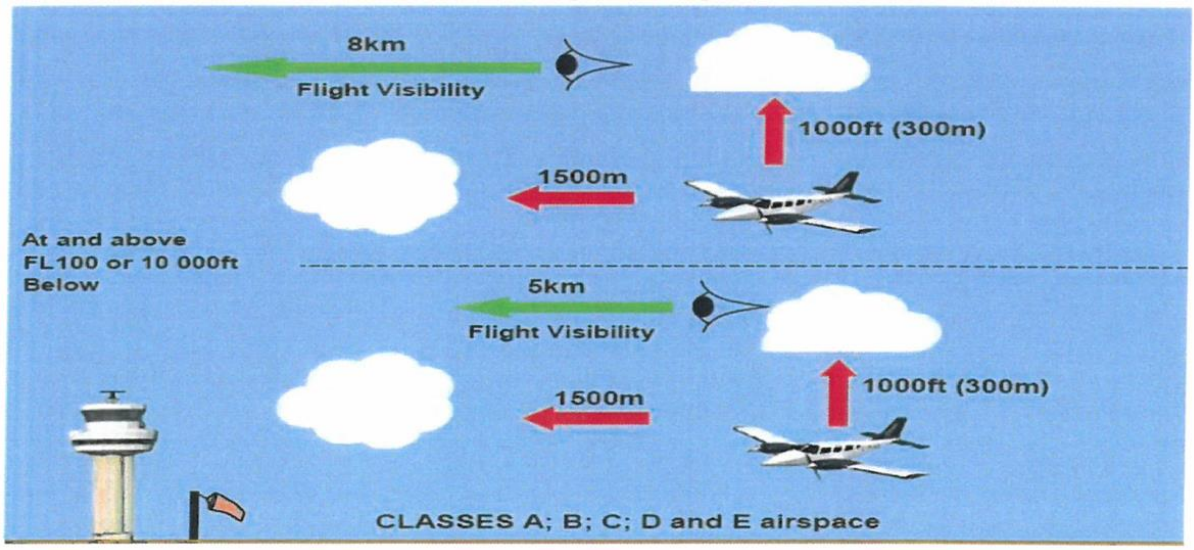
- If only **departure time is revised within validity**, the **same FIC number usually remains valid**.

VFR - Visual Flight Rules (India)

- Flight conducted **with visual reference to the ground and other aircraft**.
- **Permitted only in Visual Meteorological Conditions (VMC)** as prescribed by DGCA.
- Pilot is responsible for **navigation and see-and-avoid**.
- ATC does **not provide separation** from other VFR traffic (traffic information may be provided in controlled airspace).
- Commonly used for **training and general aviation** operations.

VMC (India — summary):

- Below 10,000 ft AMSL: **minimum 5 km flight visibility** and **1,500 m horizontal / 1,000 ft vertical cloud clearance.**
- At or above 10,000 ft AMSL: **minimum 8 km flight visibility** with the same cloud clearance.



IFR – INTRUMENT FLIGHT RULES (INDIA)

- Flight conducted **by reference to flight instruments**, independent of outside visual cues.
- Can be operated in **VMC or IMC**.
- In **IMC (weather below VMC minima)**, flight **must be conducted under IFR**.
- ATC provides air **traffic separation** between IFR flights.
- Requires **IFR clearance, instrument-rated pilot, and IFR-equipped aircraft**.
- **All scheduled airline operations in India are conducted under IFR.**