LOGGING INSTRUMENT TIME §61.51

A person may log instrument time only for that flight time when the person operates the aircraft solely by reference to instruments under actual or simulated instrument flight conditions.

An authorized instructor may log instrument time when conducting instrument flight instruction in actual instrument flight conditions.

To meet recent instrument experience requirements, the following information must be recorded in the person's logbook:
- Location & type of each instrument approach accomplished, and
- The name of the safety pilot, if required

Use of full flight simulator, FTD, or ATD for acquiring instrument aeronautical experience:
- For training towards a certificate or rating, an authorized instructor is present to observe and signs the person's logbook to verify the time and content of the session.
- For IFR recency requirements, log:
  ▷ Training device, time and content.

RECENT EXPERIENCE

To act as PIC under IFR or in weather conditions less than the minimums for VFR - "6 HITS" - Within 6 cal. months preceding the month of flight:
- 6 instrument approaches
- Holding procedures & tasks
- Intercepting & Tracking courses through the use of navigational electronic systems
- The above can be completed in a FFS, ATD, or FTD provided the device represents the category of aircraft for the instrument rating privileges to be maintained and the pilot performs the tasks and iterations in simulated instrument conditions. A flight instructor is not needed

Not current looking back 6 months?
You can still log the required "6 HITS" with a safety pilot (under simulated conditions), examiner or instructor.
- Safety pilot requirements
  □ At least a private pilot with appropriate category and class.
  □ Have adequate vision forward and to each side of the aircraft.
  □ Aircraft must have a dual control system.

Not current looking back 12 months?
- Instrument Proficiency Check (IPC) by a CFII, examiner, or other approved person is required. Guidelines are in the ACS.
- Some IPC tasks, but not all, can be conducted in a FTD or ATD. (Refer to the ACS)

To carry passengers as PIC
- 3 takeoffs & landings in category, class and type (if type rating req.) In the last 90 days.
- At periods between 1 hour after sunset to 1 hour before sunrise; 3 takeoffs & landings to full stop within 1 hour after sunset to 1 hour before sunrise.

To act as PIC - Flight review in the last 24 Calendar months (see FAR for exceptions).

(AIRPLANE-INSTRUMENT RATING MINIMUM AERONAUTICAL EXPERIENCE)

- 50 hours X-Country PIC time
  ▷ Of which, 10 hours in airplanes.
- 40 hours actual or simulated instrument time
  ▷ Of which, 15 hours with CFII.
  □ Including one X-Country flight of:
    □ 250 NM along airways or by directed ATC routing.
    □ An instrument approach at each airport.
    □ 3 different kinds of approaches using navigation systems.
  □ With a filed IFR flight plan.
  □ 3 Hours instrument flight training in last 2 Calendar months prior to practical test
- Use of approved full flight simulator or FTD, if trained by authorized instructor:
  ▷ Max. 30 hours if instrument time completed under part 142
  ▷ Max 20 hours if not completed under 142
- Use of FAA approved Aviation Training Device, if trained by an authorized instructor:
  ▷ Max.10 hours of instrument time if Basic ATD
  ▷ Max. 20 hours of instrument time if Advanced ATD
- No more than 20 hours of total instrument time can be credited in a full flight simulator, FTD or ATD, except the 30 hours exception under part 142 mentioned above.

§61.65

PERSONAL DOCUMENTS REQUIRED FOR FLIGHT

- Pilot Certificate
- Medical certificate (or US Driver’s license as permitted by §61.113 & §61.23)
- Authorized photo ID (passport, driver’s license, etc)
- Restricted Radiotelephone Operator Permit (For flights outside the US)

§61.3, §61.113, §61.23, ICAO Article 29
AIRCRAFT DOCUMENTS REQUIRED FOR FLIGHT
A.R.R.O.W —
A - Airworthiness certificate
R - Registration certificate
R - Radio station license (for flights outside the US)
O - Operating limitations & information (in AFM)
W - Weight & Balance data
§21.5, §91.103, §91.9, §91.203, ICAO Article 29

AIRCRAFT MAINTENANCE INSPECTIONS REQUIRED FOR IFR:
A.V.I.A.T.E —
■ A - Annual inspection every 12 calendar months. (§91.409)
■ V - VOR check every 30 days. (For IFR) (§91.171)
■ I - 100 hour inspection. (if for hire) (§91.409)
■ A - Altimeter, automatic altitude reporting (transponder’s) & static system every 24 calendar months. (For IFR in controlled airspace) (§91.411)
■ T - Transponder every 24 calendar months. (§91.413)
■ E - ELT every 12 months. ELT battery must be replaced after 1 hour of transmitter use or if 50% of its useful life (or, for rechargeable batteries, 50 percent of their useful life of charge) has expired. (§91.207)

PREFLIGHT SELF-ASSESSMENT:
I.M S.A.F.E —
■ I - Illness - Do I have any symptoms?
■ M - Medication - Have I taken prescription or over-the-counter drugs?
■ S - Stress - Am I under psychological pressure, worried about finances, health or family discord?
■ A - Alcohol - No drinking within 8 hours. (“8 hours bottle to throttle”). No more than .04% of alcohol in blood.
■ F - Fatigue - Am I tired / adequately rested?
■ E - Emotion - Am I emotionally upset?
§91.17, AIM 8-1-1

PREFLIGHT INFO REQUIRED FOR IFR:
N.W K.R.A.F.T — (§91.103)
■ N - NOTAMs.
■ W - Weather reports and forecasts.
■ K - Known traffic delays as advised by ATC.
■ R - Runway length of intended use.
■ A - Alternatives available if flight cannot be completed as planned.
■ F - Fuel requirements
■ T - Takeoff and landing performance data.

RISK MANAGEMENT & PERSONAL MINIMUMS
P.A.V.E —
■ P - Pilot (general health, physical / mental / emotional state, proficiency, currency)
■ A - Aircraft (airworthiness, equipment, performance)
■ V - Environmental (weather hazards, terrain, airports / runways to be used & other conditions)
■ E - External pressure (meetings, people waiting at destination, etc.)
(Pilot’s Handbook of Aeronautical Knowledge)

DECISION MAKING
D.E.C.I.D.E —
■ D - Detect that a change has occurred.
■ E - Estimate the need to counter the change.
■ C - Choose a desirable outcome.
■ I - Identify solutions.
■ D - Do the necessary actions.
■ E - Evaluate the effects of the actions
(Pilot’s Handbook of Aeronautical Knowledge)

PASSENGER BRIEFING
S.A.F.E.T.Y —
■ S ▷ Seat belts fastened for taxi, takeoff, landing.
■ A ▷ Shoulder harness fastened for takeoff, landing.
■ F ▷ Seat position adjusted and locked in place
■ E ▷ Air vents location and operation
■ T ▷ All environmental controls (discussed)
■ Y ▷ Action in case of any passenger discomfort
■ F ▷ Fire extinguisher (location and operation)
■ E ▷ Exit doors (how to secure; how to open)
■ I ▷ Emergency evacuation plan
■ T ▷ Emergency/survival kit (location and contents)
■ Y ▷ Traffic (scanning, spotting, notifying pilot)
■ T ▷ Talking, sterile flight deck expectations
■ Y ▷ Your questions? Speak up!
(Pilot’s Handbook of Aeronautical Knowledge)
TAKEOFF BRIEFING

D.E.P.A.R.T.S —

D - Departure review (e.g. takeoff type, initial heading, first fix & course, clearance readout).
E - Establish Expectations (e.g., flying pilot, PIC, positive transfer of controls).
P - Plan / special considerations (e.g., weather, visibility, terrain, unfamiliar field, inoperative equipment / MELs).
A - Alternate (takeoff alternate, if needed, or return plan)
R - Runway conditions and length.
T - Trouble / Tactics (e.g., rejected takeoff, engine failure).
S - Speak up! Questions / concerns?

IFR FLIGHT PLAN

■ Requirement: no person may operate an aircraft in controlled airspace under IFR unless that person has:
  ▶ Filed an IFR flight plan; and
  ▶ Received an appropriate ATC clearance.

■ It is legal to fly IFR in uncontrolled airspace (class G) without a flight plan or clearance. However, once airborne, you must remain in uncontrolled airspace until you file a flight plan and get an ATC clearance to enter the controlled airspace. §91.173

■ How to file an IFR flight plan?
  ▶ FSS
    □ by phone (1-800-WX-BRIEF)
  ▶ over the radio (GCO/RCO frequencies)
    □ In person.
    □ Online
      □ www.1800wxbrief.com (Leido)
      □ www.fltplan.com (Garmin)
  ▶ EFB (e.g., Foreflight)
  ▶ With ATC (over radio, or phone if no other mean available)

■ File at least 30 minutes prior to estimated departure. Non-scheduled flights above FL230 should be filed at least 4 hours before est. departure time. (AIM 5-1-8)

■ Flight plan cancelation (AIM 5-1-15)
  ▶ Towered airports - automatically cancelled by ATC upon landing.
  ▶ Non-towered airports - Pilot must contact ATC / FCC to cancel (by radio or phone)
  ▶ Can cancel anytime in flight if out of IMC and out of class A airspace.

■ Preferred IFR Routes are published in the Chart Supplement U.S. It is to the pilot’s advantage to file a preferred route if available. (AIM 5-1-8)

IFR MINIMUM FUEL REQUIREMENTS §91.167

Fuel from departure to destination airport
Fuel from destination to most distant alternate (if alternate required)
45 Minutes calculated at normal cruise

*Other fuel requirements exist for 121, 135, Flag and supplemental operations

NEED A DESTINATION ALTERNATE?

“1-2-3” RULE —

A destination alternate is always required, unless:

■ An instrument approach is published and available for the destination, AND,
  ▶ Ceiling will be at least 2000’ above airport elevation; and
  ▶ Visibility will be at least 3 SM.

§91.169

MIN WX CONDITIONS REQUIRED AT AN AIRPORT TO LIST IT AS AN ALTERNATE

The alternate airport minima published in the procedure charts, or, if none:

■ Precision approach:
  600 ft ceiling and 2 SM visibility.

■ Non-precision approach:
  800 ft ceiling and 2 SM visibility.

■ No instrument approach available at the alternate:
  Ceiling & visibility must allow descent from MEA, approach and landing under VFR.

§91.169

FILING AN ALTERNATE - GPS CONSIDERATIONS

■ Equipped with a non-WAAS GPS? You can flight plan based on GPS approaches at either the destination or the alternate, but not at both.

■ WAAS Without baro-VNAV? May base the flight plan on use of LNAV approaches at both the destination and alternate.

■ WAAS with baro-VNAV? May base the flight plan on use of LNAV/VNAV or RNP 0.3 at both the destination and the alternate.

AIM 1-1-17b.5, 1-1-18c.9, 1-2-3d

IFR CRUISING ALTITUDES

Based on magnetic course §91.179

180°-359°
0°-179°
Even
Odd
0'-399'
400'-179'
Thousands
or
Flight
Levels
Thousands
or
Flight
Levels
S
W
E
N
**IFR TAKEOFF MINIMUMS** (§91.175)

No T/O minimums mandated for part 91 operations. Part 121, 125, 129, 135:
- Prescribed T/O minimums for the runway, or, if none:
  - 1-2 engines airplanes: 1 SM visibility
  - More than 2 engines: ½ SM visibility

⚠️ Non-Standard TO mins / Departure Procedures.

Non-Standard IFR alternate minimums exist.

- Alternate minimums not authorized due to unmonitored facility or the absence of weather reporting service.

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**DEPARTURE PROCEDURES (DP)**

AIM 5-2-9

- Either textual or graphical.
- Ensures obstacle clearance, provided:
  - the airplane crossed the departure end of the runway at least 35 ft AGL,
  - reaches 400 ft AGL before turning, and
  - climbs at least 200 Feet per NM (FPNM), or as published otherwise on the chart.

  □ FPNM to feet-per-minute conversion:

\[ fpm = \text{FPNM} \times \text{Groundspeed} / 60 \]

- Pilots are encouraged to file a DP at night, during marginal VMC or IMC.

- Two types of DP
  - **Obstacle Departure Procedure (ODP)**
    - Provides only obstacle clearance.
    - Graphic ODPs will have "(OBSTACLE)" printed in the chart title.
  - **Standard Instrument Departure (SID)**
    - In addition to obstacle clearance it reduces pilot and controller workload by simplifying ATC clearances and minimizing radio communications.
    - Some SIDs may depict special radio failure procedures.

- DP are also categorized by equipment required:
  - **Non-RNAV DP** - for use by aircraft equipped with ground-based navigation (i.e., VOR, DME, NDB).
  - **RNAV DP** - for aircraft equipped with RNAV equipment (e.g., GPS, VOR/DME, DME/DME).

- Transition routes connect the end of the basic SID procedure to the en route structure.

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**IFR DEPARTURE CLEARANCE**

C.R.A.F.T —

- C - Clearance limit.
- R - Route.
- A - Altitude.
- F - Frequency (for departure).
- T - Transponder code.

Clearance void time – The time at which your clearance is void and after which you may not takeoff. You must notify ATC within 30 min after the void time if you did not depart.

"Hold for release" – You may not takeoff until being released for IFR departure.

Release time – The earliest time the aircraft may depart under IFR.

Expect Departure Clearance Time (EDCT) – A runway release time given under traffic management programs in busy airports. Aircraft are expected to depart no earlier and no later than 5 minutes from the EDCT.

Abbreviated departure clearance – “Cleared (...) as filed (...)?” (AIM 5-2-6)

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**STANDARD TERMINAL ARRIVAL (STAR)**

- Serves as a transition between the en route structure and a point from which an approach to landing can be made.
- **Transition routes** connect en route fixes to the basic STAR procedure.
- Usually named according to the fix at which the basic procedure begins.
- As with a SID, you can state “NO STARs” in the remarks section of the flight plan, to avoid getting a clearance containing a STAR.
- RNAV STARs require RNAV 1 performance.

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**IFR ALTITUDES**

**MIN IFR ALTITUDES** (§91.177)

- Except for takeoff or landing, or otherwise authorized by the FAA, no person may operate an aircraft under IFR below -
  - Minimum altitudes prescribed for the flown segment, or if none:
    - Mountainous areas: 2,000 ft above the highest obstacle within a horizontal distance of 4 NM from the course.
    - Non-mountainous areas: 1,000 ft above the highest obstacle within 4 NM from the course.
**IFR ALTITUDES** - CONTINUED (§91.177, Pilot/Controller Glossary)

- **DA / H** - Decision Altitude / Height: the Altitude (MSL) / Height (above runway threshold), on an instrument approach procedure at which the pilot must decide whether to continue the approach or go around.
- **MAA** - Maximum Authorized Altitude. Annotated “MAA-17000” (17,000 ft as an example) on IFR charts.
- **MCA** - Minimum Crossing Altitude
- **MDA / H** - Minimum Decent Altitude / Height: The lowest Altitude (MSL) / Height (above runway threshold) to which descent is authorized on a non-precision approach until the pilot sees the visual references required for landing.
- **MEA** - Minimum En route Altitude: The lowest published altitude between radio fixes which assures acceptable navigational signal coverage and meets obstacle clearance requirements. An MEA gap establishes an area of loss in navigational coverage and annotated “MEA GAP” on IFR charts.
- **MOCA** - Minimum Obstruction Clearance Altitude: Provides obstacle clearance and navigation coverage only up to 22 NM of the VOR.
  - If both an MEA and a MOCA are prescribed for a particular route segment, a person may operate an aircraft lower than the MEA down to, but not below the MOCA, provided the applicable navigation signals are available. For aircraft using VOR for navigation, this applies only when the aircraft is within 22 NM of the VOR. (§91.177)
- **MORA** - Minimum Off Route Altitude (Jeppesen):
  - Route MORA provides obstruction clearance within 10NM to either side of airway centerlines and within a 10NM radius at the ends of airways.
  - Grid MORA provide obstruction clearance within a latitude / longitude grid block.
- **MRA** - Minimum Reception Altitude
- **MTA** - Minimum Turning Altitude: Provides vertical and lateral obstacle clearance in turns over certain fixes. Annotated with the MCA X icon and a note describing the restriction.
- **MVA** - Minimum Vectors Altitude: The lowest altitude at which an IFR aircraft will be vectored by a radar controller, except as otherwise authorized for radar approaches, departures, and missed approaches. MVAs may be lower than the minimum altitudes depicted on aeronautical charts, such as MEAs or MOCAS.
- **OROCA** - Off Route Obstruction Clearance Altitude: Provides obstruction clearance with a 1,000 ft buffer in non-mountainous terrain areas, and 2,000 ft in mountainous areas. OROCA may not provide navigation or communication signal coverage.

*Designated mountainous areas are defined in 14 CFR part 95 by lat / long coordinates.

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**FLIGHT INSTRUMENTS**

**GYROSCOPIC INSTRUMENTS**

- **Two principles** of a gyroscope: **Rigidity in space** and **precession**.
- **Attitude indicator** – operates on the principle of rigidity in space. Shows bank and pitch information. Older AIs may have a tumbling limit. Should show correct attitude within 5 minutes of starting the engine. Normally vacuum-driven in GA aircraft, may be electrical in others. May have small acceleration/acceleration errors (accelerate-slight pitch up, decelerate- pitch down) and roll-out errors (following a 180 turn shows a slight turn to the opposite direction).
- **Heading indicator** – operates on the principle of rigidity in space. It only reflects changes in heading, but cannot measure the heading directly. You have to calibrate it with a magnetic compass in order for it to indicate correctly. His may be slaved to a magnetic heading source, such as a flux gate, and sync automatically to the present heading. Normally powered by the vacuum system in GA aircraft.
- **Turn indicators** – operates on the principle of precession.
  - Turn coordinators show rate-of-turn and rate of roll.
  - Turn-and-slip indicators show rate-of-turn only.

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**PITOT-STATIC INSTRUMENTS**

**ALTIMETER**

- **An aneroid barometer** that shows the height above a given pressure level, based on standard pressure lapse rate of 1000’ per inch of mercury.
- A stack of sealed aneroid wafers expand and contract with changes in atmospheric pressure received from the static port.
- **A mechanical linkage** between the aneroid and the display translates the sensed pressure to an altitude indication.
- An **altimeter setting knob** (on a “sensitive altimeter”, which are most aircraft altimeters) allows the pilot to adjust the current pressure to the current altimeter setting published locally (available from ATIS, METAR or ATC).
- The pressure setting is displayed in the “Kollsman Window” in mb and/or inches of mercury (Hg).
- In the US, when operating below 18,000’ MSL **regularly set the altimeter to a station within 100 NM**. Above 18,000’ MSL, the altimeter should be set to the standard sea level pressure of 29.92” Hg, and operate in Flight Levels (FL).
- **“High to Low - Watch out below!”**. Use caution when flying from high pressure to low pressure areas. If altimeter setting is not updated, altitude will indicate higher, causing the pilot to fly lower than desired. Flying from hot to cold areas results in the same error.
TYPES OF ALTITUDES
- **Indicated altitude** – Uncorrected altitude indicated on the dial when set to local pressure setting (QNH).
- **Pressure altitude** – Altitude above the standard 29.92 Hg plane. (QNE). Used when flying above the transition altitude (18,000’ in the US)
- **Density altitude** – Pressure alt. corrected for nonstandard temperature. Used for performance calculations.
- **True altitude** – Actual altitude above Mean Sea Level (MSL).
- **Absolute altitude** – Height above airport elevation (QFE).

VERTICAL SPEED INDICATOR (VSI)
- Indicates rate-of-climb in fpm (accurate after a 6-9 sec. lag), and rate trend (immediately with rate change).
- A diaphragm inside the instrument is connected directly to the static source.
- The area outside the diaphragm also receives static pressure, but via a calibrated leak (a restricted orifice).
- This configuration essentially responds to static pressure change over time.
- As the diaphragm expands or contracts, a mechanical linkage moves the pointer needle to display the current rate of climb to the pilot.
- **Instantaneous VSI** (IVSI) solves the lag issue with the addition of vertical accelerometers.

AIRSPEED INDICATOR (ASI)
- The airspeed indicator measures the difference between impact (ram) air pressure from the pitot tube and ambient pressure from the static port. The result pressure is called dynamic pressure and corresponds to airspeed.
- Dynamic Pressure (airspeed) = Impact Pressure – Static pressure.
- A diaphragm in the instrument receives ram pressure from the pitot tube. The area outside the diaphragm is sealed and connected to the static port. A mechanical linkage converts the expansion and contraction of the diaphragm to airspeed shown on the display dial.

TYPES OF SPEEDS
- **Indicated airspeed (IAS)** – indicated on the airspeed indicator
- **Calibrated airspeed (CAS)** – IAS corrected for instrument & position errors.
- **Equivalent airspeed (EAS)** – CAS corrected for compressibility error.
- **True airspeed (TAS)** – Actual speed through the air. EAS corrected for nonstandard temperature and pressure
- **Mach number** – The ratio of TAS to the local speed of sound.
- **Ground speed** – Actual speed over the ground. TAS corrected for wind conditions.

STATIC PORT BLOCKAGE
- **Airspeed indicator** – Indicates correctly only at the blockage altitude.
  - Higher altitudes → airspeed indicates lower than it should.
  - Lower altitudes → Indicates higher than it should.
- **Altimeter** – will freeze on the altitude where it was blocked.
- **VSI** – freezes on zero.
  - After verifying a blockage in the static port, you should use an alternate static source or break the VSI window (in which case, expect reverse VSI information).
  - When using the **alternate static source** (a lower static pressure is measured):
    - **Airspeed indicator** – indicate a faster speed than it should.
    - **Altimeter** – indicate higher than it should.
    - **VSI** – momentarily show a climb.

PITOT TUBE BLOCKAGE
The only instrument affected is the airspeed indicator.
- Ram air inlet clogged and drain hole open? Airspeed drops to zero.
- Both air inlet and drain hole are clogged? The airspeed indicator will act as an altimeter, and will no longer be reliable.
- When suspecting a pitot blockage, consider the use of pitot heat to melt ice that may have formed in or on the pitot tube.
### MINIMUM EQUIPMENT REQUIRED FOR FLIGHT (§91.205)

**For VFR day:**
- A - Altimeter
- T - Tachometer for each engine
- O - Oil temperature indicator for each engine
- M - Manifold pressure gauge for each engine altitude
- A - Airspeed indicator
- T - Temperature gauge for each liquid cooled engine
- O - Oil pressure gauge for each engine
- F - Fuel quantity gauge for each tank
- L - Landing gear position lights (if retractable gear)
- A - Anticollision lights (aircraft certified after March 11, 1996)
- M - Magnetic direction indicator (mag. compass)
- E - ELT, if required by §91.207
- S - Safety belt / shoulder harness

**For VFR night:**
- All VFR day equipment + FLAPS
- F.L.A.P.S —
- F - Fuses (spare set)
- L - Landing light (if for hire)
- A - Anticollision lights
- P - Position lights (navigation lights)
- S - Source of electrical power (i.e., battery)

**For IFR day:** all VFR day equipment + GRABCARD

**For IFR night:** all VFR day + VFR night + GRABCARD

### OPERATING WITH INOPERATIVE ITEMS (§91.213)

- Follow MEL provisions
- Aircraft has an MEL?
  - Yes
  - No

- Is the inoperative equipment required by:
  - VFR-day type certification requirements?
  - Equipment list or kind of operations equipment list?
  - §91.205 or other regulations for kind of operations?
  - An Airworthiness Directive (AD)?

- Flying is permitted, provided:
  - Inoperative equipment is removed, or
  - deactivated and placarded “Inoperative.”
  - Pilot/mechanic determines no hazard from inop item.

**Flying not allowed** without a special flight permit
DISTANCE MEASURING EQUIPMENT (DME)
- 962-1213 MHz (UHF).
- Normally tuned automatically with a paired VHF station (VOR/LOC).
- The airborne DME unit transmits an interrogation signal.
- The ground DME facility receives and replies to the interrogation.
- Airborne unit calculates the slant range distance to the station based on the reply time.
- Due to slant range error, when flying overhead the station, DME indication is not “0”.
- Slant range error is negligible at 1 NM from the DME station per every 1000 ft. For example, at 5000 ft, slant range error is negligible when further than 5 NM of the station.

NON-DIRECTIONAL BEACON (NDB)
- Operates at the 190-535 kHz range (can receive and point towards commercial radio AM station at 550 -1650 kHz).
- Low to medium frequency band.
- ADF (Automatic Direction Finder) in aircraft points towards the NDB station.
- Magnetic Bearing = Magnetic Heading + Relative Bearing

<table>
<thead>
<tr>
<th>NDB Service Volume Classes</th>
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<tbody>
<tr>
<td>Compass Locator</td>
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<tr>
<td>Medium High (MH)</td>
</tr>
<tr>
<td>High (H)</td>
</tr>
<tr>
<td>High High (HH)</td>
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</tbody>
</table>

COMPASS LOCATOR
A low-powered NDB transmitter (at least 25 Watts and 15NM range) installed at the OM or the MM on some ILS approaches.

VHF OMNI DIRECTIONAL RANGE (VOR)

STANDARD VOR SERVICE VOLUMES

Terminal
- 25 NM
- 1,000 ft
- 12,000 ft

Low
- 40 NM
- 18,000 ft
- 1,000 ft

High
- 60,000 ft
- 45,000 ft
- 18,000 ft
- 14,500 ft
- 1,000 ft

VOR limitations
- Cone of confusion
- Reverse sensing (if used incorrectly)
- Requires line-of-sight between aircraft and station.

VOR Receiver Checks (§91.171)
- Perform every 30 calendar days
  - VOT ±4º
  - Repair Station ±4º
  - VOR ground checkpoint ±4º
  - VOR airborne checkpoint ±6º
  - Dual VOR cross-check ±4º
- Above a prominent ground landmark on a selected radial at least 20 NM from a VOR, flying at a “reasonable low altitude” ±6º

VOR Check sign-off (§91.171)
D.E.P.S –
D - Date
E - Error (bearing error)
P - Place
S - Signature

AREA NAVIGATION (RNAV)
- Allows navigation on any desired path without the need to overfly ground-based facilities.
- Types:
  - Global Navigation Satellite System (GNSS) (e.g., GPS, Galileo, GLONASS, BeiDou)
  - VOR/DME RNAV
  - DME/DME RNAV
  - Inertial Reference Unit / System (IRU/IRS)
  - RNAV VNAV - Vertical NAVigation guidance.
  - BARO-VNAV - An RNAV system that uses the barometric altitude to compute vertical guidance for the pilot.
- Published RNAV routes include Q (FL180 to FL450) and T (1,200 AGL to 18,000 MSL) routes and are designated RNAV 1 unless charted otherwise.
- Magnetic Reference Bearing (MRB) - the published bearing between two waypoints on an RNAV route.

REQUIRED NAVIGATION PERFORMANCE (RNP)
- RNP is:
  - A statement of navigation equipment and service performance.
  - RNAV with navigation monitoring and alerting.
- All RNAV approaches are RNP approaches
- Most US RNP approaches are titled “RNAV (GPS)”.
- US Approaches with “RNAV (RNP)” in the title are “AR” (Authorization Required) approaches, which require special FAA approval for the crew, aircraft and operation.
- In other countries, all RNP approaches may have “RNP” in the title, even those that do not require special authorization.

RNP approach minims and equipment:
- GLS DA minims using GBAS (formerly LAAS)
- LP MDA or LPV DA minims require RNP, achieved by WAAS.
- LNAV / VNAV DA achieved by VNAV-approved WAAS, or BARO-VNAV systems.
- LNAV MDA - achieved by a basic, unaugmented IFR-approved GPS.
GLOBAL POSITIONING SYSTEM (GPS)

- GPS is a Global Navigation Satellite System (GNSS) operated by the United States.
- The constellation consists of a minimum of 24 satellites (with some spares) orbiting above the earth at 10,900 NM. The system is designed so that at least 5 satellites are in view at any given location on earth.
- The Aircraft’s GPS receiver calculates the distance to a GPS satellite based on the time lapse since the broadcast timestamp (obtained from an atomic clock onboard the satellite) and the time it received the signal.
- Using only one satellite, the aircraft could virtually be on any point on a sphere surrounding the satellite, with the calculated distance (“pseudo-range”) as the sphere’s radius.
- The GPS receiver uses the intersection of spheres, from multiple satellites, to calculate the aircraft’s geographical position.
- Course and speed data are computed from aircraft position changes.
- At least 3 satellites are required for 2d position. (latitude and longitude); at least 4 satellites are required for 3d position. (latitude, longitude and altitude).
- Receiver Autonomous Integrity Monitoring (RAIM) is a function of GPS receivers that monitors the integrity of the satellite signals.
  - RAIM (fault detection) requires a minimum of 5 satellites, or, 4 satellites + an altimeter input (baro-aided RAIM)
  - To eliminate a corrupt satellite (fault exclusion), RAIM needs an additional satellite (total of 6 or 5 + baro-aid)
- A database loaded into the receiver unit contains navigational data such as: airports, nav aids, routes, waypoints and instrument procedures.
- Airborne GPS units use great-circle navigation.
- GPS CDI deflection shows distance, unlike a VOR’s CDI, which presents an angular distance off course in degrees.
- GPS can substitute ADF or DME, except for ADF substitution on NDB approaches without a GPS overlay (“or GPS” in title).
- Check GPS NOTAMS before the flight and use RAIM prediction if available on your receiver.
- GPS Augmentation systems, or Differential GPS (DGPS) – Improves the accuracy of GPS by measuring errors received by reference stations at known geographical locations and then broadcasting those errors to supported GPS receivers.
  - Satellite Based Augmentation System (SBAS)
    - Wide Area Augmentation System (WAAS) in the US; EGNOS in Europe.
    - Ground stations (Wide-area Reference Stations and Wide-area Master Stations) measure GPS errors and produce correction signals. These corrections are broadcasted back to the satellite segment from which they are bounced back to aircraft GPS WAAS receivers to improve accuracy, integrity and availability monitoring for GPS navigation.
    - Covers a wide area
    - Facilitates APV approaches such as LPV and LNAV/VNAV and LP approaches.
  - Ground Based Augmentation System (GBAS)
    - Formerly named Local Area Augmentation System (LAAS) in the US. Now replaced with the ICAO term “GBAS.”
    - Errors are broadcasted via VHF to GBAS-enabled GPS receivers.
    - GBAS is more accurate than WAAS but covers a much smaller geographical area.
    - Allows for category I and above approaches to GLS DA minima.

Understanding the difference between RNAV, GNSS, GPS, PBN and RNP

- Area Navigation (RNAV)
  - RNAV is a system that enables navigation between any two points without the need to overfly ground-based stations.
- GNSS is a broad term for satellite-based RNAV systems.
  - GPS is the GNSS operated by the USA. Other examples are GLONASS by Russia and Galileo by the EU.
- Performance Based Navigation (PBN)
  - PBN is a general basis for navigation equipment standards, in terms of accuracy, integrity, continuity, availability and functionality for specific operation contexts (e.g., final approach, enroute, missed approach).
- Required Navigation Performance (RNP)
  - RNP is a specific statement of PBN for the flight segment and aircraft capability.
  - RNP is also defined as RNAV + navigation monitoring and alerting functionality.
    - Receiver Autonomous Integrity Monitoring (RAIM) or built-in monitoring in WAAS provide this capability.
    - En route – RNP 2.0 (2 NM accuracy 95% of the flight time)
    - Terminal & Departure – RNP 1.0 (1 NM accuracy 95% of the flight time)
    - Final Approach – RNP 0.3 (0.3 NM accuracy 95% of flight time)
    - Advanced RNP (A-RNP) - is a higher RNP standard mandatory for RNP AR, that require capability for: (AIM 1-2-2)
      - Radius-to-Fix (RF) legs
      - Scaleable RNP (meaning RNP accuracy can change value), and
      - Parallel offset flight path generation
**INSTRUMENT LANDING SYSTEM (ILS)**

**LOCALIZER (AIM 1-1-9)**
- Provides lateral course guidance.
- Frequencies: 108.1 - 111.95 MHz with odd tenths only. 90 and 150 Hz signals are carried over the VHF frequency and used by the receiver to interpret the aircraft's lateral position.
- Width: Between 3°-6° so that the width at the threshold would be 700 feet. Usually 5° total width. (2.5 full deflection to each side, 4 times more sensitive than a VOR).
- Coverage range: 35° to each side of the centerline for the first 10NM and 10° up to 18NM from the antenna and up to an altitude of 4500’.

**GLIDE SLOPE (AIM 1-1-9)**
- Provides vertical course guidance.
- Frequencies: 329.3 to 335 MHz (UHF), automatically tuned with the localizer. GLIDE SLOPE extends from the landing threshold into the approach area up to:
  - 2,400-3,000 feet for precision instrument runways, and
  - 1,400-1,500 feet for non-precision instrument runways.
- May include sequenced flashing lights, which appear to the pilot as a ball of light traveling towards the runway at twice a second (AKA "The Rabbit").
- The visible parts of the ALS configuration can help the pilot estimate flight visibility.

**MARKER BEACONS**
- Provide range information over specific points along the approach. Transmits at 75 MHz.
- Outer marker: 4-7 miles out. Indicate the position at which the aircraft should intercept the GS at the approximate interception altitude ±50 feet. BLUE “-.-”.
- Middle marker: ~3500 feet from the runway. Indicates the approximate point where the GS meets the decision height. Usually 200 feet above the touchdown zone elevation. AMBER “.-...”.
- Inner marker: between the MM and runway threshold. Indicates the point where the glide slope meets the DH on a CAT II ILS approach. WHITE “.-...”.
- Back course marker: Indicates the FAF on selected back course approaches. Not a part of the ILS approach. WHITE “....”.

**APPROACH LIGHT SYSTEMS (ALS) (AIM 2-1-1)**
- Provides basic visible means to transition between instrument-guided flight into a visual approach.
- ALS extends from the landing threshold into the approach area up to:
  - 2,400-3,000 feet for precision instrument runways, and
  - 1,400-1,500 feet for non-precision instrument runways.
- May include sequenced flashing lights, which appear to the pilot as a ball of light traveling towards the runway at twice a second (AKA "The Rabbit").
- The visible parts of the ALS configuration can help the pilot estimate flight visibility.

**ATTITUDE INSTRUMENT FLYING**

**Basic attitude instrument flying skills:**
- Cross Check
- Instrument interpretation
- Aircraft Control

**Control & Performance Method** – Divides the cockpit panel by control instruments and performance instruments. First, set the power and attitude, then monitor the performance and make adjustments.
- Control instruments
  - Power - Tachometer, Manifold pressure, EPR, N1, etc.
  - Attitude - Attitude Indicator
- Performance Instruments
  - Pitch: altimeter, airspeed and VSI
  - Bank: Heading Indicator, Turn Coordinator, and magnetic compass

**Primary & Supporting Method** – Divides the cockpit panel by Pitch, Bank, and Power instruments.
- Pitch instruments: Attitude Indicator, Altimeter, Airspeed Ind., and VSI.
- Bank instruments: Attitude ind., Heading ind., Mag. Compass, and Turn Coordinator.
- Power instruments: Airspeed, Tachometer, Manifold pressure
- For a specific maneuver, primary instruments provide the most essential information for bank and power while supporting instruments back up and supplement the information presented by the primary instruments.
- Example, for a constant rate climb with a standard rate turn –
  - Primary: Pitch - VSI; Bank - Turn Coordinator, Power - RPM / MP
  - Secondary: Pitch - ASI; attitude, Bank - AI, HI, Mag. Compass; Power - ASI
MANDATORY REPORTS UNDER IFR
M.A.R.V.E.L.O.U.S. V.F.R. C.500 -

(AIM 5-3-3, §91.183, §91.187)

- Missed approach
- Airspeed ±10 kts / 5% change of filed TAS (whichever is greater)
- Reaching a holding fix (report time & altitude)
- VFR on top when an altitude change will be made.
- ETA change ±3 min
- Leaving a holding fix
- Outer marker (or fix used in lieu of it) *
- Un-forecasted weather
- Safety of flight (any other information related to safety of flight)
- Vacating an altitude/FL
- Final Approach fix *
- Radio/Nav/approach equipment failure (§91.187)
- Compulsory reporting points ▲ * (§91.183)
- 500 - unable climb/descent 500 fpm
* Required only in non-radar environments (including ATC radar failure)

POSITION REPORT ITEMS REQUIRED IN NON-RADAR ENVIRONMENT

($91.183, AIM 5-3-2)

- Aircraft ID.
- Position.
- Time.
- Altitude.
- Type of flight plan (except when communicating with ARTCC / Approach control).
- ETA and name of next reporting fix.
- Name only of the next succeeding point along the route of flight.
- Any pertinent remarks.

HOLDING PATTERNS

(AIM 5-3-8)

- ATC may assign holding instructions to delay or separate traffic in the air for reasons such as weather or airport closures.

Non-charted holding clearance items:
  ▷ Direction of hold from the fix (e.g., N, W, S, NE)
  ▷ Holding Fix
  ▷ Radial, course, airway, or route on which to hold.
  ▷ Leg length in miles (if DME or RNAV) or minutes otherwise.
  ▷ Direction of turns (if left). Otherwise, right turns are standard.
  ▷ Expect Further Clearance (EFC) time

Charted holding clearance items
  ▷ Holding Fix
  ▷ Direction
  ▷ EFC

- Start speed reduction 3 minutes before reaching the hold fix.
- Actions at hold fix and each turn point 5 Ts
  ▷ Turn
  ▷ Time
  ▷ Twist
  ▷ Throttle
  ▷ Talk

MAKING ALL HOLD TURNS:
- 3º per second, or
- 30º bank angle, or
- Follow Flight Director bank angle

HOLDING ENTRY

- Direct - Upon crossing the fix turn to follow the holding pattern
- Parallel - Upon crossing the fix, turn to heading parallel to the holding course outbound for 1 minute. Then turn into the the hold pattern to intercept the inbound course.
- Teardrop - Upon crossing the fix, turn outbound to a heading 30º into the pattern. Fly it for 1 minute, then turn in the direction of the hold turns to intercept the inbound course.

HOLDING SPEEDS

- May be restricted to 175 kts on some instrument approach procedures

<table>
<thead>
<tr>
<th>ALTITUDE (MSL)</th>
<th>MAX AIRSPEED (KTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,000’ or below</td>
<td>200 kts</td>
</tr>
<tr>
<td>6001 - 14,000</td>
<td>230 kts</td>
</tr>
<tr>
<td>14,001 and above</td>
<td>265 kts</td>
</tr>
<tr>
<td>Air Force fields</td>
<td>310 kts *</td>
</tr>
<tr>
<td>Navy Fields</td>
<td>230 kts *</td>
</tr>
</tbody>
</table>

* Unless published otherwise.
**LOST COMMUNICATIONS PROCEDURE**

<table>
<thead>
<tr>
<th>Altitude to Fly</th>
<th>Route to Fly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLY THE HIGHEST OF:</strong></td>
<td><strong>SELECT THE ROUTE BY THIS ORDER:</strong></td>
</tr>
<tr>
<td>M.E.A —</td>
<td>A.V.E.F —</td>
</tr>
</tbody>
</table>
| M - Minimum altitude prescribed for IFR | A - Assigned route, if none:
| E - Expected (as in: “Expect 5000 10 min after departure”) | V - Vectored (fly to fix/route/airway last vectored to), if none:
| A - Assigned. Last altitude assigned by ATC. | E - Last Expected route by ATC, if none:
| | F - Filed route |

**LEAVING THE CLEARANCE LIMIT**

- If descent and approach as close as possible to the EFC, or ETA (If no EFC given).
- At EFC or clearance limit (if no EFC given), proceed to a fix which an approach begins and start the approach.

**PROCEDURE TURN**

- A PT is a maneuver that enables:
  - Course reversal.
  - A descent from from IAF.
  - Inbound course interception.
  - Max speed - 200 kts.
- Remain within the charted distance (“Remain within _NM_” note), typically 10 NM, and comply with published altitudes for obstacle clearance.
- The shape of the maneuver is mandatory if a teardrop or holding-in-lieu of a PT is published. Otherwise, only the direction of the turn is mandatory.
- A teardrop procedure may be published in lieu of a PT. In that case:
  - No IF published? Intermediate segment begins 10 miles prior to the final approach fix.
  - Nav facility located on the airport? Final approach starts at completion of the teardrop turn. However, the final approach segment begins on the final approach course 10 miles from the facility.
- A PT or hold-in-lieu-of-PT is mandatory when depicted on the approach chart. However, it is **not permitted** when: No PT depicted on the chart, radar vectors to final or when **conducting a timed approach** from a holding fix.

**DO NOT FLY A PROCEDURE TURN WHEN:**

- **S.H.A.R.P.T.T —**
  - Straight-in approach clearance.
  - Holding in lieu of a procedure turn.
  - DME Arc.
  - Radar vectors to final.
  - No PT depicted on chart.
  - Timed approach from a hold fix.
  - Teardrop course reversal.

**Instrument approach types**

- **Precision**
  - Lateral + vertical guidance to a DA.
  - ILS - Instrument Landing System
  - MLS - Microwave Landing System
  - PAR - Precision Approach Radar
  - GLS - GBAS Landing System
  - TLS - Transponder Landing System
- **Non-Precision**
  - Lateral guidance only. Flown to MDA.
  - VOR
  - NDB
  - RNAV / RNP to LNAV or LP Minima
  - LOC - Localizer
  - LDA - Localizer-type Directional Aid. Identical to a LOC but not aligned with the runway.
  - SDF - Simplified Directional Facility. Similar to a LOC with 6º or 12º width. May be aligned or not with the runway.
  - ASR - Approach Surveillance Radar

**Approach Clearances**

- When can you descend to the next instrument approach segment?
  - When cleared for the approach and established on a segment of a published approach or route. (AIM 5-5-4)
- Contact approach (AIM 5-5-3)
  - Requested by the pilot in lieu of an instrument approach. (Cannot be initiated by ATC)
  - Requires at least 1SM ground visibility and remain clear of clouds.
  - Only at airports with approved instrument approach procedures.
  - Pilot assumes responsibility for obstruction clearance.
- Visual approach (AIM 5-5-11)
  - Initiated by either ATC or the pilot.
  - Requires at least 1000’ ceiling and 3SM visibility (IFR under VMC)
  - Pilot must have either the airport or the traffic to follow in sight.
  - Pilot is responsible for visual separation from traffic to follow.

**Missed Approach**

- Execute a missed approach when:
  - Arrival at MAP or DH with insufficient visual reference to runway environment.
  - A safe approach is not possible.
  - Instructed to do so by ATC.

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Airplane IFR Quick-Review | Page 12 | Visit PilotsCafe.com for updates and other flight training resources

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When can you descend below MDA / DA? (§91.175)

1. The aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers.

2. The flight visibility (or the enhanced flight visibility, if equipped) is not less than the visibility prescribed in the standard instrument approach being used.

3. At least one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:
   (except for CAT II & III approaches)
   i. The approach light system, except that the pilot may not descend below 100 feet above the touchdown zone elevation using the approach lights as a reference unless the red terminating bars or the red side row bars are also distinctly visible and identifiable.
   ii. The threshold.
   iii. The threshold markings.
   iv. The threshold lights.
   v. The runway end identifier lights.
   vi. The visual glideslope indicator.
   vii. The touchdown zone or touchdown zone markings.
   viii. The touchdown zone lights.
   ix. The runway or runway markings.
   x. The runway lights.

### VISUAL DESCENT POINT (VDP) (AIM 5-4-5)

- A defined point on the final approach course of a non-precision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may begin, provided adequate visual reference is established.
- Identified by a ‘V’ symbol on the descent profile.
- If not equipped to identify the VDP, fly the approach as if no VDP was published.
- Do not descend below the MDA prior to reaching the VDP.
- Calculate VDP, when not published:

  - By distance: VDP (in NM from threshold) = MDH / 300

  Example: MDH is 600 ft.
  
  VDP = 600 / 300 = 2 NM
  
  Start the descent 2 NM from the threshold.

  - By time: MDH / 10 = seconds to subtract from time between FAF and MAP

  Example: MDH is 500 ft, FAF to MAP is 4:00.
  
  500 / 10 = 50 seconds. 4:00 - 0:50 = 3:10
  
  Start the descent at 3:10 (time from FAF)

### VISUAL DESCENT ANGLE (VDA) (AIM 5-4-5)

- A computed glide path from the FAF to the runway’s TCH published for non-precision approaches. Typically 3º.
- FAA policy is to publish a VDA/TCH on all non-precision approaches except those published in conjunction with vertically guided minimums (i.e., ILS or LOC RWY XX) or no FAF procedures without a stepdown fix (i.e., on-airport VOR or NDB). A VDA does not guarantee obstacle protection below the MDA in the visual segment. The presence of a VDA does not change any non-precision approach requirements.
- VDAs are advisory only, pilots must still comply with all published altitudes on the procedure.

#### Rate of Descent for a 3º Glide Path

<table>
<thead>
<tr>
<th>VS (fpm)</th>
<th>= Ground Speed X (10 / 2), or VS (fpm) = Ground Speed X 5</th>
</tr>
</thead>
</table>

Example: 120 kts X (10 / 2) = 120 kts X 5 = 600 fpm

#### How Far to Start a Descent for a 3º Glide Path?

TOD = Altitude to lose (ft) / 300

Example, on approach

800 ft to lose MDA to TCH:

800/300 = 2.67 NM

Start descent 2.67 NM from the runway threshold.

Example

Cruising at FL320, ATC: "...cross LGA OR at FL240".

Altitude to lose = 35,000 - 24,000 = 11,000 ft

11000/300 = 36.67 NM

#### Other Glide Path Angles

Descent gradient (%) = tan(descent angle) X 100

<table>
<thead>
<tr>
<th>Descent angle</th>
<th>Gradient (%) = tan(angle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2º</td>
<td>3.5%</td>
</tr>
<tr>
<td>3º</td>
<td>5.2%</td>
</tr>
<tr>
<td>4º</td>
<td>7%</td>
</tr>
<tr>
<td>5º</td>
<td>8.7%</td>
</tr>
</tbody>
</table>

VS (fpm) = Groundspeed X Descent Gradient (%)
TOD = Altitude to lose / (glidepath angle *100)

Example

At FL350, ATC: "...cross LGA OR at FL240", pilot elects a steep 4º slope, 380 kts GS:

VS = 380 X 7 = 2660 fpm

TOD = 11000 / 460 = 23.5 NM

Start the descent 23.5 NM from LGA at 2800 fpm
## BASIC VFR WEATHER MINIMUMS (§91.155)

* Minimum visibility & distance from clouds mnemonics:
  - **3152** – 3SM, 1000’ above, 500’ below, 2000’ horizontal.
  - **1152** – 1SM, 1000’ above, 500’ below, 2000’ horizontal.
  - **5111** – 5SM, 1000’ above, 1000’ below, 1SM horizontal.

### Class A: IFR only
- **Class E above 10,000’ MSL & Class G above 10,000’ & 1,200’ AGL:** 5111 *

### Class E below 10,000’ MSL: 3152 *
- **Class G above 1,200’ AGL but below 10,000’ MSL:**
  - **Day:** 1152 *
  - **Night:** 3152 *

### Class G below 1,200’ AGL:
- **Day:** 1SM clear of clouds
- **Night:** 3152 * or 1SM Clear of Clouds if in a traffic pattern within ½ SM from a runway.

## WEATHER INFORMATION SOURCES

- Flight Service Station (FSS)
- NOAA’s Aviation Weather Center Website [https://www.aviationweather.gov/](https://www.aviationweather.gov/)
- Flight planning websites such as [www.1800wxbrief.com](http://www.1800wxbrief.com) and [www.fltplan.com](http://www.fltplan.com)
- EFB software (i.e., ForeFlight, Jeppesen FlightDeck Pro)
- Transcribed Weather Broadcast (TWEB) – Available in Alaska only. A recorded broadcast over selected L/MF and VOR facilities of weather information for the local area.
- Flight Information Services-Broadcast (FIS-B) – A ground information data link service, provided through the ADS-B service network over 978 UAT MHz. Provides aviation weather and aeronautical information on cockpit displays. Some information available on FIS-B:
  - METAR, TAF, NEXRAD, AIRMET, SIGMETs and convective SIGMETs
  - TFR, Special Use Airspace updates and NOTAMs (FDC and distant)
  - PIREPs
- Automatic Terminal Information Service (ATIS) – A continuous broadcast of local airport weather and NOTAMs. Updated hourly, normally at 55 minutes passed the hour. Special updates issued outside the regular hourly cycle when needed. ATIS is published over the radio and, in locations with D-ATIS, via data link (ACARS).
- Automated Surface Observation System (ASOS) – Typically update hourly
- Automated Weather Observation System (AWOS) – Update every minute
- ATC - Center weather advisories are issued by ARTCC to alert pilots of existing or anticipated adverse weather conditions. ARTCC will also broadcast severe forecast alerts (AWW), convective SIGMETs and SIGMETs on all of its frequencies except for the emergency frequency (121.5 MHz).
- Onboard weather radar
- Onboard lightning detector
- XM Satellite weather service
- ACARS

## WEATHER PRODUCTS

- **AIRMET (WA)** –
  - An advisory of significant weather phenomena at lower intensities than those which require the issuance of SIGMETs. These conditions may affect all aircraft but are potentially hazardous to aircraft with limited capability.
  - **Valid for 6 hours.**
  - **AIRMET (T)** - describes moderate turbulence, sustained surface winds of 30 knots or greater, and/or non-convective low-level wind shear.
  - **AIRMET (I)** - describes moderate icing and provides freezing level heights.
  - **AIRMET (S)** - describes IFR conditions and/or extensive mountain obscurations.
  - **Graphical AIRMETs** (AIRMET G) – found at [www.aviationweather.gov](http://www.aviationweather.gov)
International SIGMET

- Convective SIGMET (WST)
  - An inflight advisory of convective weather significant to the safety of all aircraft.
  - Issued hourly at 55 minutes past the hour for the western (W), eastern (E) and central (C) USA.
  - Not issued for Alaska or Hawaii.
  - Valid for 2 hours.
  - Contains either an observation and a forecast or only a forecast.
  - Issued for any of the following:
    - Severe thunderstorms due to:
      - Surface winds greater or equal to 50 knots
      - Hail at the surface greater than 3/4 inch in diameter
    - Tornadoes
    - Embedded thunderstorms of any intensity level
    - A line of thunderstorms at least 60 miles long with thunderstorms affecting at least 40% of its length
    - Thunderstorms producing heavy or greater precipitation (VIP level 4) affecting at least 40% of an area of at least 3000 square miles
  - Any Convective SIGMET implies severe or greater turbulence, severe icing, and low level wind shear.
- International SIGMET
  - Issued outside the Contiguous USA and follow ICAO coding standards.
  - In the US, international SIGMETs are issued for areas that include Alaska, Hawaii, portions of the Atlantic and Pacific Oceans, and the Gulf of Mexico.

### Weather Products - Continued

- Criteria for international SIGMETs:
  - Thunderstorms occurring in lines, embedded in clouds, or in large areas producing tornadoes or large hail.
  - Tropical cyclones
  - Severe icing
  - Severe or extreme turbulence
  - Dust storms and sandstorms lowering surface visibility to less than 3 miles
  - Volcanic ash

- PIREP (UA) & Urgent PIREP (UUA)
  - Pilot weather reports.

- METAR
  - Aviation routine weather show surface weather observations in a standard international format.
  - Scheduled METARs are published every hour. Non-scheduled METARS (SPECIAL) are issued when there is a significant change in one or more reported element since the last scheduled METAR.

- TAF
  - Terminal Aerodrome Forecast. Weather forecast for 5SM radius area around the station.
  - Issued 4 times a day, every six hours and normally covers a 24 or 30 hour forecast period. TAF amendments (TAF AMD) supersede previous TAFs.

- Surface analysis chart
  - Generated from surface station reports. Shows pressure systems, isobars, fronts, air mass boundaries (e.g., dry lines and outflow boundaries) and station information (e.g., wind, temperature, dew point, sky coverage, and precipitation). Issued every 3 hours. (or every 6 hours in Hawaii and tropical and Oceanic regions).
  - A Unified Surface Analysis Chart is produced every 6 hours and combines the analysis from the 4 centers (OPC, WPC, NHC and HFO).

- Radar summary chart (SD)
  - Depicts precipitation type, intensity, coverage, movement, echoes, and maximum tops. Issued hourly.

- Wind & temp aloft forecasts (FB)
  - Issued 4 times daily for various altitudes and flight levels.
  - Winds at altitude up to 1500' AGL and temperatures at up to 2500' AGL are not shown.
  - Format: DDfftt, where DD = wind direction; ff = wind speed; tt = temperature. Light and variable winds: 9900. Winds between 100-199 Kt are coded by adding 5 to the first digit of the wind direction.
  - Above FL240 temperatures are negative and the minus sign (-) is omitted.
  - Examples:
    - 1312+05: winds 130 / 12 kt, 5°C
    - 7525-02: winds 250 / 125 kt, -2°C

- Low level significant weather chart
  - Forecasts significant weather conditions for a 12 and 24 hour period from the surface to 400 mb level (24,000 ft). Issued 4 times a day. Depicts weather categories (IFR, MVFR and VFR), turbulence and freezing levels.

- Mid-level significant weather chart
  - Forecasts of significant weather at various altitudes and flight levels from 10,000' MSL to FL450. Shows: thunderstorms, jet streams, tropopause height, tropical cyclones, moderate and severe icing conditions, moderate or severe turbulence, cloud coverage and type, volcanic ash and areas of released radioactive materials. Issued 4 times a day for the North Atlantic Region.

- Convective outlook (AC)
  - Available in both graphical and textual format. A 3-day forecast of convective activity. Convective areas are classified as marginal (MRGL), slight (SLGT), enhanced (ENH), moderate (MDT), and high (HIGH) risk for severe weather. Issuance: day 1 – 5 times a day, day 2 – twice a day, day 3 – once a day. Available on www.spc.noaa.gov.

- Weather satellite images
  - Visible
    - Helps in identifying cloud coverage based on visible light reflection.
    - Not useful for identifying cloud height.
  - Infrared (Color or B/W)
    - Measure cloud top temperature.
    - Highest clouds appear bright white.
    - Middle clouds are in shades of gray.
    - Low clouds and fog are dark gray.
  - Water vapor
    - Shows areas of moist and dry air in shades of gray from white to black.
    - Moist air areas are depicted as bright white.
    - Dry air is depicted in black.
WEATHER PRODUCTS - CONTINUED

- **Next Generation Weather Radar (NEXRAD)** products. Examples:
  - **Base reflectivity** - echo intensities in dBZ. Available for several elevation tilt angles.
  - **Echo tops** - color coded echo top heights.
  - **Composite reflectivity** - Reveals highest reflectivity of all echos, helps in examining storm structure features and the intensity of storms.
  - **1 and 3-hour precipitation**

- **Ceiling & Visibility Charts** - Shows ceiling based on surface observations. This online tool phased out the older weather depiction chart and is now replaced with the HEMS tool at [www.aviationweather.gov/hemst](http://www.aviationweather.gov/hemst)

- **Graphical turbulence Guidance (GTG)** tool at [www.aviationweather.gov/turbulence/gtg](http://www.aviationweather.gov/turbulence/gtg) – Shows color coded turbulence forecast based on aircraft category, altitude and time.

---

THUNDERSTORMS

The Three Conditions Required for the formation of Thunderstorms:

1. Sufficient water vapor (moisture).
2. An unstable temperature lapse rate. Stability is the resistance of the atmosphere to upwards or downwards displacement. An unstable lapse rate allows any air mass displacement to further grow vertically.
3. An initial uplifting force (e.g., front passages, orographic lifting by topography, heating from below, etc.).

Three Stages in Thunderstorm Lifecycle:

1. **Cumulus** (3-5 mile height) – The lifting action of the air begins, growth rate may exceed 3000 fpm.
2. **Mature** (5-10 miles height) – Begins when precipitation starts falling from the cloud base. Updraft at this stage may exceed 6000 fpm. Downdrafts may exceed 2500 fpm. All **thunderstorm hazards are at their greatest intensity at the mature stage**.
3. **Dissipating** (5-7 miles height) – Characterized by strong downdrafts and the cell dying rapidly.

Thunderstorm Hazards:

- Limited visibility
- Strong updrafts / downdrafts
- Hailstones
- Severe turbulence
- Wind shear
- Icing
- Heavy rain
- Lightning strikes and tornadoes.

---

FOG

A cloud that begins within 50 ft of the surface.

Fog occurs when:

- The air **temperature near the ground reaches its dew point**, or
- when the **dew point is raised to the existing temperature** by added moisture to the air.

Types of fog:

- Radiation fog – Occurs at calm, clear nights when the ground cools rapidly due to the release of ground radiation.
- Advection fog – Warm, moist air moves over a cold surface. Winds are required for advection fog to form.
- Ice fog – Forms when the temperature is much below freezing and water vapor turns directly into ice crystals. Ice fog is common in the arctic regions, but also occurs in mid-latitudes.
- Upslope fog – Moist, stable air is forced up a terrain slope and cooled down to its dew point by adiabatic cooling.
- Steam fog – Cold, dry air moves over warm water. Moisture is added to the airmass and steam fog forms.

---

ICING

- **Structural Ice**. Two conditions for formation: 1. **Visible moisture** (i.e., rain, cloud droplets), and 2. **Aircraft surface temperature below freezing**.
  - **Clear ice** – The most dangerous type. Heavy, hard and difficult to remove. Forms when water drops freeze slowly as a smooth sheet of solid ice. Usually occurs at temperatures close to the freezing point (-10° to 0° C) by large supercooled drops of water.
  - **Rime ice** – Opaque, white, rough ice formed by small supercooled water drops freezing quickly. Occurs at lower temperatures than clear ice.
  - **Mixed ice** – Clear and rime ice formed simultaneously.
  - **Instrument ice** – Structural ice forming over aircraft instruments and sensors, such as pitot and static.
  - **Induction ice** – ice reducing the amount of air for the engine intake.
  - **Intake ice** – Blocks the engine intake.
  - **Carburetor ice** – May form due to the steep temperature drop in the carburetor Venturi. Typical conditions are outside air temperatures of -7° to 21° C and a high relative humidity (above 80%).
  - **Frost** – Ice crystals caused by sublimation when both the temperature and the dew point are below freezing.
AEROMEDICAL (Pilot Handbook of Aeronautical Knowledge)

- **Hypoxia** - Insufficient supply of oxygen to the body cells.
  - **Hypoxic hypoxia** – Insufficient supply of O2 to the body as a whole. As altitude increases, O2 percentage of the atmosphere is constant, but its pressure decreases. The reduced pressure becomes insufficient for the O2 molecules to pass through the respiratory system's membranes.
  - **Hypemic hypoxia** – Inability of the blood to carry the O2 molecules. It may be a result of insufficient blood (bleeding or blood donation), anemia or CO poisoning.
  - **Histotoxic hypoxia** – Inability of the body cells to affectively use the O2 supplied by the blood. This can be caused by use of alcohol or drugs.
  - **Stagnant hypoxia** - Caused by the blood not flowing efficiently. Can be caused by heart problems, excessive acceleration (Gs), shock or a constricted blood vessel. Cold temperatures can restrict circulation and decrease blood supplied to the extremities.

- **Hyperventilation** - A condition which occurs when excessive amount of is eliminated from the body as a result breathing too rapidly. Symptoms may be similar to those of hypoxia. Breathing into a paper bag or talking aloud helps recovery from hyperventilation.

- **Decompression sickness** – Inert gasses (mainly nitrogen) are released rapidly from solution in the body tissues and fluids as a result of low barometric pressure. The gasses form bubbles that may harm the body in several ways. The most common result of decompression sickness is joint pain ("the bends"). To help prevent the bends after SCUBA diving: wait at least 12 hours after diving that does not require a controlled ascent (non-decompression stop diving) for flights up to 8000 ft MSL. wait 24 hours for flights above 8000 ft or after any diving that required a controlled ascent (decompression stop diving).

**Oxygen requirements** (§91.211, Note: see §121.327-121.333 & §135.89, §135.157 for O2 rules applying to parts 121/135)

- **Unpressurized cabins**
  - Cabin pressure altitudes 12,500 - 14,000 ft MSL (including) – The required minimum flight crew must be provided with and must use supplemental O2 for periods of flight over 30 minutes at these altitudes.
  - Cabin pressure altitudes above 14,000ft MSL – The required minimum flight crew must be provided with and must use supplemental O2 the entire flight time at these altitudes.
  - Cabin pressure altitudes above 15,000ft MSL – Each occupant must be provided with supplemental O2.

- **Pressurized cabins**
  - Above FL250 - an addition of at least 10 minutes of supplemental O2 for each occupant is required.
  - Above FL350 - one pilot at the controls must wear and use an O2 mask unless two pilots are at the control with quick-donning masks and the aircraft is at or below FL410.
  - If one pilot leaves the controls above FL350, the other pilot must wear and use his O2 mask regardless if it’s a quick donning type.

- **Middle Ear & Sinus blockage**
  - Air pressure in the middle ear and sinuses normally equalizes with external air through the nasal passages.
  - Allergies, colds or sinus infections may block these small opening and prevent the pressure from equalizing.
  - If the air gets trapped, it may cause extreme pain, reduction in hearing or damage to the ear drums. This effect is usually most severe during descend.
  - To relieve this condition, try the "Valsalva Maneuver": pinch your nostrils and gently try to blow air out of your nose. This forces air through the Eustachian tube into the middle ear. It may not work if the pilot has a cold, sinus or ear infection, or a sore throat.
  - Consider seeing a physician if the condition doesn’t clear after the flight.

- **Spatial disorientation and illusions**
  - 3 systems the body uses for spatial orientation
    - **Vestibular System** - Consists of organs in the inner ear
      - 3 semicircular canals sense movement in 3 axes: pitch, roll and yaw. The canals are filled with fluid, which moves against tiny sensory hairs as the head is moved. The brain gets these signals and interprets a sensation of movement.
    - **Otolith system**, the utricle and saccule, sense acceleration in the horizontal and vertical planes.
    - **Somatosensory System** - Consists of nerves in the skin, muscles and joints.
    - **Visual System** - Visual cues from our eyes help the brain figure out spatial orientation.

  - **Vestibular Illusions**
    - **The leans** - After leveling the wings following a prolonged turn, pilot may feel that the aircraft is banked in the opposite direction of the turn.
    - **Coriolis Illusion** - After a prolonged turn, the fluid in the ear canal moves at same speed as the canal. A head movement on a different plane will cause the fluid to start moving and result in a false sensation of acceleration or turning on a different axis.
    - **Graveyard Spiral** - A pilot in a prolonged, coordinated constant-rate turn may experience the illusion of not turning. After leveling the wings, the pilot may feel the sensation of turning to the other direction ("the leans"), causing the pilot to turn back in the original direction. Since a higher angle of attack is required during a turn to remain level, the pilot may notice a loss of altitude and apply back force on the elevator. This may tighten the spiral and increase the loss of altitude.
    - **Somatogravic Illusion** - Rapid acceleration stimulates the inner ear otolith organs in the same way as tilting the head backwards. This may create the illusion of a higher pitch angle. Deceleration causes the opposite illusion of the sensation of tilting the head forward and o the aircraft being in a nose-low attitude.
    - **Inversion Illusion** - An abrupt change from climb to straight and level may create the illusion of tumbling backwards due to the fluid movement in the otolith organs.
SPATIAL DISORIENTATION AND ILLUSIONS - CONTINUED

- **Elevator Illusion** - An abrupt upward vertical acceleration may create the illusion a climb, due to fluid movement in the otolith organs.

- **Visual Illusions**
  - **False Horizon** - An illusion in which the pilot may misidentify the horizon line. May be caused by sloping cloud formation, an obscured horizon, an aurora borealis, dark night with scattered lights and stars or the geometry of the ground.
  - **Autokinesis** - Staring at a stationary point of light in a dark or featureless scene for a prolonged period of time may cause the light to appear to be moving. A pilot may attempt to align the aircraft with the perceived moving light, resulting in loss of control.

- **Optical Illusions**
  - **Runway Width Illusion** - A narrow runway may create the illusion that the aircraft is higher than it actually is. A wide runway may cause the opposite effect of the aircraft flying too low.
  - **Runway and Terrain Slope Illusion** - An upsloping terrain or runway may create the illusion that the aircraft is at a higher altitude than it actually is.
  - **Featureless Terrain Illusion** - Also known as “black hole approach.” Flying over featureless or dark areas, such as in an overwater approach, can create the illusion that the aircraft is at a higher altitude than it actually is and may lead the pilot to fly at a lower altitude than desired.
  - **Water Refraction** - Rain on the windscreeng can create an illusion of being at a higher altitude due to the horizon appearing lower than it is. This can result in the pilot flying a lower approach.
  - **Haze** - Shooting an approach in haze may create the illusion that the runway is further than it actually is, or that the aircraft is higher than it actually is.
  - **Fog** - Flying into fog may create an illusion of a nose-up motion.
  - **Ground Lighting Illusion** - Lights along a straight path, such as a road or lights on moving trains, can be mistaken for runway and approach lights. Bright runway and approach lighting systems, especially where few lights illuminate the surrounding terrain, may create the illusion that the runway is closer than it actually is. This may result in the pilot flying a higher approach than desired.

Coping with spatial disorientation (Pilot Handbook of Aeronautical Knowledge)
1. Understand the causes of the illusions that may affect you as a pilot and stay alert for them when flying.
2. Obtain and understand relevant preflight weather information.
3. Maintain instrument proficiency and obtain training if needed before flying in marginal or instrument conditions.
4. Do not fly into adverse weather conditions or into adverse weather conditions, dark or featureless areas unless instrument proficient.
5. When using outside visual references, ensure they are reliable, fixed points on the earth’s surface.
6. Avoid sudden head movements, particularly during takeoff, turns, and approaches to landing.
7. Be physically tuned for flight into reduced visibility. Ensure proper rest, adequate diet, and, if flying at night, allow for night adaptation. Remember that illness, medication, alcohol, fatigue, sleep loss, and mild hypoxia are likely to increase susceptibility to spatial disorientation.
8. Most importantly, become proficient in the use of flight instruments and rely upon them. Trust the instruments and disregard your sensory perceptions.

### TABLES & REFERENCES

#### RNP Approach Minima – supported equipment

<table>
<thead>
<tr>
<th>Minima</th>
<th>GLS (DA)</th>
<th>LPV (DA)</th>
<th>LP (MDA)</th>
<th>LNAV / VNAV (DA)</th>
<th>LNAV (MDA)</th>
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<tr>
<td>Approach Type</td>
<td>Precision</td>
<td>APV</td>
<td>Non-precision</td>
<td>APV</td>
<td>Non-precision</td>
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<tr>
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<td>✓</td>
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</tbody>
</table>
### TABLES & REFERENCES - CONTINUED

#### VOR Time & Distance

| Distance off course = 200 ft per dot per NM from VOR |
| Distance to station = TAS x min between bearings / degrees of BRG change. |
| Time (minutes) to station = Seconds for BRG change / degrees of BRG change. |

#### Standard Rate Turn - Angle of Bank Calculation

**Example:** 120 KTAS

\[
\text{Angle of Bank} = \left( \frac{120 \text{ KTAS}}{10} \right) + 5 = 12 + 5 = 17^\circ \text{ of bank}
\]

#### Aircraft Approach Categories

<table>
<thead>
<tr>
<th>CAT</th>
<th>1.3Vso (kts)</th>
<th>Standard (old) circling maneuver radius (NM)</th>
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</thead>
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<tr>
<td>A</td>
<td>&lt; 90</td>
<td>1.3</td>
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<tr>
<td>B</td>
<td>91-120</td>
<td>1.5</td>
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<tr>
<td>C</td>
<td>121-140</td>
<td>1.7</td>
</tr>
<tr>
<td>D</td>
<td>141-165</td>
<td>2.3</td>
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<tr>
<td>E</td>
<td>&gt; 165</td>
<td>4.5</td>
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</table>

#### Expanded Circling Approach Maneuvering Radius

Identified by `"` on FAA approach charts. For procedures developed after late 2012. (AIM 5-4-20)

<table>
<thead>
<tr>
<th>Circling MOA (MSL)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<tr>
<td>1000 or less</td>
<td>1.3</td>
<td>1.7</td>
<td>2.7</td>
<td>3.6</td>
<td>4.5</td>
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<td>1001-3000</td>
<td>1.3</td>
<td>1.8</td>
<td>2.8</td>
<td>3.7</td>
<td>4.6</td>
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<td>1.3</td>
<td>1.8</td>
<td>2.9</td>
<td>3.8</td>
<td>4.8</td>
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<tr>
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<td>1.9</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
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<td>7001-9000</td>
<td>1.4</td>
<td>2.0</td>
<td>3.2</td>
<td>4.2</td>
<td>5.3</td>
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<td>9001 and above</td>
<td>1.4</td>
<td>2.1</td>
<td>3.3</td>
<td>4.4</td>
<td>5.5</td>
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#### Flight Categories Used in AWC Weather Products

<table>
<thead>
<tr>
<th>Category</th>
<th>Color</th>
<th>Ceiling</th>
<th>Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIFR (Low IFR)</td>
<td>Magenta</td>
<td>Less than 500'</td>
<td>and/or Less than 1 SM</td>
</tr>
<tr>
<td>IFR (Instrument Flight Rules)</td>
<td>Red</td>
<td>500' to below 1,000' AGL</td>
<td>and/or 1 SM to less than 3 SM</td>
</tr>
<tr>
<td>MVFR (Marginal VFR)</td>
<td>Blue</td>
<td>1,000' - 3,000' AGL</td>
<td>and/or 3 to 5 SM</td>
</tr>
<tr>
<td>VFR (Visual Flight Rules)</td>
<td>Green</td>
<td>Greater than 3,000' AGL</td>
<td>and Greater than 5 SM</td>
</tr>
</tbody>
</table>

**NOTES:**

By definition, IFR is ceiling less than 1,000' AGL and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

By definition, VFR is ceiling greater than or equal to 3,000' AGL and visibility greater than or equal to 5 SM while MVFR is a subcategory of VFR.

Sources: [https://aviationweather.gov/taf/help?page=plot](https://aviationweather.gov/taf/help?page=plot) and AIM 7-1-7
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>AATD</td>
<td>Advanced Aviation Training Device</td>
</tr>
<tr>
<td>AAWU</td>
<td>Alaskan Aviation Weather Unit</td>
</tr>
<tr>
<td>AC</td>
<td>Advisory Circular</td>
</tr>
<tr>
<td>ACS</td>
<td>Airman Certification Standards</td>
</tr>
<tr>
<td>ADC</td>
<td>Air Data Computer</td>
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<tr>
<td>ADM</td>
<td>Aeronautical Decision Making</td>
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<tr>
<td>ADS-B</td>
<td>Automatic Dependent Surveillance-Broadcast</td>
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<td>AFM</td>
<td>Airplane Flight Manual</td>
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<tr>
<td>AGL</td>
<td>Above Ground Level</td>
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<tr>
<td>AHRS</td>
<td>Attitude Heading Reference System</td>
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<tr>
<td>AI</td>
<td>Attitude Indicator</td>
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<tr>
<td>AIM</td>
<td>Aeronautical Information Manual</td>
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<tr>
<td>ALS</td>
<td>Approach Light System</td>
</tr>
<tr>
<td>ALSF</td>
<td>Approach Light System with Sequence Flashing Lights (e.g., ALSF-1, ALSF-2)</td>
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<tr>
<td>APV</td>
<td>Approach with Vertical guidance</td>
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<td>ARTCC</td>
<td>Air Route Traffic Control Center (&quot;Center&quot;)</td>
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<tr>
<td>ASI</td>
<td>Airspeed Indicator</td>
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<td>ASOS</td>
<td>Automated Surface Observation System</td>
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<td>Air Traffic Control</td>
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<td>Aviation Training Device</td>
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<td>AWOS</td>
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<td>DME</td>
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<td>DP</td>
<td>Departure Procedure</td>
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<td>EDCT</td>
<td>Expect Departure Clearance Time</td>
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<td>EFB</td>
<td>Electronic Flight Bag</td>
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<td>ELT</td>
<td>Emergency Locator Transmitter</td>
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<td>ETA</td>
<td>Estimated Time of Arrival</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>FCC</td>
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<td>FFS</td>
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<td>Feet per Minute</td>
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<td>FPNM</td>
<td>Feet per Nautical Mile</td>
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<td>FTD</td>
<td>Flight Training Device</td>
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<td>GBAS</td>
<td>Ground Based Augmentation System (i.e., LAAS)</td>
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<td>Glide Path</td>
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<td>HFO</td>
<td>Weather Forecast Office Honolulu</td>
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<td>HI</td>
<td>Heading Indicator</td>
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<td>IAF</td>
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<td>Instrument Meteorological Conditions</td>
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<td>KTAS</td>
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<td>Lateral Navigation</td>
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<td>LOC</td>
<td>Localizer</td>
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<td>LP</td>
<td>Localizer Performance RNAV / RNP approach</td>
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<td>MAA</td>
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<td>MALSR</td>
<td>Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights</td>
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<td>MEL</td>
<td>Minimum Equipment List</td>
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<td>MOCA</td>
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<td>MORA</td>
<td>Minimum Off Route Altitude (Jeppesen)</td>
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<td>National Meteorological Center</td>
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<td>ODALS</td>
<td>Omni-Directional Approach Lighting System</td>
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<tr>
<td>Term</td>
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<td>Receiver Autonomous Integrity Monitoring</td>
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<td>RVR</td>
<td>Runway Visual Range</td>
</tr>
<tr>
<td>SBAS</td>
<td>Satellite-based Augmentation System (e.g., WAAS, EGNOS)</td>
</tr>
<tr>
<td>SDF</td>
<td>Simplified Directional Facility</td>
</tr>
<tr>
<td>SID</td>
<td>Standard Instrument Departure</td>
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<tr>
<td>STAR</td>
<td>Standard Terminal Arrival</td>
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<tr>
<td>SVFR</td>
<td>Special VFR</td>
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<tr>
<td>TCH</td>
<td>Threshold Crossing Height</td>
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<td>TILS</td>
<td>Transponder Landing System</td>
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<tr>
<td>TOD</td>
<td>Top of Descent</td>
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<tr>
<td>TWEB</td>
<td>Transcribed Weather Broadcast</td>
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<tr>
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<td>Universal Access Transceiver</td>
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<td>VASI</td>
<td>Visual Approach Slope Indicator</td>
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<tr>
<td>VFR</td>
<td>Visual Flight Rules</td>
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<td>Visual Meteorological Conditions</td>
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<tr>
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<td>VHF Omnidirectional Range</td>
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<td>VHF Omnidirectional Range Tactical Air Navigation (VOR+TACAN)</td>
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<td>Vertical Speed</td>
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<tr>
<td>VSI</td>
<td>Vertical Speed Indicator</td>
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<td>Wide Area Augmentation System</td>
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<td>Weather Prediction Center</td>
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